


SAFER, SMARTER, GREENER

Impact Evaluation Report

Home Upgrade Program – Residential Program Year 2017

CALIFORNIA PUBLIC UTILITIES COMMISSION

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1 EXECUTIVE SUMMARY

1.1 Background and objectives

The California IOUs' programs to promote whole house energy efficiency upgrades and home performance services are now in their eighth year of activity. The programs, referred to as Home Upgrade Program (HUP) and Advanced Home Upgrade Program (AHUP), entail an approach to planning and executing whole-house retrofits and energy efficiency improvements to maximize energy savings. The approach involves following a "loading order" whereby thermal loads are decreased through air sealing, duct sealing, insulation, and other shell measures, followed by changes to energy supply systems such as space heating, water heating, and cooling to most efficiently meet the reduced load. Home performance services describe a suite of services designed to identify cost-effective activities, inform customer decisions regarding the selection and sequencing of implementation, and assure the quality and effectiveness of the technology installed.

The research objectives for the 2017 HUP and the AHUP evaluations include the following:

1. Estimate the 2017 kW, kWh, and therm savings per household for HUP and AHUP and calculate the ratio of ex post (evaluated) to ex ante (claimed) project savings, referred to as a "realization rate."
2. Review the performance of the programs over time in terms of savings relative to baseline use and ex ante (claimed) savings.
3. Estimate the level of savings attributable to the program by estimating how many program participants would have performed the energy efficiency activity even without a rebate, also known as "free-riders".
4. Explore program participant perspectives by researching any correlations between program activity, energy savings, demographics, and energy consumption related behaviors.
5. Provide program recommendations, if any, to improve per-home energy savings estimates.

1.2 Study approach

HUP and AHUP program effects were estimated based on program participation from July 2016 until June 2017. Post-participation data for participants from the second half of 2017 were not available at the time of the evaluation requiring the use of data from the second of 2016 participants for robust saving estimates. The evaluation relied on a comparison group which included households with similar energy use to HUP and AHUP participants prior to program intervention. The comparison group controls for non-program and non-weather related changes.

The evaluation also relied on the calculation of weather normalized energy consumption to identify the effect of HUP and AHUP without the effect of weather. Weather normalization was facilitated with advanced metering infrastructure (AMI) data, which enabled a more precise identification of the effect of weather on energy use.

The difference between weather normalized annual consumption before and after HUP or AHUP intervention was modeled to identify the effect of the program on energy use. Program effects on peak demand were estimated using hourly energy and weather data.

Lastly, a web survey was conducted with HUP and AHUP program participants to derive an estimate of how many program participants would have installed the energy efficient equipment offered by the program even without any rebate from the program.

1.3 Key findings and recommendations

Table 1-1 summarizes the findings and recommendations from this evaluation. These findings are discussed in greater detail in the full report.

Table 1-1. Key findings and Recommendations

Key findings	Recommendations & Implications
1. Ex post (evaluated) savings in program year 2017 are 13-63% of ex ante (claimed) savings for HUP statewide and 16%-39% of ex ante savings for AHUP statewide.	Overall, forecast savings continue to overstate the savings potential from the program. There has been some movement to address that ongoing overstatement, especially for HUP, but more needs to be done.
2. This large delta between ex post (evaluated) savings and ex ante (claimed) savings is a trend that has continued since the last evaluation.	There is limited evidence that the simulation tools used to estimate forecasted energy savings per household from the program's custom projects have closed the gap seen between ex ante and ex post (realized) savings noted in the past evaluation cycle.
3. Offering rebates to customers who were already planning to perform an energy efficient upgrade, also known as "free-ridership", continues to be significant.	" Free-ridership" can be lowered by targeting customers who fit the following descriptors: live inland, implement larger upgrades of seven measures or more, and are candidates for the advanced path program.
4. Percent savings of baseline energy use for electricity are consistently lower than for gas and have remained largely unchanged over time.	Customer responses and program staff interviews indicate that use of air-conditioning increases after installation of new/upgraded equipment, sometimes referred to as "takeback". Combined with the finding of comfort being a desired customer benefit, this outcome points to takeback being a factor in reducing the achieved electric savings.
5. Net metered customers are an increasing customer segment in the HUP and AHUP programs.	The trend of increasing solar photovoltaic (PV) adoption has implications for future evaluations of HUP and AHUP and pay for performance programs (programs with incentives based on normalized metered energy consumption). Billing data does not currently provide a measure of consumption that includes the share from self-generation.
6. Improved comfort in the home is a key part of program messaging and a desired program benefit for customers.	Increased energy consumption from increased or new heating or cooling load could be a contributor to takeback and result in lower than expected program savings.

1.3.1 HUP and AHUP realization rate trends

Realization rates, or the ratio of ex ante (claimed) savings to ex post (evaluated) savings, allow us to gauge performance relative to what program administrators expect programs to achieve. Realization rates closer to 1.0 or 100% indicate better performance, but we should note that these values include savings from participants that would have undertaken energy efficient upgrades without any rebate. In other words, the reported realization rates include "free-ridership".

Figure 1-1 provides 2015 and 2017 gross electric realization rates for HUP and AHUP. For HUP, the general trend is a closer correspondence between program savings claimed by program administrators and evaluated savings over time. This is especially notable for two of the program administrators - PG&E and SoCalREN.

In 2017, realization rates for AHUP do not show the improvement seen for HUP. Thus, there is no evidence that the simulation tools used to estimate forecasted energy savings per household from the program's custom projects (AHUP) have closed the gap seen between forecasted (ex ante) and realized (ex post) savings in the past evaluation cycle. The tools used that are supposed to address the problem of inflated energy savings provided by EnergyPro[1] still appear to provide inflated forecasts.

Figure 1-1. Electric realization rates (kWh)

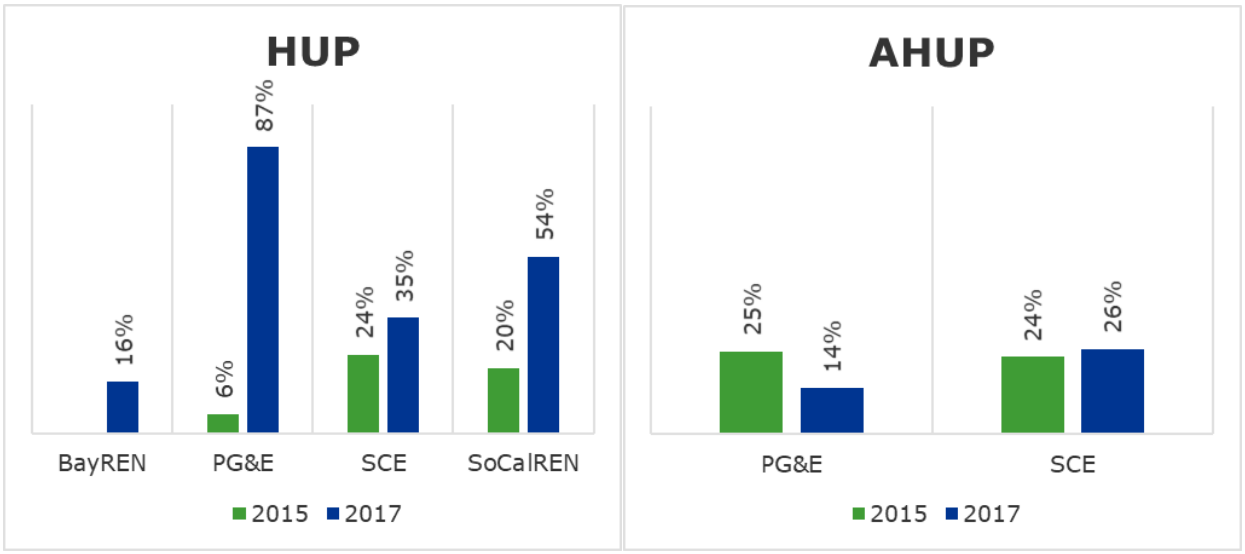
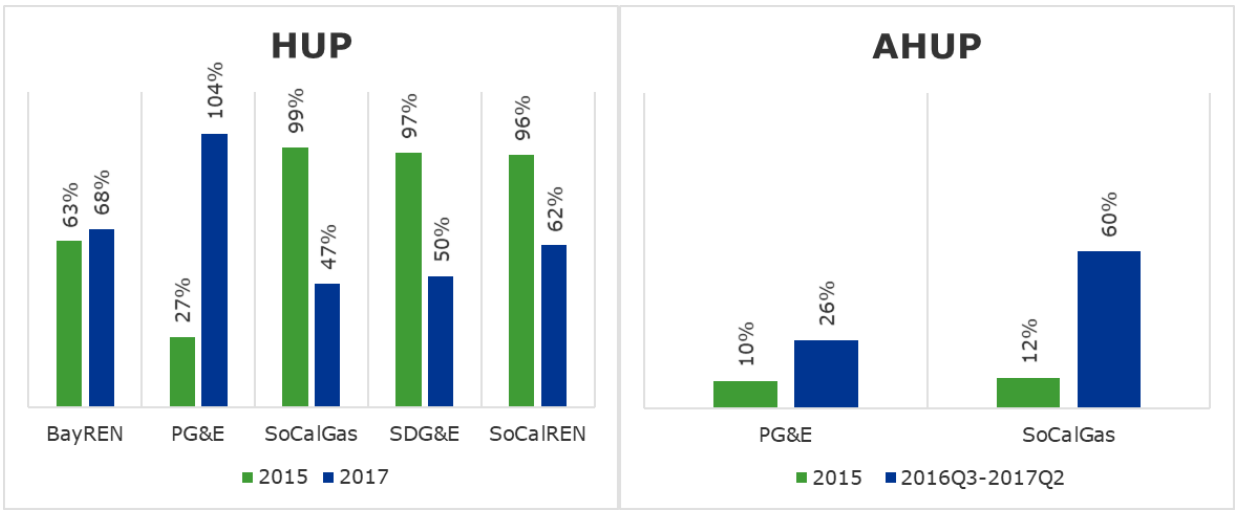


Figure 1-2 provides the analogous findings for gas. Gas realization rates were relatively higher for HUP than AHUP and ranged from 104% for PG&E to 47% for SoCalGas in 2017. While the simulation tools used to determine expected gas savings for custom projects from AHUP overestimate gas savings, they indicate a notable improvement for SoCalGas.

[1] Energy Pro is the modeling engine used in the energy efficiency industry for building simulations.

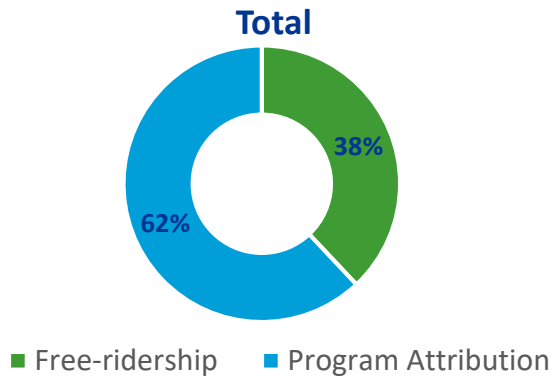
Figure 1-2. Gas realization rates (therms)



1.4 HUP and AHUP free-ridership

Free-ridership measures the extent of program participation that would have occurred even in the absence of program incentives. HUP program incentives for single-family homes built before 2001 range from $1,000 - $3,000; AHUP offers incentives up to $6,500 for single-family homes of any year. Overall free-ridership for HUP and AHUP for program year 2017 is estimated at 38%. This means that 62% of all the savings from these two programs can be directly attributed to the program. Thus, the program rebates and design contributed to 62% of all program savings. (Figure 1-3).

Figure 1-3. Free-ridership



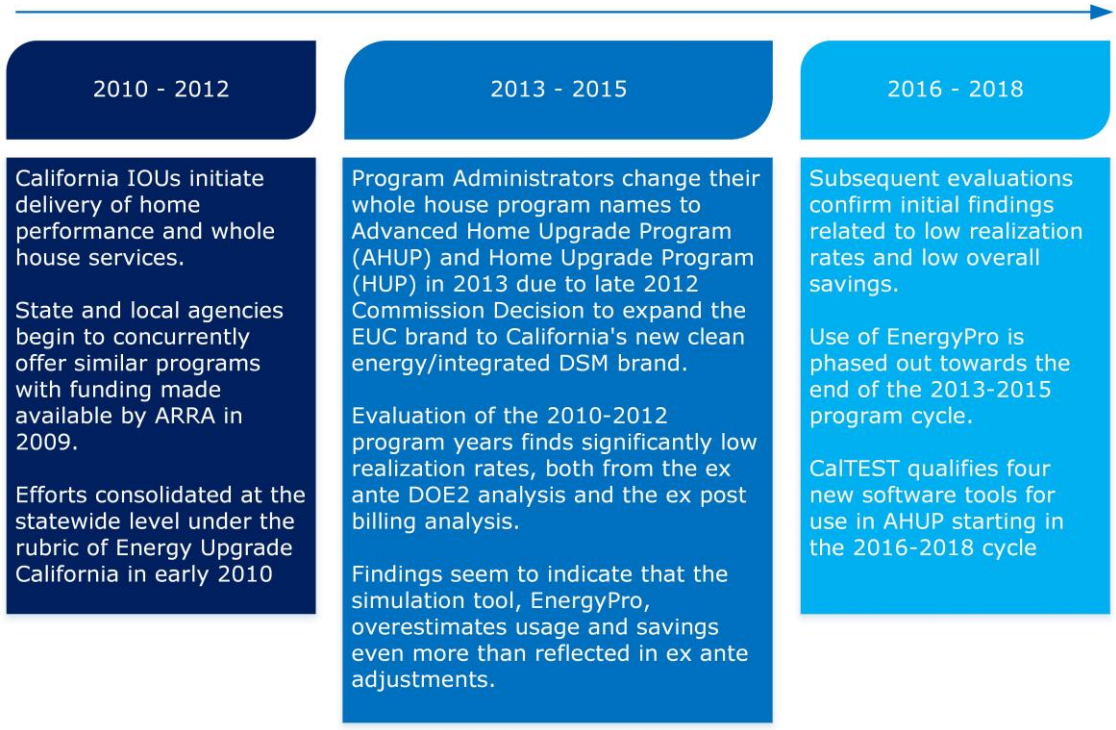
Free-ridership varies along key customer dimensions and this has implications for targeting future participants. Program attribution can be improved by targeting customers who fit the following descriptors: live inland, implement larger upgrades of seven measures or more, and/or are candidates for the advanced path of the program.

2 INTRODUCTION

2.1 Program description

The Home Upgrade Program was introduced statewide in 2010 to promote long-term energy savings in single-family dwellings using a whole-house approach. The program's strategy is to transform the residential efficiency market from discrete appliances and single-measure upgrades to whole-building retrofits that capitalize on the interactive effects of measures that produce deeper energy savings. A summary of the Home Upgrade Program's evolution is provided below (Figure 2-1).

Figure 2-1. Summarized program evolution



The program has two participation pathways: Home Upgrade (formerly Basic Package or Enhanced Basic/Modified Flex Path), which is more prescriptive, and Advanced Home Upgrade (formerly Advanced Package), which is more customized and requires a whole-house energy assessment. Owners of single-family detached homes, including manufactured homes, were the initial program target. At present, the Advanced Home Upgrade pathway is open to residents in 2-4-unit buildings.

Home Upgrade: The Home Upgrade Program (HUP) is an entry point for customers into whole-house efficiency upgrades. Customers must install at least three measures, including one base measure such as duct sealing, air sealing, or attic insulation. Incentives are based on the measures installed. They are capped at 50% of the total project cost or $1,300 to $3,000, depending on the program administrator (PA).

The (HUP) is offered statewide by the following 6 PAs:

- Bay Area Regional Energy Network (BayREN)
- Pacific Gas and Electric Company (PG&E)
- Southern California Edison (SCE)

- Southern California Gas Company (SoCalGas)
- San Diego Gas and Electric Company (SDG&E)
- Southern California Regional Energy Network (SoCalREN)

The investor owned utilities maintain their service territories, but the regional energy networks (BayREN and SoCalREN) operate within these territories. For example, BayREN is the exclusive implementer of HUP for PG&E customers in the nine Bay Area counties of San Francisco, Sonoma, Marin, Napa, Solano, Contra Costa, Alameda, Santa Clara, and San Mateo. 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.

Advanced Home Upgrade: The Advanced Home Upgrade Program (AHUP) helps customers to accomplish more complex efficiency upgrades than HUP and involves a comprehensive energy assessment. Incentives are based on the modeled percent energy savings rather than on the measures installed, up to $5,500, with higher incentives awarded through "bonus kickers" based on total modeled savings. The investor owned utilities offer the Advanced Home Upgrade Program (AHUP) to customers in their territories. BayREN and SoCalREN do not offer AHUP; however, BayREN offers a $300 audit incentive to households who participate in PG&E's AHUP.

Both HUP and AHUP decreased in size from 2016 to 2017 in terms of expenditures (Table 2-1) and ex ante (claimed) savings for all PAs, except for PG&E's ex ante (claimed) gross savings (Table 2-2). The ex ante (claimed) gross and net savings presented in Table 2-2 include only HUP for the RENs and reflect HUP, AHUP, and Multifamily, which is not included in this evaluation, for the IOUs.[2]

Table 2-1. Program expenditures, 2016-2017

Program Administrator	Program ID	Expenditures	
		2016	2017
BayREN	BAYREN01	$8,068,506	$5,822,883
PG&E	PGE21004	$24,860,499	$17,690,082
SCE	SCE-13-SW-001D	$11,531,291	$5,088,740
SoCalGas	SCG3705	$11,274,603	$6,291,327
SDG&E	SDGE3209	$4,198,179	$2,818,565
SoCalREN	SCR-EUC-A3	$2,689,841	$2,323,361

Source: California Data and Energy Reporting System, Confirmed Claims Dashboards for 2016 and 2017, https://cedars.sound-data.com/upload/dashboard/list/

[2] Multifamily is included in Table 2-1 and Table 2-2 because the program budgets and claimed savings do not split out multifamily. In 2016, multifamily accounted for less than 1% of participants, 25% of electric gross savings, 17% of demand gross savings, and 7% of gas gross savings. In 2017, multifamily again accounted for less than 1% of participants, 48% of electric gross savings, 29% of demand gross savings, and 17% of gas gross savings.

Table 2-2. Ex ante (claimed) savings, 2016-2017

Program Administrator	Gross Savings		Net Savings	
	2016	2017	2016	2017
Electric (kWh)				
BayREN	933,329	520,164	839,996	390,123
PG&E	7,287,406	9,154,968	6,363,803	6,537,192
SCE	3,207,896	1,301,988	2,310,828	816,487
SDG&E	1,272,332	1,052,907	1,097,800	938,431
SoCalREN	480,314	185,964	317,328	139,473
Gas (therms)				
BayREN	200,163	138,024	180,147	103,518
PG&E	649,516	506,064	532,235	350,908
SoCalGas	674,092	315,988	605,508	237,471
SDG&E	48,742	38,148	37,949	32,399
SoCalREN	44,052	28,917	39,647	21,688
Demand (kW)				
BayREN	1,320.3	792.4	1,188.3	594.3
PG&E	4,189.1	5,155.0	3,617.3	3,654.3
SCE	4,009.6	1,825.8	3,044.9	1,155.5
SDG&E	855.6	249.1	697.9	210.3
SoCalREN	803.6	358.7	723.3	269.0

Source: California Data and Energy Reporting System, Confirmed Claims Dashboards for 2016-2017, https://cedars.sound-data.com/upload/dashboard/list/

2.2 Evaluation objectives and key research questions

The research objectives and key research questions for the HUP and AHUP evaluation include the following:

1. Estimate the 2017 gross and net energy savings (kW, kWh, and therm) for HUP and AHUP per household and calculate the ratio of ex post (evaluated) savings to ex ante (claimed) savings.
2. Review the performance of these programs over time in terms of savings relative to baseline use and ex ante (claimed) savings.
3. Estimate the level of savings attributable to the program by estimating free-ridership for participating customers and contractors.
4. Explore participant perspectives relative to HUP and AHUP upgrades by researching any correlations between program activity, energy savings, project costs, incentive levels, demographics, homeowner preferences, and energy consumption related behaviors.
5. Provide recommendations, if any, to improve per-home energy savings estimates for gross savings for HUP and AHUP.

3 IMPACT METHODOLOGY

3.1 Data sources

DNV GL used data from various sources to evaluate HUP and AHUP for program year 2017, as summarized in Table 3-1. HUP and AHUP participation information was collected from the CPUC 2015-2017 program tracking databases using the program IDs provided by the PAs. Additionally, DNV GL used IOU billing and AMI data and weather data from NOAA[3] and CZ2010[4] for the evaluation.

Table 3-1. Data Available in the Home Upgrade Impact Evaluation

Data		PG&E	BayREN	SCE	SoCalGas	SoCalREN	SDG&E
Tracking Data (source: CPUC Tracking Data 2016-2017)	Program name	Energy Upgrade California (EUC) Home Upgrade	BayREN Single-Family Residential Subprogram	Energy Upgrade California Home Upgrade (EUC - HU)	Energy Upgrade California	Flex Path	Statewide CALSPREE - Energy Upgrade California Whole House Retrofit Program
Billing Data (Source: IOU)	Billing periods available	Monthly billing Jan. 2014 - Aug. 2018	Monthly billing Jan. 2014 - Aug. 2018	Monthly billing Jan. 2014 - Aug. 2018	Monthly billing Jan. 2014 - Aug. 2018	Monthly billing Jan. 2014 - Aug. 2018	Monthly billing Jan. 2014 - Aug. 2018
Interval Data (Source: IOU)	Interval periods available	Hourly electric and daily gas data, Jan. 2014 - Dec. 2018	Hourly electric and daily gas data, Jan. 2014 - Dec. 2018	Hourly electric data, Jan. 2014 - Dec. 2018	Limited	Hourly electric data, Jan. 2014 - Dec. 2018	Yes
Customer Data (Source: IOU)	Available	Yes	Yes	Yes	Yes	Yes	Yes
Weather Data (Source: NOAA and CZ2010)	Available (actual and TMY3 California weather data)	Yes	Yes	Yes	Yes	Yes	Yes

Table 3-2 provides tracking data summary for program year 2017. In 2017, approximately 9,000 customers participated in HUP and AHUP with total ex ante (claimed) gross savings of 6,099 MWh, 6 MW, and 80,995 dekatherms. These total ex ante (claimed) gross savings values are not adjusted by ex ante realization rates.

[3] National Oceanic and Atmospheric Administration Hourly Weather Data.

[4] California Energy Commission Title 24. https://www.energy.ca.gov/title24/.

Table 3-2. Tracking data summary, 2017

Program Administrator	Projects from Tracking Data	Reported Gross MWh Savings	Reported Gross MW Savings	Reported Gross Dekatherm Savings
PG&E	2,457	3,932	2.6	32,594
BayREN	1,368	520	0.8	13,802
SCE	1,400	1,303	1.8	NA
SoCalGas	3,371	NA	NA	30,350
SoCalREN	508	185	0.4	2,869
SDG&E	245	159	0.2	1,380
Overall	**9,349**	**6,099**	**5.8**	**80,995**

In general, PAs expected high gross realization rates from both HUP and AHUP projects, as the rates they used were 0.7 or better for all fuels (Table 3-3). Moreover, some PAs expected HUP projects to achieve all ex ante (claimed) savings.

Table 3-3. Program pathway participant numbers and realization rates (evaluated to claimed savings ratios), 2017

Program Administrator	HUP Projects from Tracking Data	AHUP Projects from Tracking Data	HUP Ex Ante Gross Realization Rates	AHUP Ex Ante Gross Realization Rates
PG&E	921	1,536	0.94	0.95
BayREN	1,368	NA	0.90	NA
SCE	640	760	1.00	0.93
SoCalGas	2,065	1,306	1.00	0.90
SoCalREN	508	0	0.98	NA
SDG&E	205	40	0.73	0.97
Overall	**5,707**	**3,642**	**0.95**	**0.93**

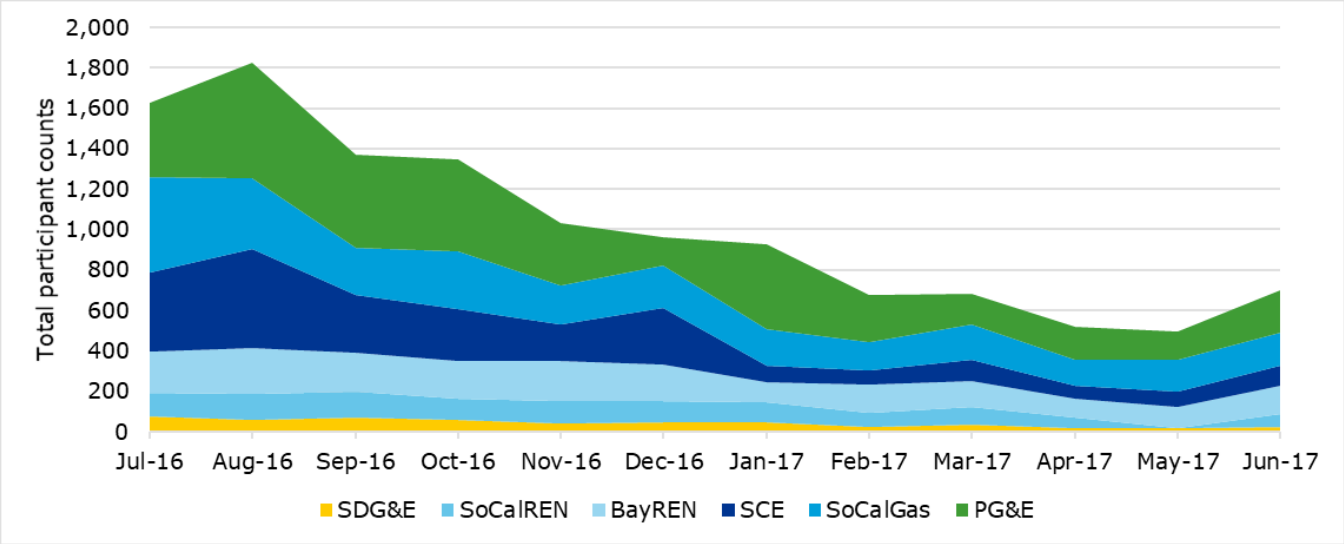
*All realization rates in the table are for electric except for SoCalGas, where they are gas, but values are very similar across both fuels.

3.2 Participation of timing

DNV GL included program participants with installation dates that occurred between July 2016 and June 2017 in the analysis. Activity and outcome for these participants were used as a proxy for 2017 program performance. There are several important reasons for this choice. First, the analysis method that we use requires a year of pre- and post-installation data to estimate program outcome. At the time of this study, only data up to the summer of 2018 was available and, thus, we could only include those who participated prior to the summer of 2017. Only such participants in 2017 had a year of post-installation data needed for the analysis. In addition, data from the first half of 2017 was not sufficient to obtain robust and statistically precise estimates requiring that we include participant data from the second half of 2016. The hybrid year is the best possible data that we could use to estimate program activity in 2017.

Figure 3-1 illustrates the timing of participation in these programs. The number of participants varies by month but is higher in the second half of 2016 than in the first half of 2017. Participants from this 12-month period have the required one year of both pre- and post-program installation period data for the analysis. Estimates that result from the modeling framework for these participants provide an average annual savings estimate for program year 2017.

Figure 3-1. Timing of participation in HUP and AHUP



3.3 Gross savings

HUP and AHUP are whole-house retrofit programs that involve a comprehensive set of energy efficiency measures. Thus, methods that are suitable for analyzing energy use changes of the entire home are required to identify the effect of these interventions. A two-stage modeling approach with a comparison group is a best practice method, which permits the estimation of whole house energy savings.

The first stage of this approach is a site-level modeling framework that controls for weather effects, which is a significant driver of energy consumption change. Details of this model are presented in section 3.3.1. In the second stage, weather normalized household energy consumption is used in a difference-in-difference (DID) model to estimate gross savings. Detailed discussion of this method is provided in section 3.3.2.

A comparison group is used in the second-stage model to control for the effect of non-program related changes in a pre- and post-program intervention setting. Comparison groups can be constructed in a variety of ways. In this evaluation, DNV GL constructed a matched comparison group that provides a reasonable means of controlling for non-program related energy consumption trends. The method used to construct a matched-comparison group is discussed in section 3.3.3.

Whole-house interventions affect both the rate at which households use energy (measured in kWh for electricity) and energy use during a specified period of time (measured in kW). In this study, we also evaluated changes in energy demand during peak periods due to whole-house upgrades. Peak demand impact methods are presented in section 3.3.4.

Some elements of the energy efficiency measures installed by the program would have occurred without the program, a phenomenon referred to as "free-ridership." DNV GL conducted a participant survey to determine program free-ridership based on self-reported responses. The complement of free-ridership, net-to-gross (NTG) ratio, is used to adjust gross savings estimates. The NTG method and net savings are discussed in section 3.4.

3.3.1 Site-level modeling

The first stage site-level model correlates daily energy consumption with heating and cooling degree days. Based on PRISM,[5] this model is used to estimate each household's response to (1) outdoor temperatures, (2) the temperature points (base or balance points) that trigger cooling and heating, and (2) weather-adjusted consumption that reflects typical weather for each site. The outcome of this process is weather normalized energy consumption.

The site-level model is given by:

$$E_{im} = \mu_i + \beta_H H_{im}(\tau_H) + \beta_C C_{im}(\tau_C) + \varepsilon_{im}$$

Where:

E_{im}	Average electric (or gas) consumption per day for participant i during period m
μ_i	Base load usage (intercept) for participant i
$H_{im}(\tau_H)$	Heating degree-days (HDD) at the heating base temperature τ_H
$C_{im}(\tau_C)$	Cooling degree-days (CDD) at the cooling base temperature τ_C (not included in gas models)
β_H	Heating coefficient determined by the regression
β_C	Cooling coefficient determined by the regression (not included in gas models)
τ_H	Heating base temperatures, determined by choice of the optimal regression model
τ_C	Cooling base temperatures, determined by choice of the optimal regression model
ε_{im}	Regression residual

Consumption is estimated over a range of 64F° to 80F° for cooling and 50F° to 70F° for heating to identify the temperature base points for each site (household); statistical tests identify the optimal set of base points. The outcome of the site-level model is parameters that indicate the level of baseload (consumption not correlated with either HDD or CDD) and the relationship between heating and cooling consumption and HDD and CDD, respectively.

Model parameter estimates for each site allow the prediction of consumption under any weather conditions. For evaluation purposes, all consumption is put on a typical weather basis called normalized annual consumption (NAC). NAC for the pre- and post-installation periods are calculated for each site and analysis time frame by combining the estimated coefficients $\hat{\beta}_H$ and $\hat{\beta}_C$ with the annual typical meteorological year (TMY) degree days H_0 and C_0 calculated at the site-specific degree-day base(s), $\hat{\tau}_H$ and $\hat{\tau}_C$. Normalized annual consumption is given by:

$$NAC_i = (365 \times \hat{\mu}_i) + \hat{\beta}_H H_0 + \hat{\beta}_C C_0$$

3.3.2 Difference-in-difference model

Normalized annual consumption from site-level models form the basis for the second-stage of the analysis. A model based on the pre- and post-difference in NAC for participant households and a matched comparison group is estimated using a difference-in-difference modelling approach. This model is given by:

$$\Delta \mathrm{NAC}_i = \alpha + \beta T_i + \varepsilon_i$$

[5] Princeton Scorekeeping Method (PRISM™). F. Fels, Margaret. (1986). PRISM: An introduction. Energy and Buildings - ENERG BLDG. 9. 5-18.

In this model, i subscripts a household and T is a treatment indicator that is 1 for HUP/AHUP households and 0 for matched comparison homes. The effect of the program is captured by the coefficient estimate of the term associated with the treatment indicator, $\hat{\beta}$.

Pre- and post-program periods are based on a definition of a blackout period for each participant. Based on the CalTrack recommendation and the CPUC tracking data, DNV GL defined a three-month black out period to include the installation month and two months prior to installation for all projects. According to CalTrack, an intervention period is a "time between the end of the baseline period and the beginning of the reporting period in which a project is being installed. It advises the use of "the earliest intervention date as project start date and the latest date as the project completion date."[6] Typically, the tracking data indicates a single installation date, though some sites have multiple installation months indicated. In addition, the tracking data includes project application dates that indicate a typical gap of 1 to 3 months between the start and end of a project which supports the chosen blackout period definition.

3.3.3 Matched comparison groups

The goal of energy efficiency evaluation is to estimate change in energy use due to a program, while accounting for the effect of other changes in consumption, such as weather, income, and household characteristics. Weather normalization accounts for the effect weather has on consumption changes. After weather normalizing consumption, there remain two other possible explanations for pre-post differences: program-related savings and exogenous consumption changes (non-program, non-weather related changes in consumption). Exogenous changes may be driven by economic or other factors but, importantly, they occur across all customers, not just program participants. If, for instance, customers are coming out of a period of economic recession, an average two to three percent increase in consumption may occur across all customers. If this increase is not addressed, it will directly undermine true savings.

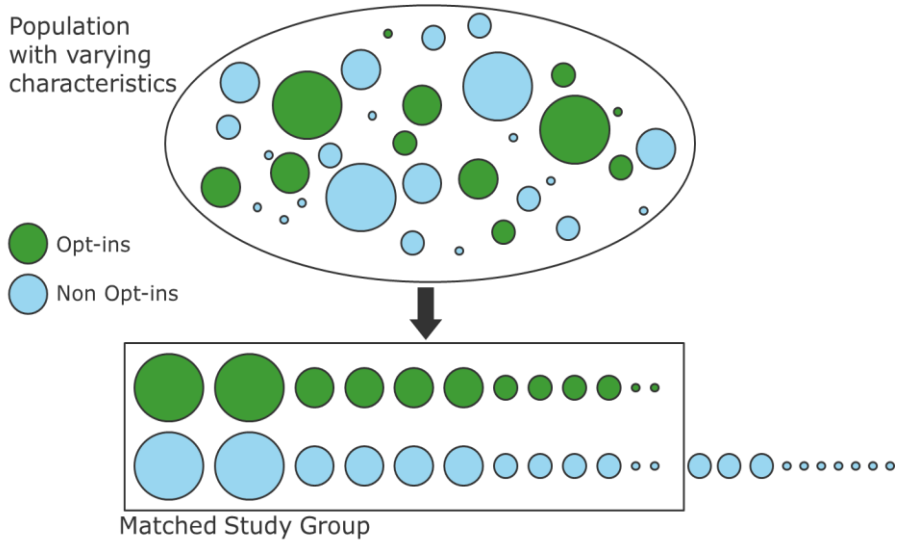
DNV GL controlled for the effect of these types of exogenous changes by using a comparison group. A comparison group is similar to a participant group except for program participation. Data from a comparison group, thus, makes it possible to isolate the effect of the program on consumption change.[7] DNV GL used data from a comparison group, along with data from participants, in a difference-in-difference model to estimate program impact.

DNV GL used propensity score matching to construct a comparison group. This approach is based on propensity scores that measure the probability that households can be assigned to a program given their characteristics. An alternative way to think of propensity scores is as metrics that summarize several dimensions of household characteristics, such as consumption levels and patterns, into single values that can be used to group similar households. Thus, propensity scores are used to match program participants with similar non-participant households. As Figure 3-2 illustrates, matching is a process of funneling population members with varying characteristics into a matched set that share similar traits. Further details on the matching methodology and results are provided in Appendix B.

[6] http://docs.caltrack.org/en/latest/methods.html#section-2-data-management

[7] A comparison group is the best we can do to control for exogenous trends in consumption for opt-in programs such as the ones considered in this evaluation, but it does not address all elements of self-selection present.

Figure 3-2. Propensity score matching process



For this evaluation, matched-comparison households are identified using information on all households' consumption levels and patterns. Household and other external characteristics that drive consumption habits are embedded in such data, which provide a readily available source of information that can be used to identify similar households. Matching is done using monthly billing data prior to any program start months for candidate participant groups and comparators.

DNV GL generated six comparison matches for every participant and requested interval data for the identified households. DNV GL received hourly AMI electric and daily gas use data. Hourly AMI electric data were aggregated to daily level to estimate program driven consumption changes. Daily electric and gas interval data formed the basis of first stage site-level and second-stage difference-in-difference models. This approach provided estimated kWh and therm reductions from HUP and AHUP.

3.3.4 Peak demand savings

Hourly AMI electric data for each PA's HUP and AHUP participants and their comparison counterparts were also used to fit a fixed-effects peak demand model. This model was fitted and estimated using hourly demand and actual cooling degree data from the three pre-program and the three post-program summer months of July – September of each site. The model is given by:

$$E_{ih} = \mu_i + \theta_h + \beta_{1\mathrm{h}} Post_{ih} + \beta_{2\mathrm{h}} CDD_{ih} + \beta_{3\mathrm{h}} PostCDD_{ih} + \beta_{4\mathrm{h}} TreatCDD_{ih} + \beta_{5\mathrm{h}} TreatPost_{ih} + \beta_{6\mathrm{h}} TreatPostCDD_{ih} + \varepsilon_{ih}$$

Where:

E_{ih}	Electric consumption for participant i during hour h
μ_i	Site-specific intercept for participant i
$Post_{ih}$	Post-retrofit period indicator (1 for post-installation and 0 for pre-installation period)
CDD_{ih}	Average daily cooling degree days (CDD) at 65ºF for participant i
$PostCDD_{ih}$	Interaction term between post-retrofit indicator and CDD
$TreatCDD_{ih}$	Interaction term between treatment indicator and CDD
$TreatPost_{ih}$	Interaction term between treatment indicator and post-retrofit indicator
$TreatPostCDD_{ih}$	Interaction term between treatment and post-retrofit indicators and CDD
θ_h	Binary variables for each hour h
β_{1h}	Change in energy consumption post-installation
β_{2h}	Effect of cooling on energy consumption

β_{3h}	Change in the effect of cooling on energy consumption post-installation
β_{4h}	Difference in cooling effect on energy use between participant and comparison groups
β_{5h}	Difference in the change in consumption post-installation between treatment and comparison groups
β_{6h}	The difference in the change in the effect of cooling on energy consumption during post-installation period between treatment and comparison group
ε_{ih}	Error term for participant i in hour h

Peak demand savings estimates from this model are based on DEER defined heat wave period cooling degree days.[8] According to the DEER (2008) definition, a peak period is 3 consecutive non-holiday weekdays between June 1 and September 30 with the hottest temperatures within the 9-hour window of 2 p.m. to 5 p.m. This definition considers the average temperature, average afternoon temperature (12 p.m.–6 p.m.), and maximum temperature over the course of 3-day heatwave candidates.

In the HUP/AHUP analysis, the peak period for each of the state's 16 Title 24 climate zones (CZs) is determined using the most current TMY (typical meteorological year) datasets so average demand impact is estimated under conditions that represent a grid peak. The following table provides a definition of the peak period (heat wave) applicable to each climate zone based on this definition.

DNV GL uses the CZ2010 peak period definitions in Table 3-4, which are based on the most recent TMY weather files: CZ2010 (2013 Title-24) Weather Files.

Table 3-4. Typical meteorological year -based heat wave definitions by climate zone

Climate Zone	CZ2 (2008 Title-24) Weather Files				CZ2010 (2013 Title-24) Weather Files			
	Start Date	Weekday	Peak T	Ave T	Start Date	Weekday	Peak T	Ave T
CZ01	30-Sep	Mon	80	58.0	16-Sep	Wed	81	59.8
CZ02	22-Jul	Mon	99	77.9	8-Jul	Wed	103	75.9
CZ03	17-Jul	Wed	89	65.4	8-Jul	Wed	91	69.2
CZ04	17-Jul	Wed	97	70.8	1-Sep	Tue	99	77.5
CZ05	3-Sep	Tue	93	67.6	8-Sep	Tue	87	64.8
CZ06	9-Jul	Tue	85	69.0	1-Sep	Tue	102	77.1
CZ07	9-Sep	Mon	92	70.1	1-Sep	Tue	90	73.9
CZ08	23-Sep	Mon	98	78.2	1-Sep	Tue	105	79.8
CZ09	6-Aug	Tue	101	78.3	1-Sep	Tue	107	86.6
CZ10	8-Jul	Mon	104	83.5	1-Sep	Tue	109	86.3
CZ11	31-Jul	Wed	104	80.7	8-Jul	Wed	113	88.3
CZ12	5-Aug	Mon	103	81.0	8-Jul	Wed	109	82.4
CZ13	14-Aug	Wed	106	87.1	8-Jul	Wed	108	86.7
CZ14	9-Jul	Tue	106	89.7	26-Aug	Wed	105	86.8
CZ15	30-Jul	Tue	114	96.2	25-Aug	Tue	112	97.5
CZ16	6-Aug	Tue	96	73.1	8-Jul	Wed	90	78.8

Source: http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2013-July2013-Workshop.ppt

[8] DEER2008 version 2.05, adopted by CPUC Decision 09-09-047,3

DNV GL calculated each climate zone's TMY cooling degrees for the defined heat wave periods. A participant weighted sum of such cooling degree day values for each PA are used to calculate peak demand savings from the program.

Peak demand savings or the average hourly savings for the 9-hour DEER defined peak period is given by:

$$Average\ Normalized\ Hourly\ Savings = \frac{1}{h}\sum_{h} \hat{\beta}_{5h} + \left(\hat{\beta}_{6h} \times \overline{CDD65}_{norm}\right)$$

Where:

$\hat{\beta}_{5h}\ and\ \hat{\beta}_{6h}$ = Coefficients estimated from the fixed-effects model

$\overline{CDD65}_{norm} = \sum_{cz} CDDNorm_{cz} * N_{cz}$

= sum of participant number weighted TMY CDD from each climate zone

3.4 Free-ridership and net savings

Free-ridership measures the extent of program participation that would have occurred even in the absence of the program. The core objective of the participant survey for HUP/AHUP is to assess the extent of free-ridership in the program.

DNV GL's participant survey followed CPUC guidelines to assess free-ridership based on self-reported responses. The survey development process solicited PA input, incorporated changes to the survey based on CPUC and PA feedback and finalized the survey subsequent to multiple rounds of this process. Respondent fatigue, instrument complexity, timing, and budget constraints were all considered in survey development. The net-to-gross ratio is the complement of free-ridership. This ratio was applied as an adjustment to gross savings to arrive at net savings and represents the portion of gross savings that is fully attributable to the program.

4 IMPACT RESULTS

4.1 Savings per household

Table 4-1 and Table 4-2 provide percent energy and demand savings based on the results of the second-stage models for HUP and AHUP, respectively. The tables indicate the extent of energy and demand savings as a percent of baseline household energy consumption and demand. Model coefficients used for these results are provided in Appendix D.

Table 4-1. Average 2017 percent savings per household, HUP

Program Administrator	kWh	kW	Therms
BayREN	1%	1%	12%
PG&E	8%	9%	10%
SCE	2%	8%	NA
SoCalGas	NA	NA	5%
SDG&E	0%	-5%	8%
SoCalREN	5%	5%	9%

The results for HUP indicate savings of 0% to 8% for kWh. Apart for SDG&E, kW results are at or above their associated kWh results indicating that savings are concentrated in weather-correlated measures such as HVAC and insulation. For all PAs, gas savings as a percent of baseline consumption are greater than electric savings.

The second-stage saving regressions do not provide insight into the causes of these results. There are a number of possible explanations for the greater gas savings. The number of gas end uses in a household are limited and the program efforts target HVAC consumption which is mostly likely to be the primary gas end use. To the extent that program efforts are successful, this will lead to higher gas savings compared to electric savings since substantial proportions of electric related consumption are not targeted by the program. In addition, insulation and sealing measures have a proven record as effective program measures.

Further, electric savings as a percentage of consumption are lower than expected due to possible take back effects from HVAC repairs that allow people to use air conditioners that did not work prior to the program. Some home upgrades also accompany home remodels, which means home square foot expansions and additional plug loads that increase energy use.

Table 4-2 provides the savings as a percentage of consumption for AHUP. AHUP is intended to provide deeper savings. In all but one case, savings as a percentage of consumption are greater for AHUP than HUP.

Table 4-2. Average 2017 percent savings per household, AHUP

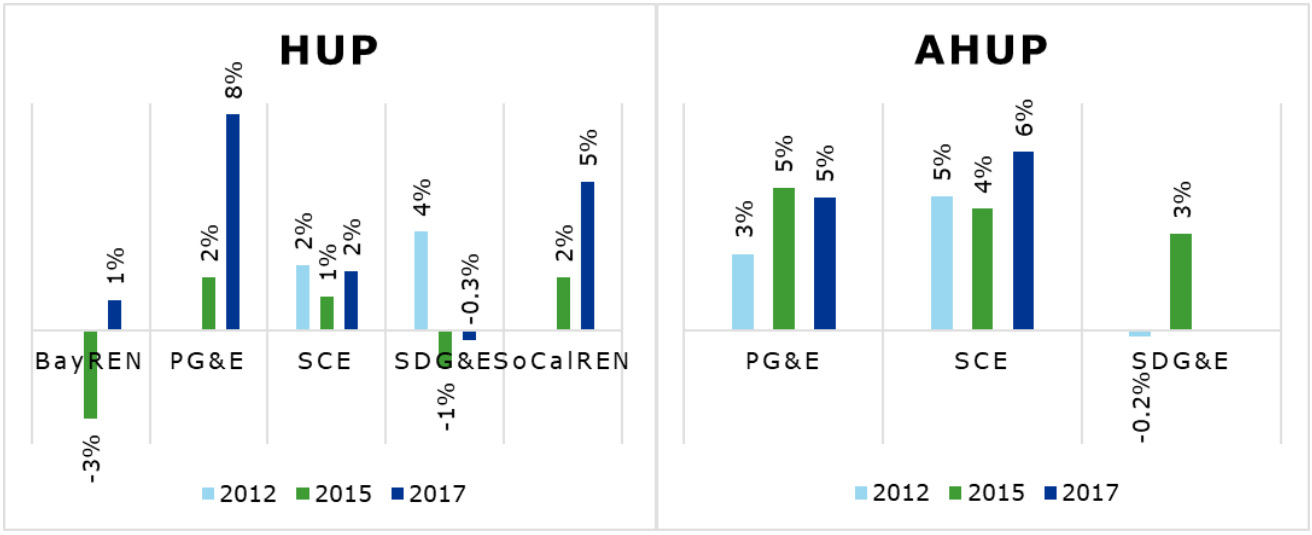
Program Administrator	kWh	kW	Therms
PG&E	5%	10%	11%
SCE	6%	16%	NA
SoCalGas	NA	NA	15%
SDG&E	*	*	*

Notes: SDG&E AHUP results are not reported because the small number of observations did not make it possible to obtain robust savings estimates.

Figure 4-1. provides savings as a percent of consumption from this evaluation in the context of similar values from past evaluations. Although there is no trend over time, electric savings from the current

evaluation are in line with past findings for electric savings from these programs, except for PG&E and SoCalREN HUP which indicate greater savings than in past evaluations.

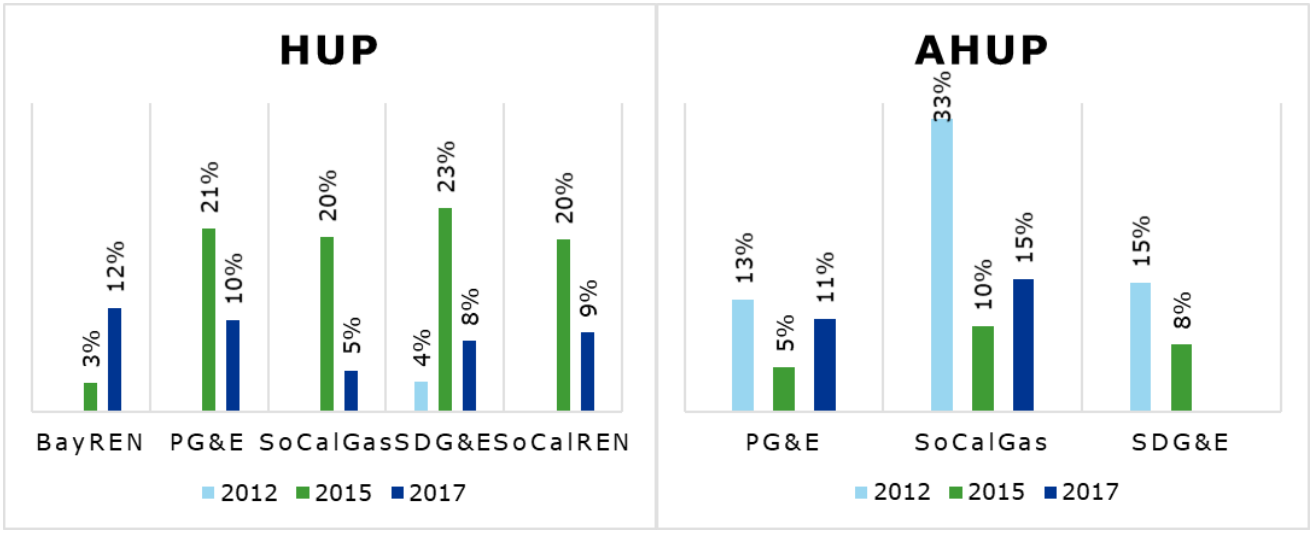
Figure 4-1. Percent electric savings over time



Note: AHUP figures exclude 2017 SDG&E results because the small number of observations did not make it possible to obtain robust savings estimates.

Gas savings as a percent of household energy consumption have consistently been higher than electric savings over time (Figure 4-2.). However, for both HUP and AHUP, estimated gas savings in 2017 are lower than in 2015. The 2017 gas findings are more in line with what is expected for HUP, which is a deemed program that is anticipated to deliver 10% savings. AHUP, as a customized offering, is expected to achieve savings that are in the range 15% to 20%.

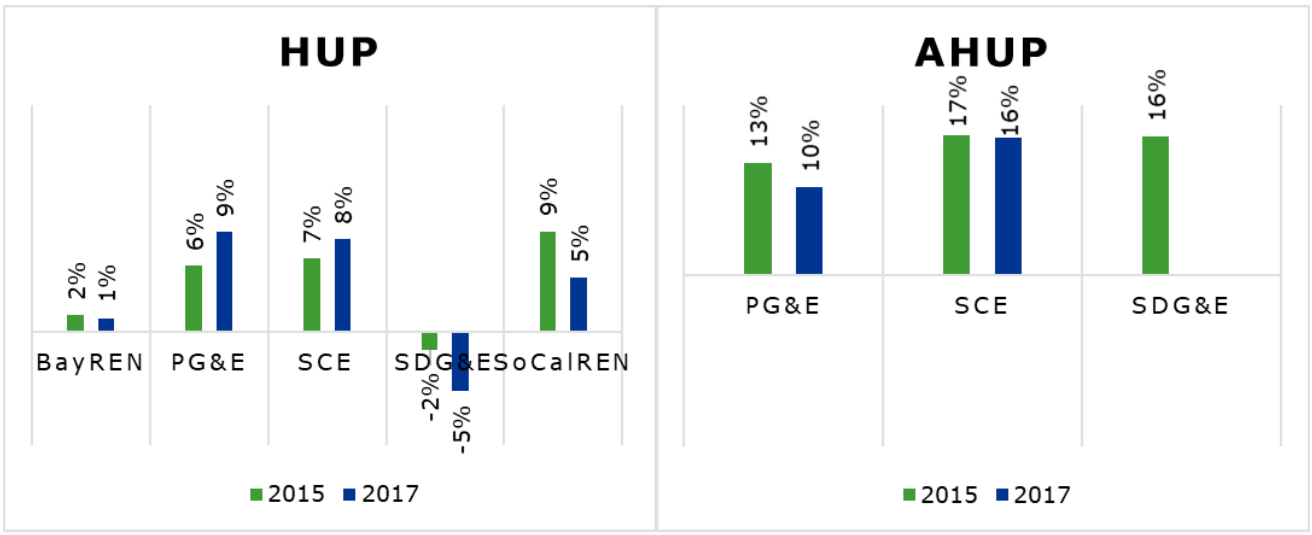
Figure 4-2. Gas savings over time



Note: AHUP figures exclude 2017 SDG&E results because the small number of observations did not make it possible to obtain robust savings estimates.

Figure 4-3. provides peak demand savings over time. Apart from SDG&E, peak demand savings are similar to past evaluated values. The results also suggest that AHUP is more effective in generating peak savings as a percent of baseline demand than HUP.

Figure 4-3. Peak demand savings over time



Note: AHUP figures exclude 2017 SDG&E results because the small number of observations did not make it possible to obtain robust savings estimates.

Average annual savings per household for both HUP and AHUP were estimated using the households in the analysis dataset. These are a subset of the population of households that participated in the programs in the second half of 2016 and the first half of 2017.[9]

Table 4-3 provides these savings estimates for HUP along with the number of households included in the second-stage models. The table also includes average ex ante (claimed) savings for the analysis households that reflect PA reported realization rate adjustments. The evaluated gross realization rates in the table were calculated based on these ex ante (claimed) savings.

[9] The attrition analysis in Section 7.5.3 explains how the analysis population was selected from the full program population.

Table 4-3. Ex post (evaluated) and ex ante (claimed) savings per household and realization rates, HUP 2017

Program Administrator	Electric			
	Analysis Households	Ex Post Savings per Household (kWh)	Ex Ante Savings per Household (kWh)	Gross Realization Rate
BayREN	1,132	74	475	16%
PG&E	433	706	809	87%
SCE	1,071	153	436	35%
SDG&E	183	-22	528	-4%
SoCalREN	358	385	716	54%
Statewide	**3,177**	**216**	**538**	**40%**
Program Administrator	**Gas**			
	Analysis Households	**Ex Post Savings per Household (therms)**	**Ex Ante Savings per Household (therms)**	**Gross Realization Rate**
BayREN	1,250	62	91	68%
PG&E	451	53	51	104%
SoCalGas	763	25	52	47%
SDG&E	251	32	63	50%
SoCalREN	241	54	87	62%
Statewide	**2,956**	**48**	**72**	**66%**
Program Administrator	**Demand**			
	Analysis Households	**Ex Post Savings per Household (kW)**	**Ex Ante Savings per Household (kW)**	**Gross Realization Rate**
BayREN	1,132	0.0	0.7	7%
PG&E	433	0.1	0.8	16%
SCE	1,071	0.2	0.5	39%
SDG&E	183	-0.2	0.7	-25%
SoCalREN	358	0.1	1.2	8%
Statewide	**3,177**	**0.1**	**0.7**	**7%**

Note: Statewide savings per household were calculated using the HUP population counts by PA.

Table 4-4 provides savings per household estimates for AHUP. It also provides evaluated gross realization rates that were calculated based on ex ante gross savings that reflect PA reported realization rate adjustments. Estimated savings per household for AHUP are greater than for HUP, except for PG&E electric where HUP electric savings are greater than AHUP.

Table 4-4. Ex post (evaluated) and ex ante (claimed) savings per household and realization rates, AHUP 2017

Program Administrator	Electric			
	Analysis Households	Ex Post Savings per Household (kWh)	Ex Ante Savings per Household (kWh)	Gross Realization Rate
PG&E	910	412	2,941	14%
SCE	346	456	1,758	26%
SDG&E	11	*	3,650	*
Statewide	**1,267**	**420**	**2,624**	**16%**
Program Administrator	**Gas**			
	Analysis Households	**Ex Post Savings per Household (therms)**	**Ex Ante Savings per Household (therms)**	**Gross Realization Rate**
PG&E	955	57	219	26%
SoCalGas	505	85	142	60%
SDG&E	13	*	33	*
Statewide	**1,473**	**66**	**191**	**35%**
Program Administrator	**Demand**			
	Analysis Households	**Ex Post Savings per Household (kW)**	**Ex Ante Savings per Household (kW)**	**Gross Realization Rate**
PG&E	910	0.2	0.8	28%
SCE	346	0.4	2.0	22%
SDG&E	11	*	2.5	*
Statewide	**1,267**	**0.2**	**1.1**	**18%**

Notes: SDG&E AHUP results are not reported because the small number of observations did not make it possible to obtain robust savings estimates.
Statewide savings per household were calculated using the AHUP population counts by PA, excluding SDG&E.

4.2 Total program savings

Total ex post gross savings are based on the household savings estimates produced by this evaluation applied to the full program population. They reflect per household savings estimates from the 12-month evaluation period applied to population counts of 2017. They are estimates of total savings actually achieved by the programs.

Table 4-5 provides HUP total savings for 2017. The table includes the number of program participants in 2017 used to estimate total ex post (evaluated) gross savings. The table also presents gross realization rates - what the programs accomplished relative to what they were expected to do so - in 2017. In addition, the table provides the net-to-gross ratio (NTGR) adjustments (discussed in section 3.4 and provided in section 5.2.2.3) and the associated total ex post (evaluated) net program savings.

Table 4-5. HUP programs savings, 2017

Program Administrator	Program participants	Total Gross Ex Ante Savings (kWh)	Gross Realization Rate	Total Gross Ex Post Savings (kWh)	NTG Ratio	Total Net Ex Post Savings (kWh)
BayREN	1,337	520,164	16%	81,287	58%	47,433
PG&E	919	321,793	87%	280,545	62%	174,973
SCE	638	233,781	35%	82,151	65%	53,416
SDG&E	199	61,236	-4%	-2,544	46%	-1,166
SoCalREN	491	184,752	54%	99,491	55%	55,011
Statewide	**3,584**	**1,321,726**	**41%**	**540,930**	**61%**	**329,668**
Program Administrator	**Program participants**	**Total Gross Ex Ante Savings (therms)**	**Gross Realization Rate**	**Total Gross Ex Post Savings (therms)**	**NTG Ratio**	**Total Net Ex Post Savings (therms)**
BayREN	1,365	138,024	68%	93,623	58%	54,631
PG&E	915	36,105	104%	37,623	62%	23,465
SoCalGas	2,065	114,713	47%	53,905	68%	36,543
SDG&E	203	12,895	50%	6,447	46%	2,954
SoCalREN	507	28,692	62%	17,698	55%	9,785
Statewide	**5,055**	**330,430**	**63%**	**209,295**	**61%**	**127,378**
Program Administrator	**Program participants**	**Total Gross Ex Ante Savings (kW)**	**Gross Realization Rate**	**Total Gross Ex Post Savings (kW)**	**NTG Ratio**	**Total Net Ex Post Savings (kW)**
BayREN	1,337	792.4	7%	54.5	58%	31.8
PG&E	919	374.9	16%	58.7	62%	36.6
SCE	638	397.6	39%	154.1	65%	100.2
SDG&E	199	92.2	-25%	-23.1	46%	-10.6
SoCalREN	491	356.4	8%	26.8	55%	14.8
Statewide	**3,584**	**2,013.5**	**13%**	**270.9**	**64%**	**172.8**

Table 4-6 provides total ex post (evaluated) gross savings and ex ante (claimed) gross savings for AHUP. The total ex ante (claimed) gross savings reflect ex ante realization rate adjustments. The table also provides evaluated gross realization rates, net-to-gross ratios, and total net ex post program savings for AHUP in 2017.

Table 4-6. AHUP program savings, 2017

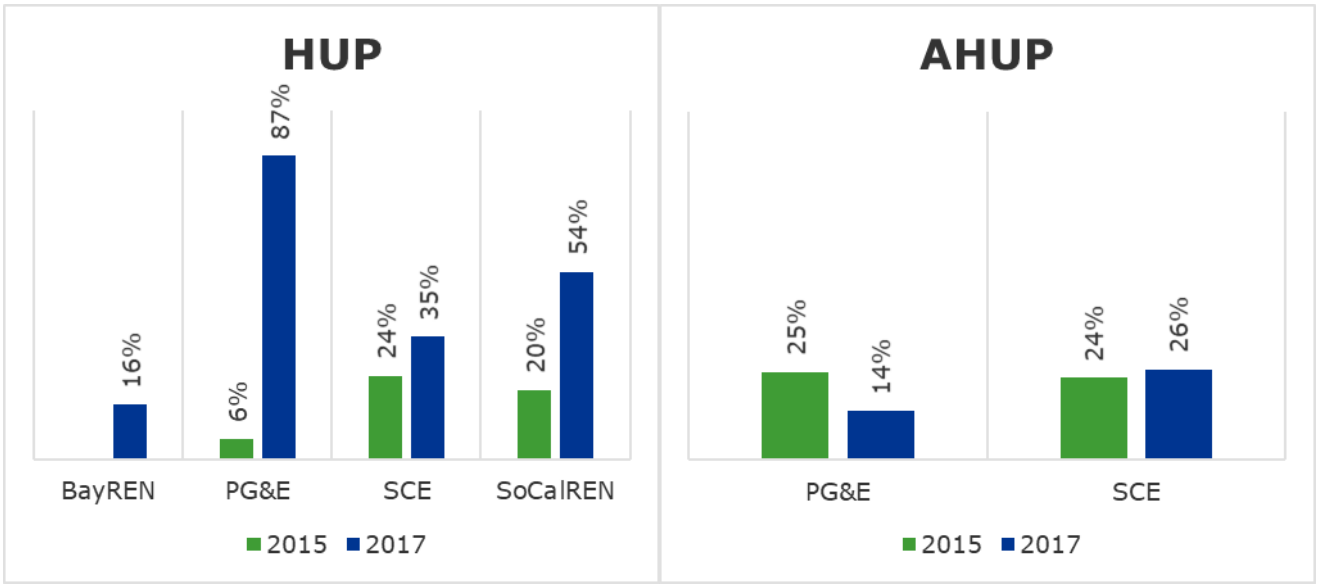
Program Administrator	Program participants	Total Gross Ex Ante Savings (kWh)	Gross Realization Rate	Total Gross Ex Post Savings (kWh)	NTG Ratio	Total Net Ex Post Savings (kWh)
PG&E	1,413	3,609,887	14%	505,704	62%	315,403
SCE	725	1,069,418	26%	277,319	65%	180,317
SDG&E	40	97,892	*	*	*	*
Statewide	**2,178**	**4,777,197**	**16%**	**783,023**	**63%**	**495,720**
Program Administrator	**Program participants**	**Total Gross Ex Ante Savings (therms)**	**Gross Realization Rate**	**Total Gross Ex Post Savings (therms)**	**NTG Ratio**	**Total Net Ex Post Savings (therms)**
PG&E	1,270	289,834	26%	75,387	62%	47,018
SoCalGas	1,304	188,783	60%	112,537	65%	73,174
SDG&E	40	905	*	*	*	*
Statewide	**2,614**	**479,523**	**39%**	**970,947**	**64%**	**120,192**
Program Administrator	**Program participants**	**Total Gross Ex Ante Savings (kW)**	**Gross Realization Rate**	**Total Gross Ex Post Savings (kW)**	**NTG Ratio**	**Total Net Ex Post Savings (kW)**
PG&E	1,413	2,250.1	28%	634.6	62%	395.8
SCE	725	1,430.4	22%	321.8	65%	209.2
SDG&E	40	71.7	*	*	*	*
Statewide	**2,178**	**3,752.2**	**25%**	**971,903.3**	**63%**	**605.0**

*SDG&E results are not reported and are not included in statewide totals because the small number of observations did not make it possible to obtain robust savings estimates.

4.3 Gross realization rates

Gross realization rates, the ratio of gross ex post (evaluated) savings to ex ante (claimed) savings, facilitate an understanding of program performance relative to what administrators expect programs to achieve. Figure 4-4. provides gross electric realization rates for 2015 and 2017, for HUP and AHUP. The 2017 values are presented numerically in the tables above. These realization rates, as stated above, are calculated based on ex ante first year savings that reflect PA reported realization rate adjustments.

Figure 4-4. Gross electric realization rates (kWh)



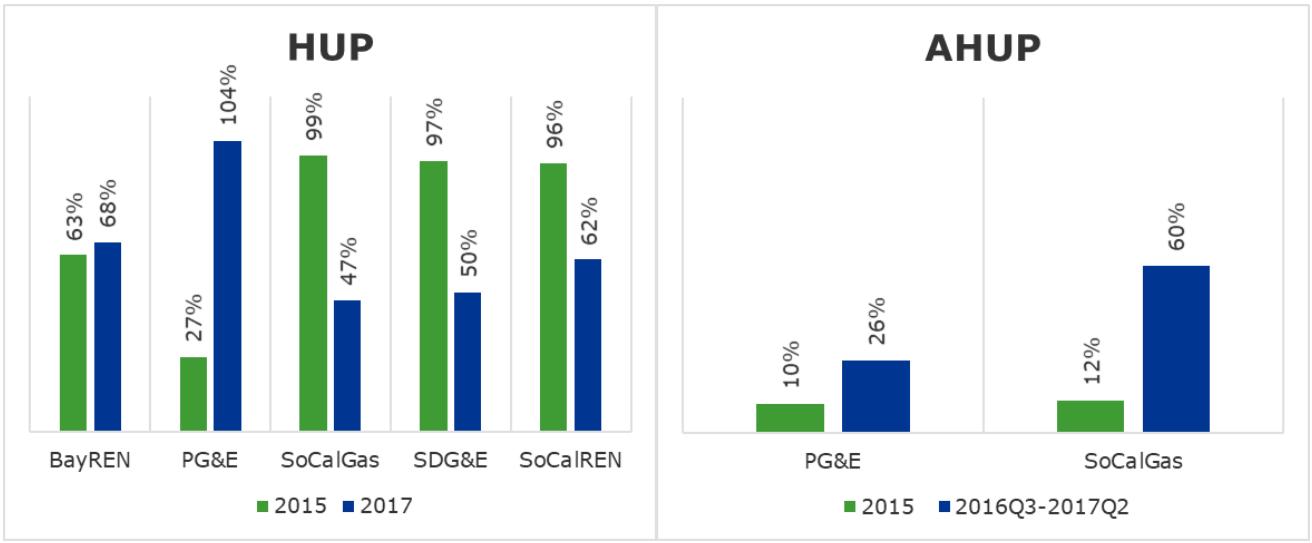
Note: Negative realization rates are excluded from the figures above.

For HUP, the general trend is toward a closer correspondence between the ex ante (claimed) program savings and ex post (evaluated) savings over time. This is especially notable for two of the program administrators - PG&E and SoCalREN. While AHUP realization rates were similar to HUP in 2015, realization rates for the 2017 AHUP program show none of the improvements seen for HUP realization rates.

The AHUP realization rates provide evidence that the simulation tools used to estimate forecasted energy savings per household for AHUP's custom projects have not closed the gap seen between forecasted and evaluated electric savings in the past evaluation cycle. The tools that were supposed to address the problem of inflated energy savings provided by EnergyPro appear to still provide inflated forecasts.

Figure 4-5. provides the gas realization rates over time. For gas, gross realization rates were relatively higher for HUP than AHUP and ranged from 104% for PG&E to 47% for SoCalGas in 2017. The simulation tools used to determine expected gas savings for custom projects overestimate gas savings as well, though to a lesser extent than for electricity as indicated by the higher gross realization rate for SoCalGas at 60%.

Figure 4-5. Gross gas realization rates (therms)



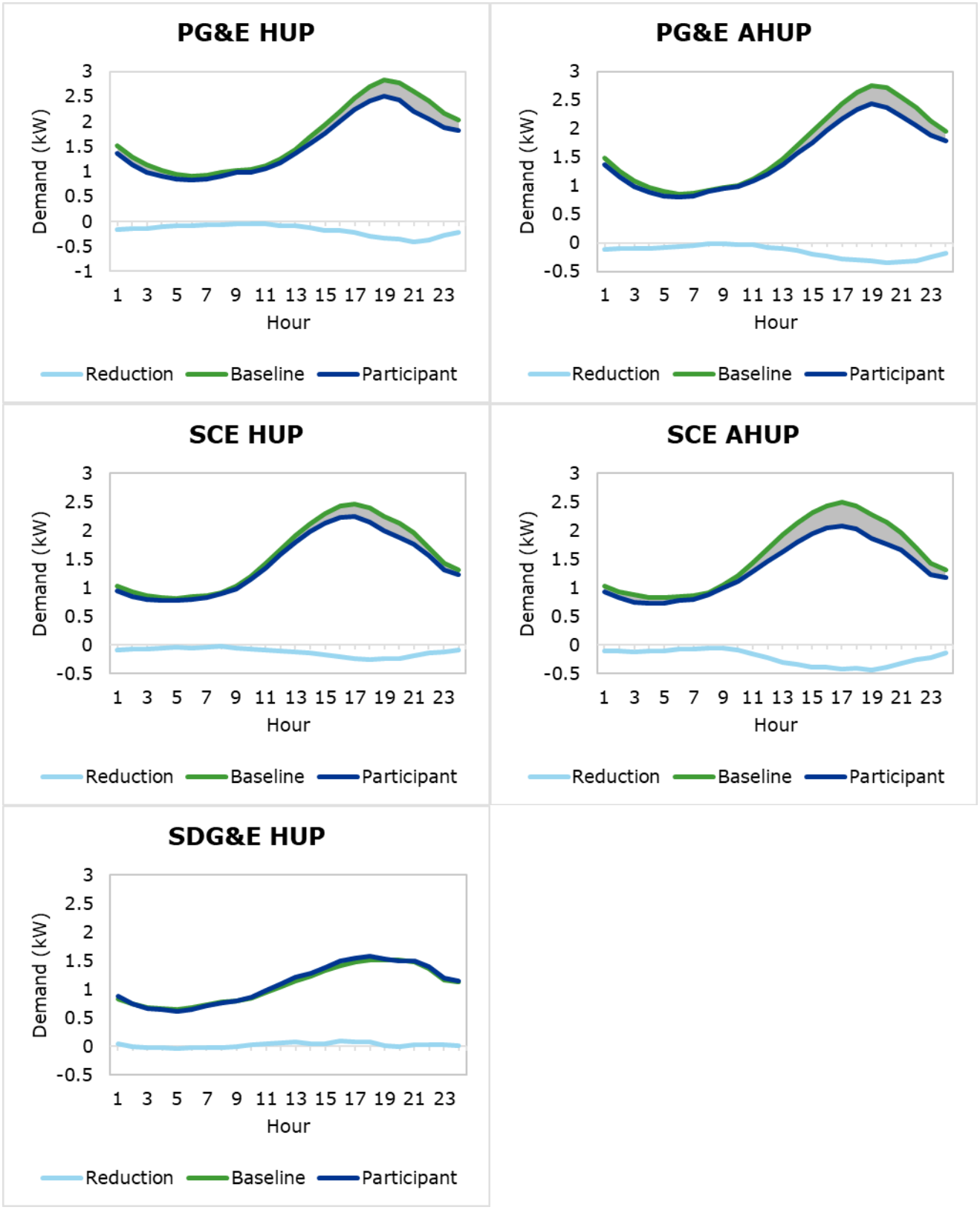
Note: Negative realization rates are excluded from the figures above.

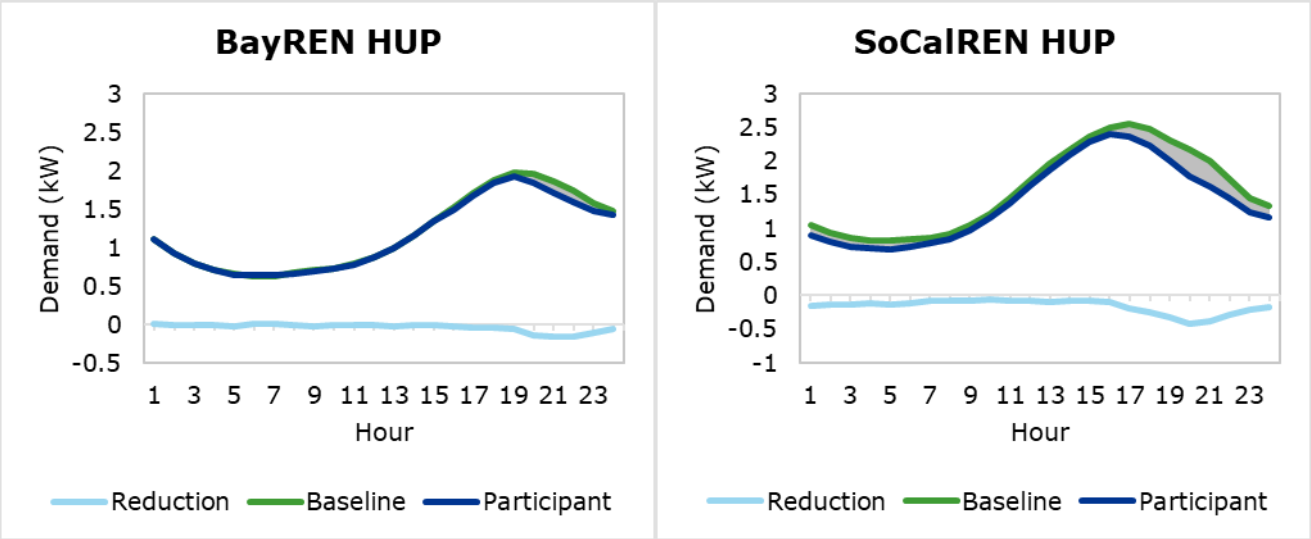
4.4 Peak demand

Figure 4-6 shows peak demand savings by hour, PA, and program, as well as baseline and post-program participant load shapes. The difference between these load shapes is the reduction in peak demand, which is captured by the gray shaded area in the figure. The load shapes are fitted values from the peak demand model estimated using hourly data for participant and comparison group households. Hourly data was drawn from pre- and post-upgrade summer months for each participant.

The plots show consistent peak period load reduction for all PAs and both programs with the exception of SDG&E. SDG&E HUP results are based on a reasonable number of sites but indicate an increase in peak period load rather than a decrease. SDG&E AHUP results are not provided due to the small number of viable households that could be used for analysis.

Figure 4-6. Peak demand savings by program





4.5 Net metered customers in HUP and AHUP

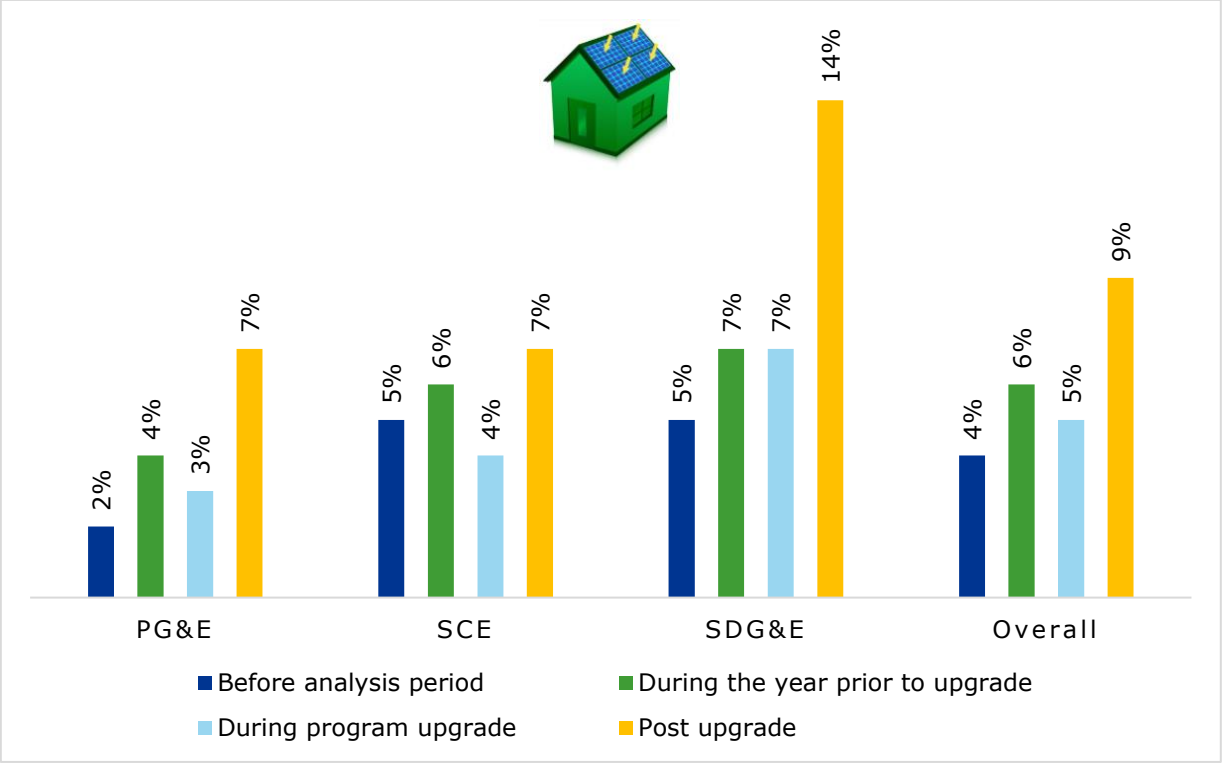
California will move to 100% renewable electricity by 2045 per the terms set forth in Senate Bill 100 and rooftop solar photovoltaic (PV) installations are proliferating. There is evidence of this trend in the data used for this impact evaluation. Figure 4-7 below summarizes the prevalence of solar PV among the population of HUP participants over time. In the post-upgrade period, the prevalence more than doubles to 9% relative to 4% in the pre-analysis period.

Billing data does not currently provide a measure of energy consumption that includes the share from self-generation. As the prevalence of program participants with solar PV increases, this trend has implications for future evaluations of HUP and AHUP and pay for performance programs (programs with incentives based on normalized metered energy consumption).

Customers that had solar before the analysis period (4% of sampled households) are included in the evaluation as the effect of solar on their energy use is likely the same throughout the analysis period. Customers that acquired solar during the year prior to upgrade, during program upgrade or post upgrade are not included because it is difficult to disentangle the effect of self-generation and program upgrade on energy use. The effect of conversion to solar is likely to dwarf any notable program effect, even if such program effects were high.

Further investigation of the implication of solar for evaluation of energy efficiency programs as well as energy use in general is a topic this worth pursuing in the coming few years.

Figure 4-7. Prevalence of net-metered customers among HUP and AHUP participants



5 SURVEY

5.1 Survey approach

The primary objective of the HUP impact evaluation survey was 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, dwelling characteristics, as well as changes in energy usage behavior. The non-participant survey is an addition to the impact evaluation in this evaluation. The main purpose of the non-participant survey is to serve as a point of comparison with respect to any self-reported changes in the household, separate from the program, for participant survey respondents.

5.1.1 Survey mode and design

DNV GL administered web-based surveys to HUP and AHUP program participants and non-participants. The complete surveys are provided in Appendix H. Topics covered by the participant and non-participant survey are listed below:

Participant survey:

- Year of participation in HUP/AHUP
- Had an energy audit, tests included in the audit, audit payment, opportunities identified by audit
- Motivation for participation in HUP/AHUP
- Contractor selection process
- Free rider module for installed measures (13 possible measures including insulation, HVAC, windows etc.)
- Benefits experienced from program participation
- Information on rates and solar for home
- Changes to home, appliances, energy usage behavior
- Dwelling characteristics (vintage, bedrooms, square footage, floors)
- Demographics

Non-participant survey

- Information on rates and solar for home
- Changes to home, appliances, energy usage behavior
- Dwelling characteristics (vintage, bedrooms, square footage, floors)
- Demographics

5.1.2 Sample disposition

DNV GL administered web surveys for approximately 30 days from mid-December 2018 through mid-January 2019. The sample frames were a census of PY 2015-17 HUP/AHUP participants for the participant survey. The set of matched comparison households drawn from the group of non-participants served as the sample frame for the non-participant survey. Matched comparison households were a set of non-participants who have been matched to the participants, post-hoc, based on their energy consumption patterns.

DNV GL included all customers in the sample frames with available email contact information and who were not on the PAs' do-not-contact list in the final survey sample frame. Respondents were incentivized to participate in the survey and offered a $100 lottery incentive to complete the survey. Survey invitees were

encouraged to complete the participant and non-participant surveys and two reminders were sent through the survey fielding period. The survey also included a link to a dedicated page on the CPUC website that allowed respondents to validate the sponsor and the legitimacy of the surveys. The sample disposition is summarized in Table 5-1.

Table 5-1. Sample disposition and response rates

	HUP Participants		HUP Non-Participants	
	Total	%	Total	%
Starting sample	9,923		58,769	
Delivered sample	9,923	100%	58,769	100%
Bounced sample	878	8.8%	12,486	21.2%
Total eligible sample	9,045		46,283	
Completed	542	6%	2,216	5%
In-progress	169	2%	535	1%
Total completed and in-progress	**711**	**8%**	**2,751**	**6%**

5.1.3 Sample weights

DNV GL applied sample weights in order to balance participant and non-participant survey samples to population proportions by PA, climate zone, and fuel type combination. Details of the weighting procedure may be found in Appendix G. The team developed two sets of weights for the participant survey, one for the total sample and another for the subset of the sample that answered the free-ridership questions to inform the NTG adjustment, and one set of weights for the total sample for the non-participant survey.

NTG sample weights for participant survey sample. No trimming of weights was required with the minimum weight, maximum weight, and the ratio of the maximum to minimum sample weight at 0.4, 1.9, and 4 respectively. Minimum cell size to which weights were applied was 29.

Total sample weights for participant survey sample. No trimming of weights was required with the minimum weight, maximum weight, and the ratio of the maximum to minimum sample weight at 0.5, 1.8, and 3.4 respectively. Minimum cell size to which weights were applied was 34.

Total sample weights for non-participant survey sample. No trimming of weights was required with the minimum weight, maximum weight, and the ratio of the maximum to minimum sample weight at 0.7, 1.5, and 2.2 respectively. Minimum cell size to which weights were applied was 64.

This indicates a generally balanced survey sample requiring minor corrections for over and under representation thus reducing the design effect on the data and any potential inflation of standard errors for estimated statistics.

5.2 Survey results

5.2.1 Sample characteristics

DDNV GL examined the survey samples on key demographic characteristics and compared against statewide statistics for California. The surveys had a significantly higher proportion of those with annual household

incomes greater than $75,000 and a college degree education or higher (Table 5-2).[10] Respondents also had larger homes with an average of more than three bedrooms versus the California general population average of 2.6 bedrooms, although they had almost the same number of household members (2.9 and 2.8, respectively).

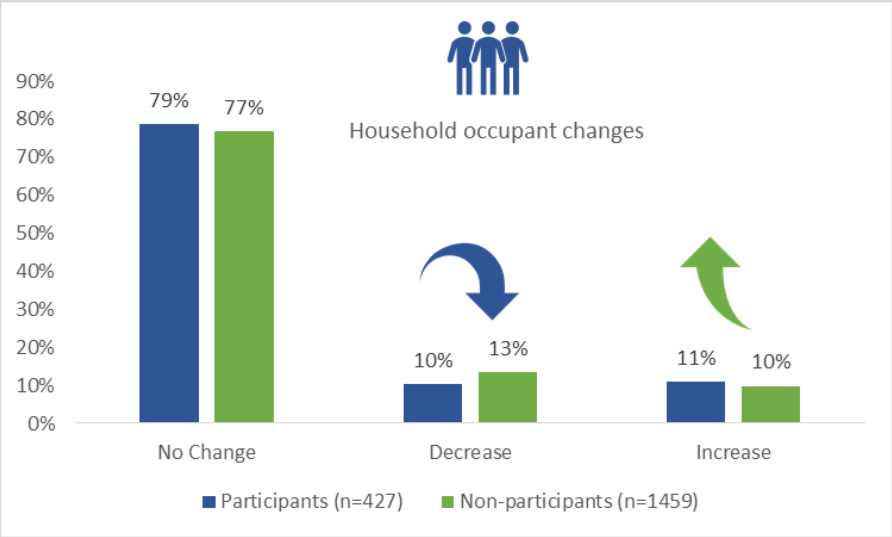
Table 5-2. Sample characterization

	CA	Participants (n=429)	Non-participants (n=1744)
Income over $75,000	42%	79%*	58%*
Education – Bachelor's degree or higher	31%	73%*	61%*
Number of members in the household	2.9	2.8	2.8
Number of bedrooms in home	2.6	3.3	3.2
Area of home (square feet)		1,835	2,080
Pre–1980 dwelling vintage		71%	56%*

Note: * Indicates statistically significant difference at the 95% confidence level between CA and the evaluation survey sample (participant or non-participant). A total of 710 and 2057 participant and non-participant completed the survey, respectively, although only 429 participants and 1744 non-participants responded to the demographic questions.

Research shows that home occupancy strongly influences household energy use. The survey asked respondents about the number of year-round occupants in the household in 2016, 2017, and 2018, which represented years prior to, during, and after the program year 2017. While nearly four-fifths of all respondents reported no change in household size from 2016 to 2018, 11% of participants and 10% of non-participants reported an increase in household size at an average of 1.3 and 1.4 respectively, and 10% of participants and 13% of non-participants reported a decrease at an average of 1.5 and 1.4 respectively (Figure 5-1). While these occupancy trends by participants and non-participants are largely similar, non-participants report a decrease in household size at a marginally higher rate than participants.

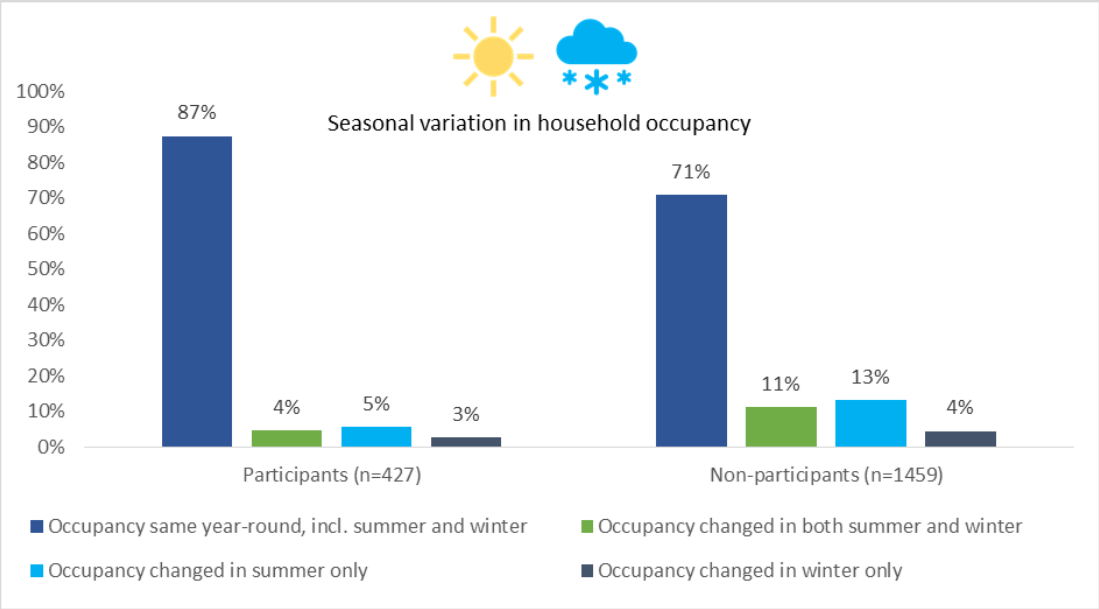
Figure 5-1. Change in household size from 2016 to 2018



[10] Low income or in-language/non-English speaking customers who face the barrier of the digital divide in higher proportions are not as likely to be HUP participants or take this survey

The survey probed respondents on seasonal changes in household occupancy in 2017 that may have resulted in their household size increasing or decreasing in summer or winter due to part-time residents who stayed or left for a month or more. 87% of participants and 71% of non-participants indicated no seasonal changes in household occupancy (Figure 5-2). Non-participants reported changes in household size in both summer/winter and summer only at significantly higher rates than participants at 11% to 4% and 13% to 5% respectively. Both groups reported comparable levels of change that were isolated to just winter at 3% and 4% each respectively.

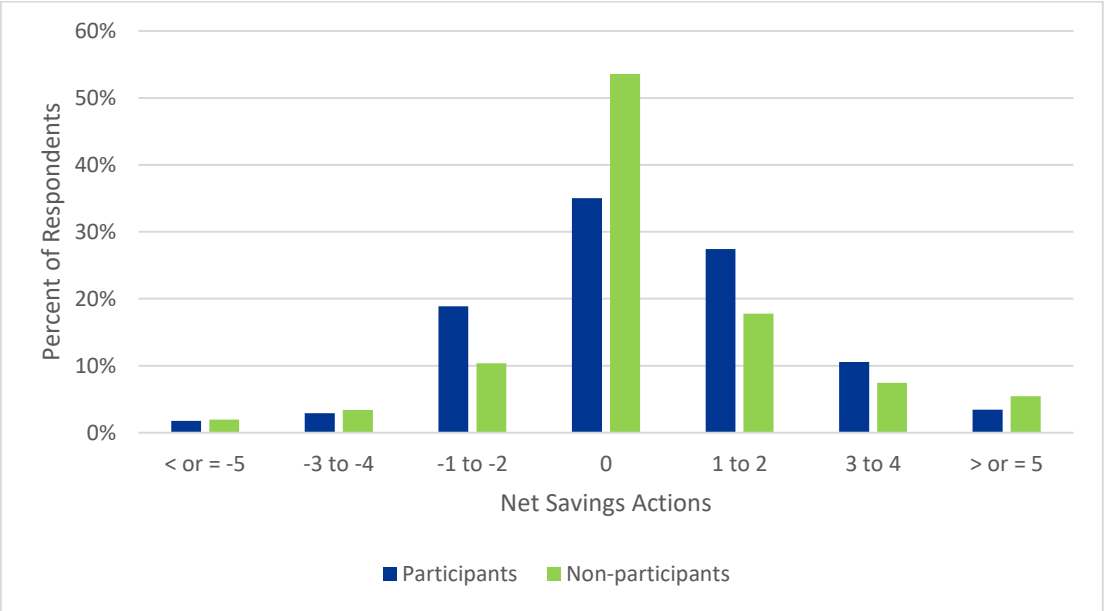
Figure 5-2. Seasonal changes in household occupancy



Participants and non-participants were asked about any changes they made to the home, appliances used, or their energy usage behavior, separate from the changes participants undertook as part of the program. These included changes such as getting rid of an additional refrigerator, which is counted as an action that saves energy, and increasing the square footage of the home or using more heating, which is counted as an action that increases energy use.

A net count of actions that save energy was computed as the difference between the total number of energy saving actions and energy use increasing actions for each respondent. The difference between program participants and non-participants on these changes is summarized below (Figure 5-3). Participants in significantly higher proportions had at least one net energy saving action at 41% compared to 30% for non-participants.

Figure 5-3. Net actions to save energy by participants and non-participants



The results underscore the self-selection issue that is a factor in opt-in programs such as HUP/AHUP. They are different from the general public and that makes it harder to develop a comparison group. While participants are matched on their baseline energy consumption with a comparison group to support savings estimation using a difference-in-difference model, the motivation to participate in an energy efficiency program manifests itself in other related energy use behaviors as well. Because of the difference-in-difference structure, this will only negatively affect the savings estimation process to the extent that participants and non-participants change their consumption levels differently over time.

The demographic comparison above indicates some real differences in the two groups. The participant sample has relatively higher incomes, is more educated, and has a higher proportion of customers who live in older homes. These factors could translate into easier access to funds for a home upgrade, more comfort with navigating program information and requirements, and a higher need to upgrade their older homes respectively.

5.2.2 Free-Ridership and NTG Results

The central objective of the HUP participant survey was to capture program participants' self-reported responses that provide information on free-ridership and allow estimation of net-to-gross ratios (NTGRs) which are then used to adjust gross savings estimates. This self-reported approach involved asking program 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 the level of measure installation might have differed in the absence of the program.

Full free-riders are defined as those who would have installed exactly the same measure at the same quantity (Q), efficiency (E), and time (T), even in the absence of the program. The survey captured both full and partial free-riders, which are those who would have undertaken/installed the measure(s), but of lesser quantity, at and/or lesser efficiency, or at a different time.

Respondents selected one of two options when they began the survey—whether they:

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 a short-form battery that applied to the entire project. If they selected "separate buying decision," they were given a long-form battery for each measure they reported installing. The full participant survey, which includes both the short-form and long-form paths, is provided in Appendix H.

5.2.2.1 Short-form survey respondents

Respondents who indicated that they considered all the measures installed as a package for which they made a single purchase decision were given the short form survey that contains questions related to free-ridership. Those who receive the short form survey are not asked the quantity question as they consider the whole project as one single decision. An example of the scoring process for short form survey respondents may be found in Appendix F.

5.2.2.2 Long-form survey respondents

Measure level free-ridership

Respondents who indicated that they did not consider all the measures as one package were administered the long-form. This version of the survey asked questions related to free-ridership for each measure that they reported installing. In some cases, the QET questions may not have been relevant for the specific measure under consideration. For example, those who stated that they had their ducts air sealed to reduce leakage were only asked whether the timing of undertaking the installation would be different in the absence of the program. Quantity and efficiency related free-ridership questions were not applicable to this measure. An example of the scoring process for measure level free-ridership for long form survey respondents may be found in Appendix F.

Overall respondent level free-ridership

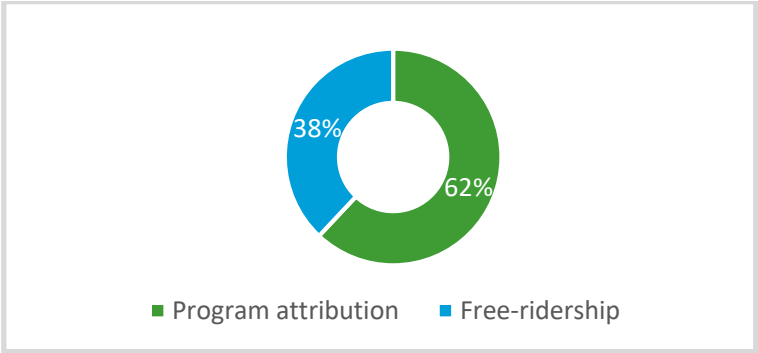
For respondents who took the long form of the survey, we aggregated measure level free-ridership scores to obtain one overall respondent level free-ridership score. For example, if a respondent has installed 5 measures, the overall free-ridership score for the respondent is simply the average of the free-ridership scores for each measure installed.

5.2.2.3 Free-ridership by PA and key program and customer dimensions

Free-ridership measures the extent of program participation that would have occurred even in the absence of program incentives. Program incentives on HUP for single-family homes built before 2001 range from $1,000 - $3,000; AHUP offers incentives up to $6,500 for single-family homes of any year.

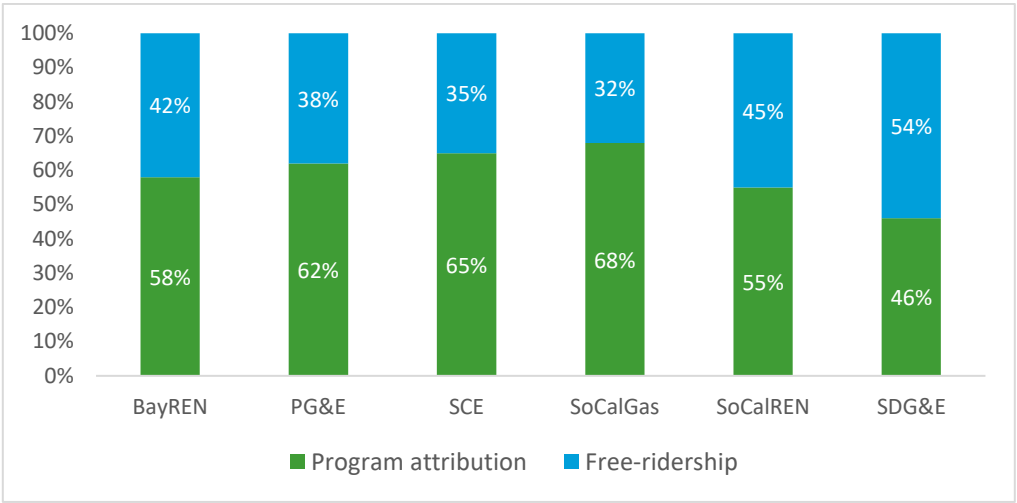
DNV GL began the free-ridership analysis by reviewing the distribution of scores based on the number of measures installed and the results for each individual measure. Case-weights were applied to the subset of the sample of 399 respondents that completed the free-ridership questions to ensure that the sample was balanced to reflect true population proportions. The sample used for the estimation of free-ridership was well above the minimum required to report results at the 90/10 precision level. The final case-weighted results by utility, geography, and other subgroups of interest (e.g., short-form versus long-form survey respondents) were then applied to the gross savings results. Overall free-ridership for HUP and AHUP for program year 2017 is estimated at 38% (Figure 5-4).

Figure 5-4. Total Free-ridership



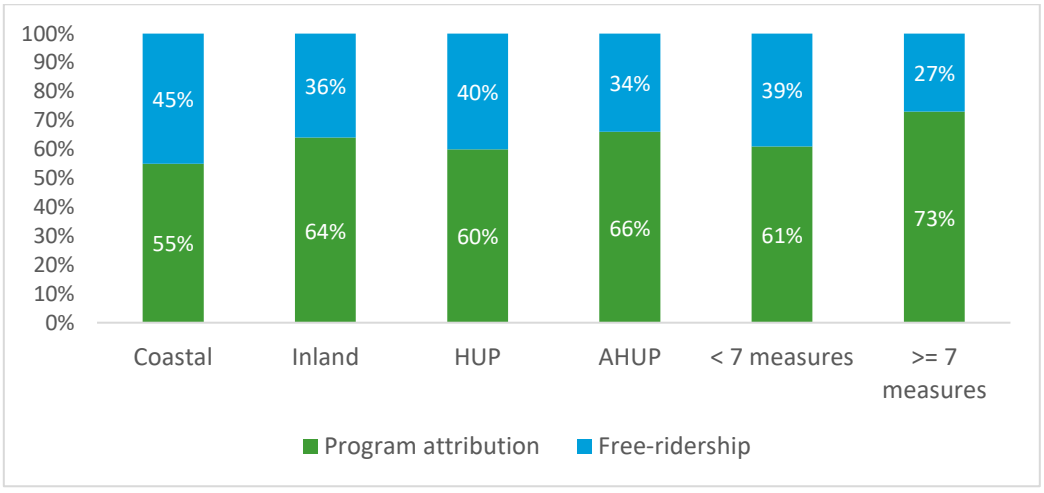
While levels of free-ridership are largely comparable by PA, there is significantly higher free-ridership, compared to the statewide average, among SDG&E's HUP/AHUP program participants (Figure 5-5).

Figure 5-5. Free-ridership by PA



Free-ridership varies along key dimensions and this has implications for targeting future participants (Figure 5-6).

Figure 5-6. Free-ridership along key program and customer dimensions



Program attribution can be improved by targeting customers who fit the following descriptors: live inland, implement larger upgrades of seven measures or more, and/or who are candidates for the advanced path of the program. These findings and recommendations are similar to those from previous evaluations.

The majority of participants in the program (53%) scored as partial free-riders. Free-ridership is particularly sensitive to partial free-riders. A partial free-rider either increases efficiency or acts sooner or implements a greater quantity as a result of the program but was not motivated solely by the program. The use of a prorated calculation in this evaluation for timing and efficiency captures the spectrum of free-ridership. This is a refinement over measurements in previous cycles that used a single catch-all response to capture partial free-ridership where lesser amounts and later installations had served as partial free-ridership response options. A sensitivity analysis examining free-ridership under the extreme boundary conditions where we set partial free-ridership to total/pure free-riders or non-free-riders results in a potential low free-rider score of 19% and a high of 72%.

5.2.3 Geographical trends to HUP and AHUP participation

The HUP and AHUP programs had a total of 28,409 participants in PY 2016 through June 2017 with over 75% of these customers participating in the HUP. There was at least one program participant in 2,190 out of over 2,600 zip codes in California indicating increased program penetration geographically from the 2010-2012 program cycle when the program had penetrated only 1,300 zip codes. HUP participation was also more diffuse with at least one participant in 1,620 zips versus AHUP participants who were spread across 969 zips.

The maps below summarize the geographical distribution of program participants by zip code in the service territories covered by the PAs (Figure 5-7 - Figure 5-12). The map denotes participation level from low to high participation in shades of green to shades of yellow/rust respectively, with color saturation increasing at the extremes. Tracking data indicates that over 80% of all HUP and AHUP participants live inland.

The program did not achieve expected savings despite the promising trend for the program of lower free-ridership inland where the potential for savings is higher. This could be due to low gross realization rates that indicate that the software used to model expected savings from the home upgrade have still not bridged the gap, identified in prior evaluations, between claimed and evaluated savings.

An additional contributing factor is takeback from customers motivated by comfort participating in the program. This is especially relevant for customers inland as their responses indicate increasingly hot summers and air conditioning being an imperative where there was none before or being used more than in previous years. A majority of respondents (75%) who installed HVAC measures live inland.

Figure 5-7. Distribution of PG&E's AHUP and HUP participants

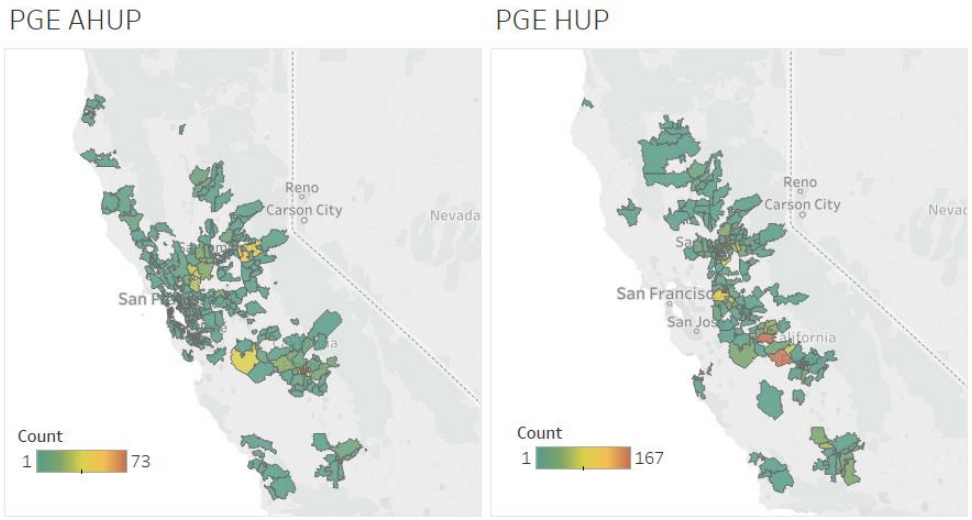


Figure 5-8. Distribution of BayREN's HUP participants

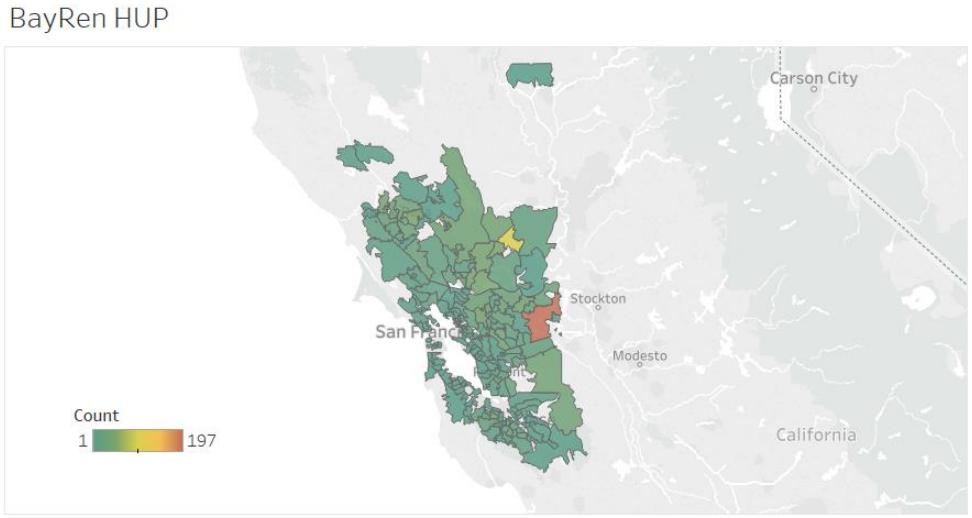


Figure 5-9. Distribution of SCE's AHUP and HUP participants

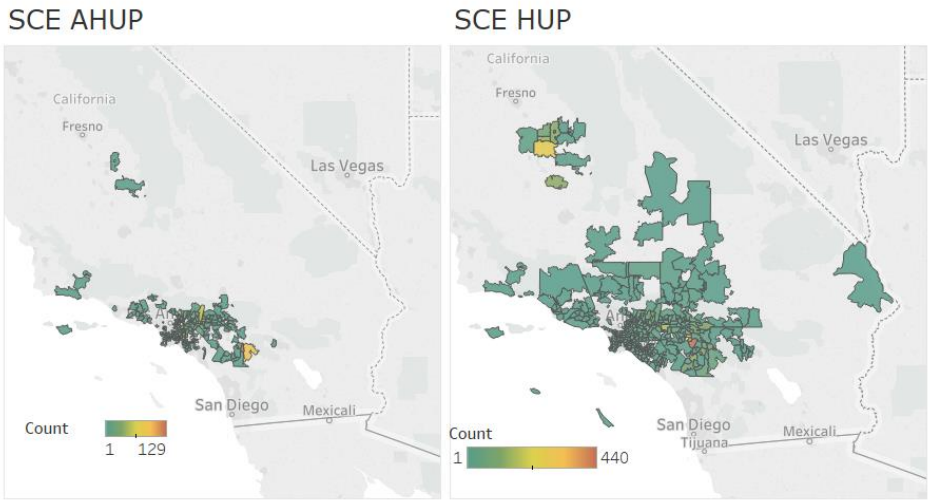


Figure 5-10. Distribution of SCG's AHUP and HUP participants

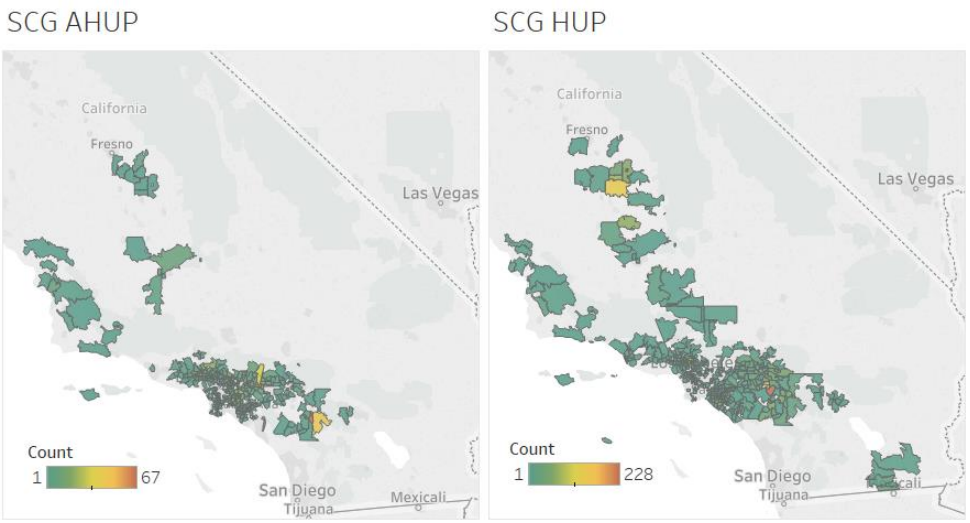


Figure 5-11. Distribution of SoCalREN's HUP participants

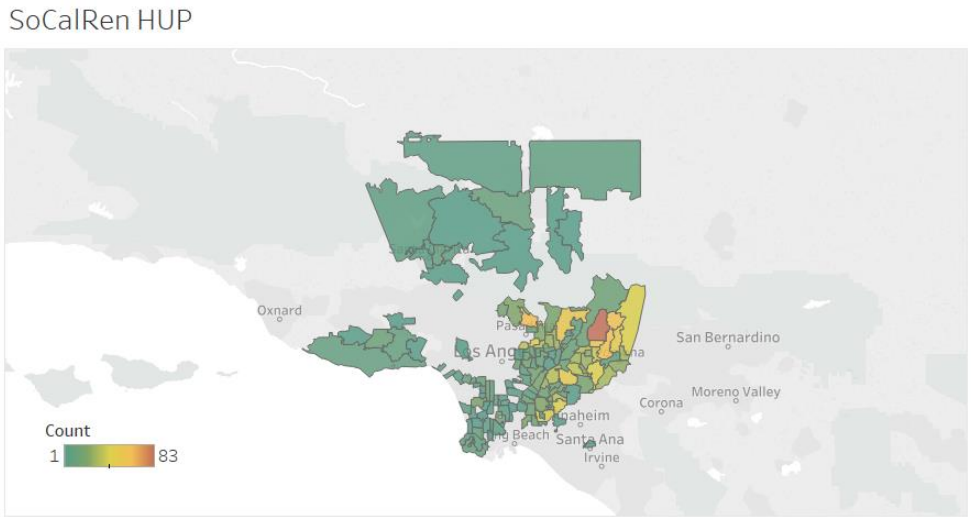
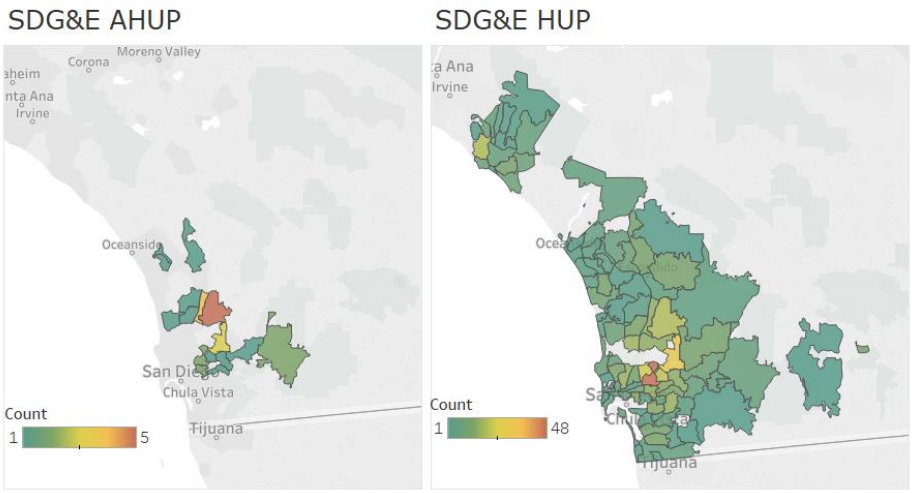


Figure 5-12. Distribution of SDG&E's AHUP and HUP participants

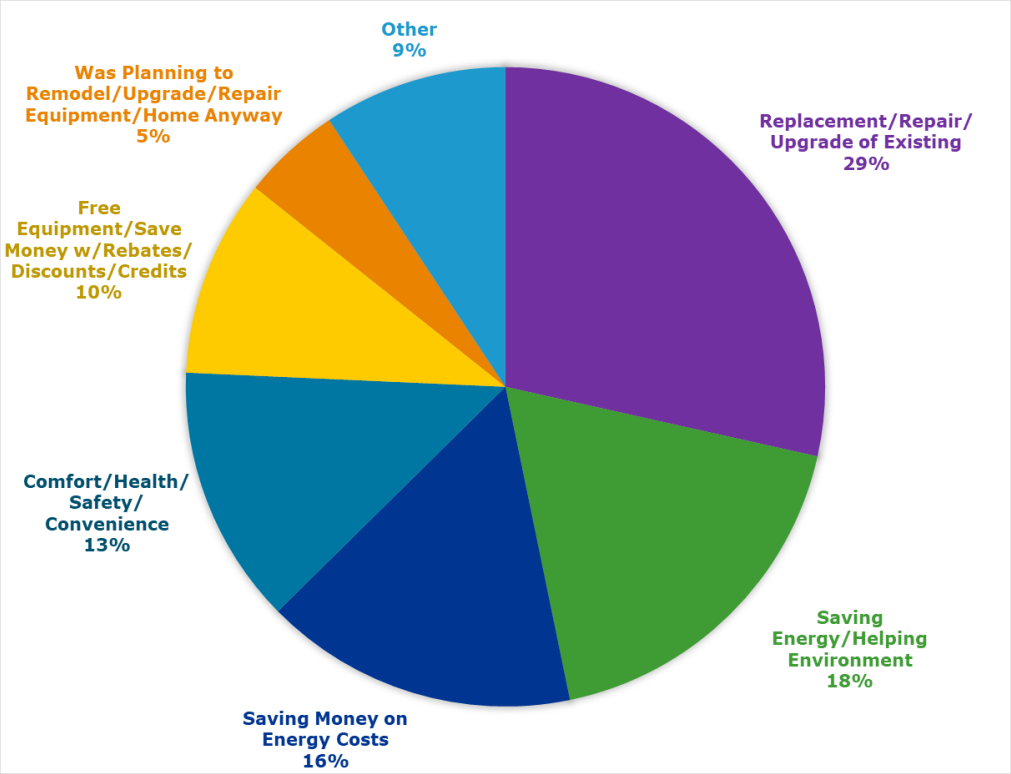


5.2.4 Motivators of program participation

The survey asked respondents what triggered their participation and the main reason for participation.

Participation Triggers. Verbatim responses from over 400 respondents on triggers were analyzed and grouped into broad categories. When their responses included more than one factor, we counted that response as one individual response in all the matching trigger categories, which resulted in approximately 618 separate trigger responses. Figure 5-13 summarizes the results from this analysis.

Figure 5-13. Self-Reported Triggers for Participating in the Home Upgrade Program



Replacement, repair, and upgrade of existing equipment or measures was referred to most often as a trigger at 29%. Typical examples of verbatim responses include:

- *Old furnace broke.*
- *Failure of an 18-year-old heat pump.*
- *Our heater was no longer functioning properly. The blower fan would not turn off unless the entire unit was manually turned off.*

Saving energy, whether by increasing efficiency of equipment, appliances, or whole-house in context of helping the environment was the trigger mentioned second most often at 18%. Examples of typical responses for this trigger category:

- *It was the right thing to do for the planet and for us.*
- *Wanted to do my part in energy conservation.*

Saving money on energy costs was referred to 16% of the time, the third most frequent reason respondents mentioned. Respondent comments include:

- *High utility bills.*
- *Wanted to lower my energy bills.*
- *Wanted to cut my electrical costs for long term.*

About 13% of respondents reported that the desire for increased comfort, health, safety, and convenience triggered them to participate. This was the fourth most common reason cited. This category has responses such as:

- *My home, built in 1940, was too cold in winter & too hot in summer.*
- *To increase comfort and efficiency of AC*
- *Comfort and convenience*
- *My son has severe allergies, so I wanted to install an air purification system.*

The fifth most commonly referred to trigger was obtaining a financial benefit from the program, whether it was free equipment, rebates, discounts, and credits (including tax credits). This accounted for about 10% of responses, such as:

- *To make home improvements without having to pay for it all at once.*
- *The loan repayment plan.*

Approximately 5% of respondents said that their trigger was the fact that they were planning on, or in the midst of, making general home improvements anyway. Examples include:

- *I was planning on doing a renovation, so I thought this would be a good time to look at energy savings.*
- *We were adding square footage and the upgrade was part of the HVAC work.*

The Other category comprised 9% of trigger responses. This group of responses was classified into four categories. The most common Other response was Referral/Recommendations/Advertisement (friend, family, utility, contractor, store/sales rep, media ad), which was claimed as a trigger 4% of total responses. The remainder of Other categories were Did Not Have heating and/or Cooling at all Before & Wanted It (3% of total), for a Backup Energy Source/Wanted Solar (1.8% of total), and Improved Home Resale Value (0.3% of total).

As could be expected with an open-ended question, respondents often cited many reasons as the trigger for their participation. For example, one respondent attributed the trigger to:

- *High power bills, hot weather in the summer, cold weather in the winter, upgrade to new efficient heater, installation of air conditioning, and installation of solar panels.*

In that instance, this one response was counted as an individual response for the categories of Saving Money on Energy Costs, Comfort/Health/Safety/Convenience, Replacement/Repair/Upgrade of Existing Equipment, and Wanted Solar.

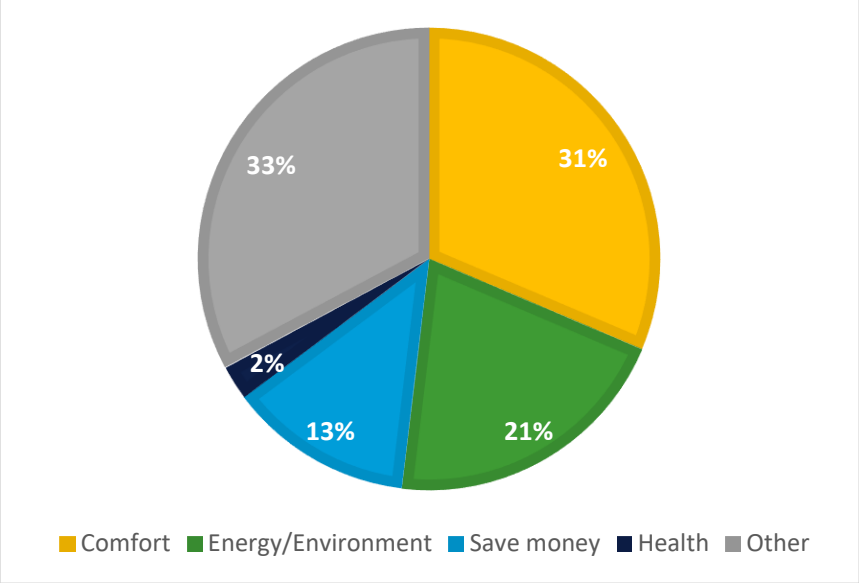
Main reason for participation. After respondents were asked what triggered them to participate in the Home Upgrade Program, they were then asked to select their *main reason* for participating. A total of 341 respondents chose to answer the question and selected a main reason. The 5 broad categories of response options participants could choose from are as shown below (Table 5-3).

Table 5-3. Main Reason Categories: Respondents Could Only Choose One

Main Reason Category	Selection
Saving Money	❑ Saving money
Maintaining Health	❑ Maintaining health
Improving Comfort	❑ Improving comfort
Saving Energy/Helping Environment	❑ Protecting the environment ❑ For the benefit of future generations ❑ Saving energy ❑ Helping California lead the way on saving energy
Other	❑ Other, please specify

Figure 5-14 summarizes the main reason for participation in the program. Improving comfort was the most frequent reason (except for Other), followed by saving energy/helping the environment, and saving money. Health was the least frequent reason chosen.

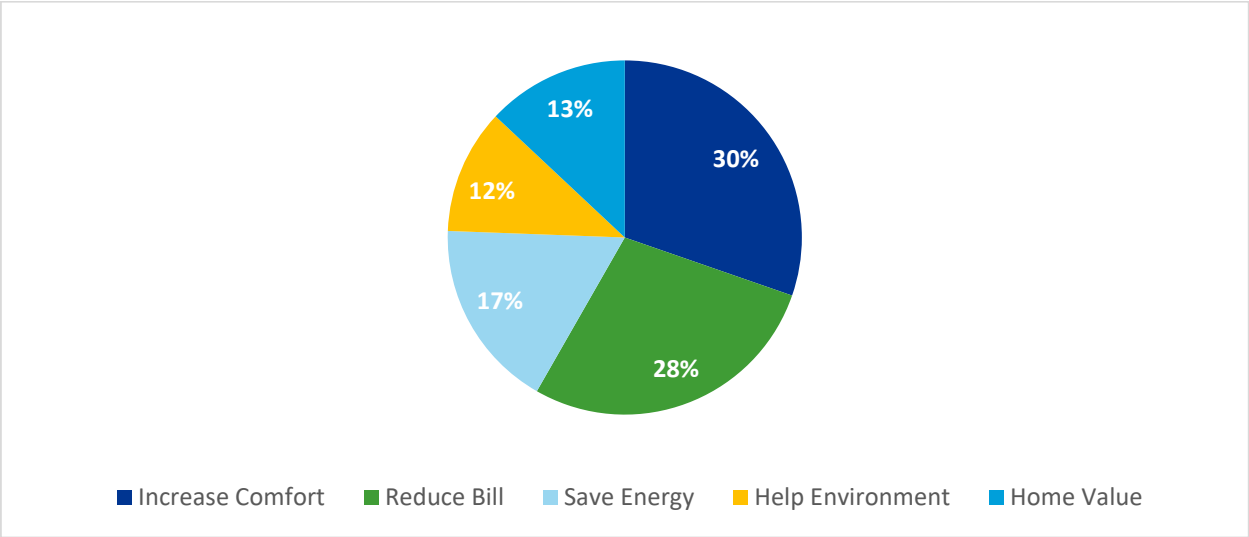
Figure 5-14. Main reasons for participating in the Home Upgrade Program



5.2.5 Perception of benefits due to program participation

The survey presented participants with a list of five benefits they might have experienced due to program participation and asked them to allocate 100 points between the five benefits. Respondents' point allocation provides an indication of participant perception of benefits experienced due to program participation. Improving comfort and saving money on the energy bill emerge as the top two benefits with almost 30 points each out of the total 100 points (Figure 5-15).

Figure 5-15. Point allocation for benefits experienced on the HUP/AHUP program



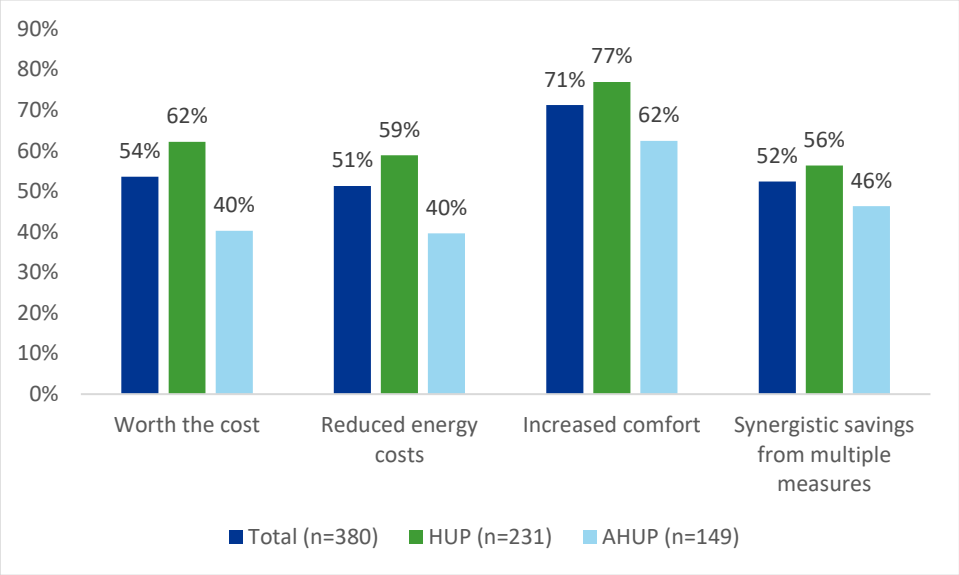
While the differences are not all statistically significant, there is some directional evidence of differences in perception of benefits experienced due to the program by climate zone, level of energy consumption, education, size of home, and household income.

- Customers from the coastal climate zone allocate a significantly higher 29 points to "reducing energy bill" as a program benefit they value, relative to customers who live inland who allocate 22 points to this benefit. This could be due to customers who live inland having a higher cooling load and consequently a higher need to trade-off comfort with potential energy savings.
- A significantly higher 24% of respondents living in homes smaller than 1500 square feet rated increasing their home's market value as the program's most important benefit versus only 15% of respondents living in larger homes who rated this benefit as paramount.
- Customers from the coastal climate zone allocate 15 points to "helping the environment" as a program benefit they valued versus customers who live inland who allocate 10 points.
- Customers indicate increased comfort as the greatest benefit of the program allocating 30 points overall. This perceived benefit is even higher among participants whose annual consumption is greater than 6000kWh, who have a college education or higher, or whose annual household incomes are greater than $100,000 who allocate 31 points to 33 points.

The survey also asked respondents to indicate their level of agreement with project benefit statements on project costs, energy costs, comfort, and synergistic savings achieved due to their home upgrade on a 5 point-scale ranging from strong agreement to strong disagreement. Overall, there was strongest agreement with the statement that the project resulted in improving their home's comfort with 71% saying they strongly agreed versus only around half the participants strongly agreeing with statements on project costs, energy costs, and synergistic savings (Figure 5-16).

There are significant differences on participants' level of agreement on these benefits by program type. Participants of HUP indicate stronger agreement on the project benefits delivered versus participants of AHUP. Just 40% of AHUP participants agree strongly with the cost related benefits from the project. Improved comfort in the home is the project benefit most AHUP customers most strongly agree at 62%.

Figure 5-16. Level of agreement on project benefits



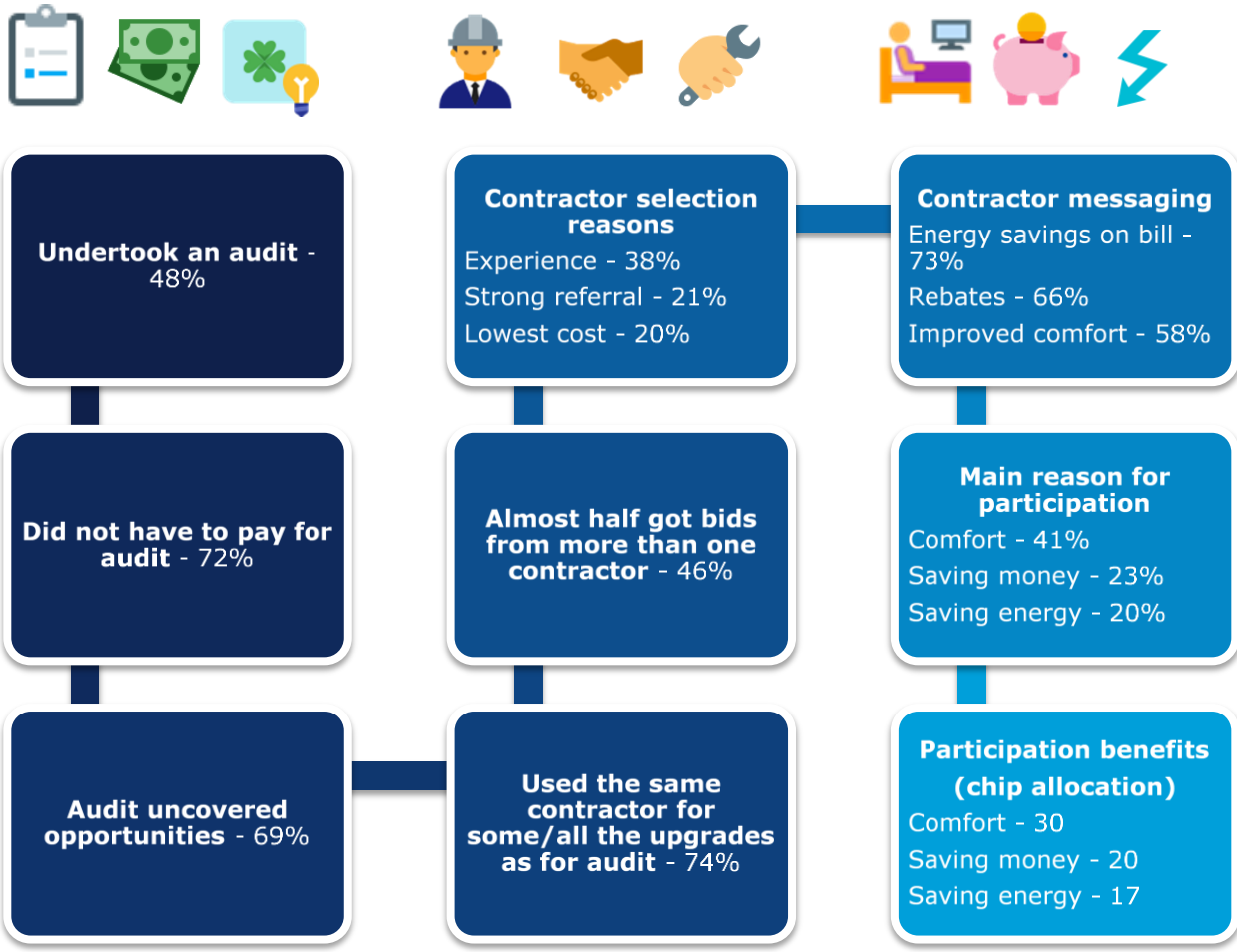
5.2.6 Customer journey on the program

The evaluation also examined the customer journey from start to finish for a HUP/AHUP participant (Figure 5-17). Almost half of all customers who responded to the NTG survey reported undertaking an audit prior to the upgrade; a majority of customers did not have to pay for their audit, as it was covered by the program, and indicated that the audit uncovered opportunities for energy savings of which they were not aware previously.

The majority of customers used the same contractor for most or all of the upgrade as well as the audits. Almost half of all participants seek multiple bids to make a more informed decision on contractor selection. Customers favor contractors with the most experience to implement their home upgrade almost twice as much as choosing a contractor that comes with a strong referral or the lowest bid at 38% versus around 20% each respectively.

Contractor messaging, program participation motivations, and benefits derived from the program align, with the same themes of comfort, saving energy, and saving money rising as the top three respondent answers. Verbatim responses indicate increasingly "hotter days in summer and cooler days in winter" requiring an HVAC upgrade or a new installation where there was none before to improve comfort in the home. Participation triggers mostly tend to be faulty/aging/failed HVAC equipment that customers want to upgrade before a change in season/onset of summer or winter. Increased energy consumption from increased or new heating or cooling load could be a contributor to takeback and result in lower than expected program savings.

Figure 5-17. Customer journey on the program



6 CONCLUSIONS AND RECOMMENDATIONS

1. The evaluation revealed that, in general, HUP ex ante (claimed) savings are higher than ex post (evaluated) savings. Statewide, total ex post (evaluated) gross savings amounted to 13%-63% of total ex ante (claimed) gross savings. This is much lower for AHUP, where gross realization rates ranged from 16%-39% statewide.

   Realization rates for AHUP do not show much change over time. The tools approved under CalTest that were supposed to address the problem of inflated energy savings provided by EnergyPro still provide inflated forecasts.

2. Free-ridership continues to be a significant issue for the program, meaning program participants would have made the upgrades even in the absence of program incentives. Overall free-ridership for HUP and AHUP for program year 2017 is estimated at 38%. Free-ridership varies along key characteristics of program participants.

   The level of free riders at 38% has implications for targeting future participants. Program savings can be improved by targeting customers who fit the following descriptors: live inland, implement larger upgrades with 7 measures or more, and are candidates for the advanced path program.

3. Percent savings for electricity are consistently lower than for gas and do not show much variation over time (except for PG&E and SoCalREN HUP which indicate greater savings in 2017 than in past evaluations). For both HUP and AHUP, estimated gas savings in program year 2017 are lower than in 2015. The 2017 findings are more in line with what is expected for HUP, which is a deemed program that is anticipated to deliver 10% savings. AHUP, as a customized offering, is expected to achieve savings that are in the range of 15% to 20%.

Program staff interviews indicate that use of air-conditioning increases after installation of new/upgraded equipment. Verbatim customer responses indicate increasingly "hotter days in summer and cooler days in winter" requiring an HVAC upgrade or a new installation where there was none before to improve comfort in the home. Improved comfort in the home is also a key part of program messaging and a desired program benefit for customers.

Electrification trends such as heat pumps that deliver both heating and cooling further diminish potential electric savings for fuel switching customers. Increased energy consumption from additional or new heating or cooling load could be a contributor to increased energy consumption after the upgrade and result in lower than forecasted program savings. Combined with the finding of comfort being a desired customer benefit, this points to takeback being a contributing factor in reducing the achieved electric savings.

Forecasted savings calculations should factor in implementation of HVAC measures. Any departures from default hours of use assumptions and potential changes to households' baseline use should be factored in as well.

4. The trend of increasing solar photovoltaic (PV) adoption has implications for future evaluations of HUP and AHUP and pay for performance programs (programs with incentives based on normalized metered energy consumption). Billing data does not currently provide a measure of energy consumption that includes the share from self-generation.

   a) Program administrators and implementers should consider devices to measure energy production at the customer site and linking measurements to billing data. This will enable an accurate measurement of energy consumption from the household load for net-metered customers.

   b) Future program evaluations should factor in solar when forecasting expected savings and also include these as parameters in the models used to evaluate savings.

7 APPENDICES

7.1 Appendix AA Gross and Net Lifecycle Savings

Gross and net lifecycle savings are presented in the tables beginning on the next page.

Gross Lifecycle Savings (MWh)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	AHUP	54,831	7,681	0.14	0.0%	0.14
PGE	HUP	3,685	4,177	1.13	0.0%	1.13
PGE	**Total**	**58,516**	**11,858**	**0.20**	**0.0%**	**0.20**
SCE	AHUP	14,948	3,880	0.26	0.0%	0.26
SCE	HUP	2,825	1,472	0.52	0.0%	0.52
SCE	**Total**	**17,773**	**5,352**	**0.30**	**0.0%**	**0.30**
SCG	AHUP	1,179	1,179	1.00	0.0%	1.00
SCG	HUP	1,500	1,500	1.00	0.0%	1.00
SCG	**Total**	**2,679**	**2,679**	**1.00**	**0.0%**	**1.00**
SDGE	AHUP	1,615	1,615	1.00	100.0%	
SDGE	HUP	548	-42	-0.08	0.0%	-0.08
SDGE	**Total**	**2,163**	**1,573**	**0.73**	**74.7%**	**-0.08**
BAY	HUP	4,977	1,486	0.30	0.0%	0.30
BAY	**Total**	**4,977**	**1,486**	**0.30**	**0.0%**	**0.30**
SCR	AHUP	7	6	0.78	0.0%	0.78
SCR	HUP	1,111	1,794	1.62	0.0%	1.62
SCR	**Total**	**1,118**	**1,800**	**1.61**	**0.0%**	**1.61**
	Statewide	***87,226***	***24,748***	***0.28***	***1.9%***	***0.27***

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	AHUP	35,865	5,146	0.14	0.0%	0.65	0.67	0.65	0.67
PGE	HUP	2,740	2,798	1.02	0.0%	0.74	0.67	0.74	0.67
PGE	**Total**	**38,606**	**7,945**	**0.21**	**0.0%**	**0.66**	**0.67**	**0.66**	**0.67**
SCE	AHUP	8,971	2,716	0.30	0.0%	0.60	0.70	0.60	0.70
SCE	HUP	2,119	1,031	0.49	0.0%	0.75	0.70	0.75	0.70
SCE	**Total**	**11,090**	**3,746**	**0.34**	**0.0%**	**0.62**	**0.70**	**0.62**	**0.70**
SCG	AHUP	884	860	0.97	0.0%	0.75	0.73	0.75	0.73
SCG	HUP	1,138	1,095	0.96	0.0%	0.76	0.73	0.76	0.73
SCG	**Total**	**2,022**	**1,956**	**0.97**	**0.0%**	**0.75**	**0.73**	**0.75**	**0.73**
SDGE	AHUP	1,454	824	0.57	0.0%	0.90	0.51	0.90	0.51
SDGE	HUP	411	-21	-0.05	0.0%	0.75	0.51	0.75	0.51
SDGE	**Total**	**1,865**	**802**	**0.43**	**0.0%**	**0.86**	**0.51**	**0.86**	**0.51**
BAY	HUP	3,733	936	0.25	0.0%	0.75	0.63	0.75	0.63
BAY	**Total**	**3,733**	**936**	**0.25**	**0.0%**	**0.75**	**0.63**	**0.75**	**0.63**
SCR	AHUP	5	3	0.62	0.0%	0.75	0.60	0.75	0.60
SCR	HUP	833	1,077	1.29	0.0%	0.75	0.60	0.75	0.60
SCR	**Total**	**838**	**1,080**	**1.29**	**0.0%**	**0.75**	**0.60**	**0.75**	**0.60**
	Statewide	***58,153***	***16,465***	***0.28***	***0.0%***	***0.67***	***0.67***	***0.67***	***0.67***

Gross Lifecycle Savings (MW)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	AHUP	34.1	9.6	0.28	0.0%	0.28
PGE	HUP	4.2	0.9	0.20	0.0%	0.20
PGE	**Total**	**38.3**	**10.5**	**0.27**	**0.0%**	**0.27**
SCE	AHUP	20.0	4.5	0.23	0.0%	0.23
SCE	HUP	4.7	2.8	0.59	0.0%	0.59
SCE	**Total**	**24.6**	**7.3**	**0.29**	**0.0%**	**0.29**
SCG	AHUP	1.5	1.5	1.00	0.0%	1.00
SCG	HUP	2.5	2.5	1.00	0.0%	1.00
SCG	**Total**	**4.0**	**4.0**	**1.00**	**0.0%**	**1.00**
SDGE	AHUP	1.2	1.2	1.00	100.0%	
SDGE	HUP	0.9	-0.4	-0.43	0.0%	-0.43
SDGE	**Total**	**2.1**	**0.8**	**0.39**	**57.1%**	**-0.43**
BAY	HUP	12.6	1.0	0.08	0.0%	0.08
BAY	**Total**	**12.6**	**1.0**	**0.08**	**0.0%**	**0.08**
SCR	AHUP	0.0	0.0	0.67	0.0%	0.67
SCR	HUP	2.1	0.5	0.23	0.0%	0.23
SCR	**Total**	**2.2**	**0.5**	**0.23**	**0.0%**	**0.23**
	Statewide	***83.8***	***24.0***	***0.29***	***1.4%***	***0.28***

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	AHUP	22.3	6.4	0.29	0.0%	0.65	0.67	0.65	0.67
PGE	HUP	3.1	0.6	0.18	0.0%	0.75	0.67	0.75	0.67
PGE	**Total**	**25.4**	**7.0**	**0.28**	**0.0%**	**0.66**	**0.67**	**0.66**	**0.67**
SCE	AHUP	12.0	3.2	0.26	0.0%	0.60	0.70	0.60	0.70
SCE	HUP	3.5	1.9	0.55	0.0%	0.75	0.70	0.75	0.70
SCE	**Total**	**15.5**	**5.1**	**0.33**	**0.0%**	**0.63**	**0.70**	**0.63**	**0.70**
SCG	AHUP	1.1	1.1	0.97	0.0%	0.75	0.73	0.75	0.73
SCG	HUP	1.9	1.8	0.97	0.0%	0.76	0.73	0.76	0.73
SCG	**Total**	**3.0**	**2.9**	**0.97**	**0.0%**	**0.75**	**0.73**	**0.75**	**0.73**
SDGE	AHUP	1.1	0.6	0.57	0.0%	0.90	0.51	0.90	0.51
SDGE	HUP	0.7	-0.2	-0.29	0.0%	0.75	0.51	0.75	0.51
SDGE	**Total**	**1.7**	**0.4**	**0.24**	**0.0%**	**0.84**	**0.51**	**0.84**	**0.51**
BAY	HUP	9.4	0.6	0.07	0.0%	0.75	0.63	0.75	0.63
BAY	**Total**	**9.4**	**0.6**	**0.07**	**0.0%**	**0.75**	**0.63**	**0.75**	**0.63**
SCR	AHUP	0.0	0.0	0.54	0.0%	0.75	0.60	0.75	0.60
SCR	HUP	1.6	0.3	0.18	0.0%	0.75	0.60	0.75	0.60
SCR	**Total**	**1.6**	**0.3**	**0.18**	**0.0%**	**0.75**	**0.60**	**0.75**	**0.60**
	Statewide	***56.7***	***16.4***	***0.29***	***0.0%***	***0.68***	***0.68***	***0.68***	***0.68***

Gross Lifecycle Savings (MTherms)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	AHUP	5,637	1,466	0.26	0.0%	0.26
PGE	HUP	497	526	1.06	0.0%	1.06
PGE	**Total**	**6,134**	**1,992**	**0.32**	**0.0%**	**0.32**
SCE	AHUP	1,441	1,441	1.00	0.0%	1.00
SCE	HUP	564	561	1.00	0.0%	1.00
SCE	**Total**	**2,005**	**2,002**	**1.00**	**0.0%**	**1.00**
SCG	AHUP	3,111	1,855	0.60	0.0%	0.60
SCG	HUP	1,849	874	0.47	0.0%	0.47
SCG	**Total**	**4,960**	**2,729**	**0.55**	**0.0%**	**0.55**
SDGE	AHUP	15	15	1.00	100.0%	
SDGE	HUP	209	106	0.51	0.0%	0.51
SDGE	**Total**	**224**	**121**	**0.54**	**6.7%**	**0.51**
BAY	HUP	2,102	1,737	0.83	0.0%	0.83
BAY	**Total**	**2,102**	**1,737**	**0.83**	**0.0%**	**0.83**
SCR	AHUP	1	2	1.79	0.0%	1.79
SCR	HUP	174	322	1.85	0.0%	1.85
SCR	**Total**	**176**	**325**	**1.85**	**0.0%**	**1.85**
	Statewide	***15,601***	***8,906***	***0.57***	***0.1%***	***0.57***

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	AHUP	3,670	982	0.27	0.0%	0.65	0.67	0.65	0.67
PGE	HUP	372	352	0.95	0.0%	0.75	0.67	0.75	0.67
PGE	**Total**	**4,042**	**1,335**	**0.33**	**0.0%**	**0.66**	**0.67**	**0.66**	**0.67**
SCE	AHUP	865	1,009	1.17	0.0%	0.60	0.70	0.60	0.70
SCE	HUP	423	393	0.93	0.0%	0.75	0.70	0.75	0.70
SCE	**Total**	**1,288**	**1,402**	**1.09**	**0.0%**	**0.64**	**0.70**	**0.64**	**0.70**
SCG	AHUP	2,333	1,354	0.58	0.0%	0.75	0.73	0.75	0.73
SCG	HUP	1,391	638	0.46	0.0%	0.75	0.73	0.75	0.73
SCG	**Total**	**3,724**	**1,992**	**0.53**	**0.0%**	**0.75**	**0.73**	**0.75**	**0.73**
SDGE	AHUP	13	8	0.57	0.0%	0.90	0.51	0.90	0.51
SDGE	HUP	157	54	0.35	0.0%	0.75	0.51	0.75	0.51
SDGE	**Total**	**170**	**62**	**0.36**	**0.0%**	**0.76**	**0.51**	**0.76**	**0.51**
BAY	HUP	1,576	1,094	0.69	0.0%	0.75	0.63	0.75	0.63
BAY	**Total**	**1,576**	**1,094**	**0.69**	**0.0%**	**0.75**	**0.63**	**0.75**	**0.63**
SCR	AHUP	1	1	1.43	0.0%	0.75	0.60	0.75	0.60
SCR	HUP	131	193	1.48	0.0%	0.75	0.60	0.75	0.60
SCR	**Total**	**132**	**195**	**1.48**	**0.0%**	**0.75**	**0.60**	**0.75**	**0.60**
	Statewide	***10,932***	***6,079***	***0.56***	***0.0%***	***0.70***	***0.68***	***0.70***	***0.68***

Gross First Year Savings (MWh)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	AHUP	3,610	506	0.14	0.0%	0.14
PGE	HUP	322	281	0.87	0.0%	0.87
PGE	**Total**	**3,932**	**786**	**0.20**	**0.0%**	**0.20**
SCE	AHUP	1,068	277	0.26	0.0%	0.26
SCE	HUP	234	82	0.35	0.0%	0.35
SCE	**Total**	**1,302**	**359**	**0.28**	**0.0%**	**0.28**
SCG	AHUP	71	71	1.00	0.0%	1.00
SCG	HUP	90	90	1.00	0.0%	1.00
SCG	**Total**	**162**	**162**	**1.00**	**0.0%**	**1.00**
SDGE	AHUP	98	98	1.00	100.0%	
SDGE	HUP	61	-3	-0.04	0.0%	-0.04
SDGE	**Total**	**159**	**95**	**0.60**	**61.5%**	**-0.04**
BAY	HUP	520	81	0.16	0.0%	0.16
BAY	**Total**	**520**	**81**	**0.16**	**0.0%**	**0.16**
SCR	AHUP	1	0	0.26	0.0%	0.26
SCR	HUP	185	99	0.54	0.0%	0.54
SCR	**Total**	**186**	**100**	**0.54**	**0.0%**	**0.54**
	Statewide	***6,260***	***1,583***	***0.25***	***1.6%***	***0.24***

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	AHUP	2,361	339	0.14	0.0%	0.65	0.67	0.65	0.67
PGE	HUP	240	188	0.78	0.0%	0.75	0.67	0.75	0.67
PGE	**Total**	**2,601**	**527**	**0.20**	**0.0%**	**0.66**	**0.67**	**0.66**	**0.67**
SCE	AHUP	641	194	0.30	0.0%	0.60	0.70	0.60	0.70
SCE	HUP	175	58	0.33	0.0%	0.75	0.70	0.75	0.70
SCE	**Total**	**816**	**251**	**0.31**	**0.0%**	**0.63**	**0.70**	**0.63**	**0.70**
SCG	AHUP	54	52	0.97	0.0%	0.75	0.73	0.75	0.73
SCG	HUP	68	66	0.96	0.0%	0.76	0.73	0.76	0.73
SCG	**Total**	**122**	**118**	**0.97**	**0.0%**	**0.75**	**0.73**	**0.75**	**0.73**
SDGE	AHUP	88	50	0.57	0.0%	0.90	0.51	0.90	0.51
SDGE	HUP	46	-1	-0.03	0.0%	0.75	0.51	0.75	0.51
SDGE	**Total**	**134**	**49**	**0.36**	**0.0%**	**0.84**	**0.51**	**0.84**	**0.51**
BAY	HUP	390	51	0.13	0.0%	0.75	0.63	0.75	0.63
BAY	**Total**	**390**	**51**	**0.13**	**0.0%**	**0.75**	**0.63**	**0.75**	**0.63**
SCR	AHUP	1	0	0.21	0.0%	0.75	0.60	0.75	0.60
SCR	HUP	139	60	0.43	0.0%	0.75	0.60	0.75	0.60
SCR	**Total**	**139**	**60**	**0.43**	**0.0%**	**0.75**	**0.60**	**0.75**	**0.60**
	Statewide	***4,203***	***1,056***	***0.25***	***0.0%***	***0.67***	***0.67***	***0.67***	***0.67***

Gross First Year Savings (MW)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	AHUP	2.3	0.6	0.28	0.0%	0.28
PGE	HUP	0.4	0.1	0.16	0.0%	0.16
PGE	**Total**	**2.6**	**0.7**	**0.26**	**0.0%**	**0.26**
SCE	AHUP	1.4	0.3	0.22	0.0%	0.22
SCE	HUP	0.4	0.2	0.39	0.0%	0.39
SCE	**Total**	**1.8**	**0.5**	**0.26**	**0.0%**	**0.26**
SCG	AHUP	0.1	0.1	1.00	0.0%	1.00
SCG	HUP	0.1	0.1	1.00	0.0%	1.00
SCG	**Total**	**0.2**	**0.2**	**1.00**	**0.0%**	**1.00**
SDGE	AHUP	0.1	0.1	1.00	100.0%	
SDGE	HUP	0.1	0.0	-0.25	0.0%	-0.25
SDGE	**Total**	**0.2**	**0.0**	**0.30**	**43.7%**	**-0.25**
BAY	HUP	0.8	0.1	0.07	0.0%	0.07
BAY	**Total**	**0.8**	**0.1**	**0.07**	**0.0%**	**0.07**
SCR	AHUP	0.0	0.0	0.22	0.0%	0.22
SCR	HUP	0.4	0.0	0.08	0.0%	0.08
SCR	**Total**	**0.4**	**0.0**	**0.08**	**0.0%**	**0.08**
	Statewide	***6.0***	***1.5***	***0.26***	***1.2%***	***0.25***

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	AHUP	1.5	0.4	0.29	0.0%	0.65	0.67	0.65	0.67
PGE	HUP	0.3	0.0	0.14	0.0%	0.75	0.67	0.75	0.67
PGE	**Total**	**1.8**	**0.5**	**0.27**	**0.0%**	**0.67**	**0.67**	**0.67**	**0.67**
SCE	AHUP	0.9	0.2	0.26	0.0%	0.60	0.70	0.60	0.70
SCE	HUP	0.3	0.1	0.36	0.0%	0.75	0.70	0.75	0.70
SCE	**Total**	**1.2**	**0.3**	**0.29**	**0.0%**	**0.63**	**0.70**	**0.63**	**0.70**
SCG	AHUP	0.1	0.1	0.97	0.0%	0.75	0.73	0.75	0.73
SCG	HUP	0.1	0.1	0.97	0.0%	0.76	0.73	0.76	0.73
SCG	**Total**	**0.2**	**0.2**	**0.97**	**0.0%**	**0.75**	**0.73**	**0.75**	**0.73**
SDGE	AHUP	0.1	0.0	0.57	0.0%	0.90	0.51	0.90	0.51
SDGE	HUP	0.1	0.0	-0.17	0.0%	0.75	0.51	0.75	0.51
SDGE	**Total**	**0.1**	**0.0**	**0.19**	**0.0%**	**0.82**	**0.51**	**0.82**	**0.51**
BAY	HUP	0.6	0.0	0.06	0.0%	0.75	0.63	0.75	0.63
BAY	**Total**	**0.6**	**0.0**	**0.06**	**0.0%**	**0.75**	**0.63**	**0.75**	**0.63**
SCR	AHUP	0.0	0.0	0.18	0.0%	0.75	0.60	0.75	0.60
SCR	HUP	0.3	0.0	0.06	0.0%	0.75	0.60	0.75	0.60
SCR	**Total**	**0.3**	**0.0**	**0.06**	**0.0%**	**0.75**	**0.60**	**0.75**	**0.60**
	Statewide	***4.1***	***1.0***	***0.26***	***0.0%***	***0.68***	***0.68***	***0.68***	***0.68***

Gross First Year Savings (MTherms)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	AHUP	290	75	0.26	0.0%	0.26
PGE	HUP	36	38	1.04	0.0%	1.04
PGE	**Total**	**326**	**113**	**0.35**	**0.0%**	**0.35**
SCE	AHUP	103	103	1.00	0.0%	1.00
SCE	HUP	31	31	1.00	0.0%	1.00
SCE	**Total**	**134**	**134**	**1.00**	**0.0%**	**1.00**
SCG	AHUP	189	112	0.60	0.0%	0.60
SCG	HUP	115	54	0.47	0.0%	0.47
SCG	**Total**	**303**	**166**	**0.55**	**0.0%**	**0.55**
SDGE	AHUP	1	1	1.00	100.0%	
SDGE	HUP	13	6	0.50	0.0%	0.50
SDGE	**Total**	**14**	**7**	**0.53**	**6.6%**	**0.50**
BAY	HUP	138	94	0.68	0.0%	0.68
BAY	**Total**	**138**	**94**	**0.68**	**0.0%**	**0.68**
SCR	AHUP	0	0	0.60	0.0%	0.60
SCR	HUP	29	18	0.62	0.0%	0.62
SCR	**Total**	**29**	**18**	**0.62**	**0.0%**	**0.62**
	Statewide	***944***	***532***	***0.56***	***0.1%***	***0.56***

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	AHUP	189	51	0.27	0.0%	0.65	0.67	0.65	0.67
PGE	HUP	27	25	0.93	0.0%	0.75	0.67	0.75	0.67
PGE	**Total**	**216**	**76**	**0.35**	**0.0%**	**0.66**	**0.67**	**0.66**	**0.67**
SCE	AHUP	62	72	1.17	0.0%	0.60	0.70	0.60	0.70
SCE	HUP	23	22	0.93	0.0%	0.75	0.70	0.75	0.70
SCE	**Total**	**85**	**94**	**1.10**	**0.0%**	**0.64**	**0.70**	**0.64**	**0.70**
SCG	AHUP	141	82	0.58	0.0%	0.75	0.73	0.75	0.73
SCG	HUP	87	39	0.45	0.0%	0.75	0.73	0.75	0.73
SCG	**Total**	**228**	**121**	**0.53**	**0.0%**	**0.75**	**0.73**	**0.75**	**0.73**
SDGE	AHUP	1	0	0.57	0.0%	0.90	0.51	0.90	0.51
SDGE	HUP	10	3	0.34	0.0%	0.75	0.51	0.75	0.51
SDGE	**Total**	**10**	**4**	**0.36**	**0.0%**	**0.76**	**0.51**	**0.76**	**0.51**
BAY	HUP	104	59	0.57	0.0%	0.75	0.63	0.75	0.63
BAY	**Total**	**104**	**59**	**0.57**	**0.0%**	**0.75**	**0.63**	**0.75**	**0.63**
SCR	AHUP	0	0	0.48	0.0%	0.75	0.60	0.75	0.60
SCR	HUP	22	11	0.49	0.0%	0.75	0.60	0.75	0.60
SCR	**Total**	**22**	**11**	**0.49**	**0.0%**	**0.75**	**0.60**	**0.75**	**0.60**
	Statewide	***665***	***364***	***0.55***	***0.0%***	***0.70***	***0.68***	***0.70***	***0.68***

7.2 Appendix AB Per Unit (Quantity) Gross and Net Energy Savings

Per unit (quantity) gross and net energy savings are presented in the tables beginning on the next page.

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	AHUP	0	0.0%	0.0%	15.3	1.9	0.1	0.1
PGE	HUP	0	1.9%	0.0%	15.4	134.2	9.0	9.0
SCE	AHUP	0	0.5%	0.0%	14.0	4,923.5	351.5	351.5
SCE	HUP	0	100.0%	0.0%	17.8	2,241.1	125.0	125.0
SCG	AHUP	0	0.0%	0.0%	16.5	857.2	52.0	52.0
SCG	HUP	0	0.8%	0.0%	19.6	22.0	1.3	1.3
SDGE	HUP	0	100.0%	0.0%	16.5	-195.3	-11.8	-11.8
SDGE	AHUP	1	0.0%		16.5	40,380.5	2,447.3	2,447.3
BAY	HUP	0	100.0%	0.0%	18.5	1,069.8	58.5	58.5
SCR	AHUP	0	100.0%	0.0%	17.9	1,394.0	78.5	78.5
SCR	HUP	0	75.3%	0.0%	13.6	2,658.4	147.4	147.4

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	AHUP	0	0.0%	0.0%	15.3	0.4	0.0	0.0
PGE	HUP	0	1.9%	0.0%	15.4	16.9	1.2	1.2
SCE	AHUP	0	0.5%	0.0%	14.0	1,829.1	130.6	130.6
SCE	HUP	0	100.0%	0.0%	17.8	854.1	47.4	47.4
SCG	AHUP	0	0.0%	0.0%	16.5	1,348.8	81.7	81.7
SCG	HUP	0	0.8%	0.0%	19.6	12.8	0.8	0.8
SDGE	HUP	0	100.0%	0.0%	16.5	494.7	30.0	30.0
SDGE	AHUP	1	0.0%		16.5	373.5	22.6	22.6
BAY	HUP	0	100.0%	0.0%	18.5	1,250.3	67.4	67.4
SCR	AHUP	0	100.0%	0.0%	17.9	599.4	33.5	33.5
SCR	HUP	0	75.3%	0.0%	13.6	477.6	26.2	26.2

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	AHUP	0	0.0%	0.0%	15.3	1.3	0.1	0.1
PGE	HUP	0	1.9%	0.0%	15.4	89.9	6.0	6.0
SCE	AHUP	0	0.5%	0.0%	14.0	3,446.4	246.1	246.1
SCE	HUP	0	100.0%	0.0%	17.8	1,568.8	87.5	87.5
SCG	AHUP	0	0.0%	0.0%	16.5	625.7	37.9	37.9
SCG	HUP	0	0.8%	0.0%	19.6	16.1	1.0	1.0
SDGE	AHUP	0	0.0%	0.0%	16.5	20,594.1	1,248.1	1,248.1
SDGE	HUP	0	100.0%	0.0%	16.5	-99.6	-6.0	-6.0
BAY	HUP	0	100.0%	0.0%	18.5	674.0	36.9	36.9
SCR	AHUP	0	100.0%	0.0%	17.9	836.4	47.1	47.1
SCR	HUP	0	75.3%	0.0%	13.6	1,595.0	88.4	88.4

Per Unit (Quantity) Net Energy Savings (Therms)

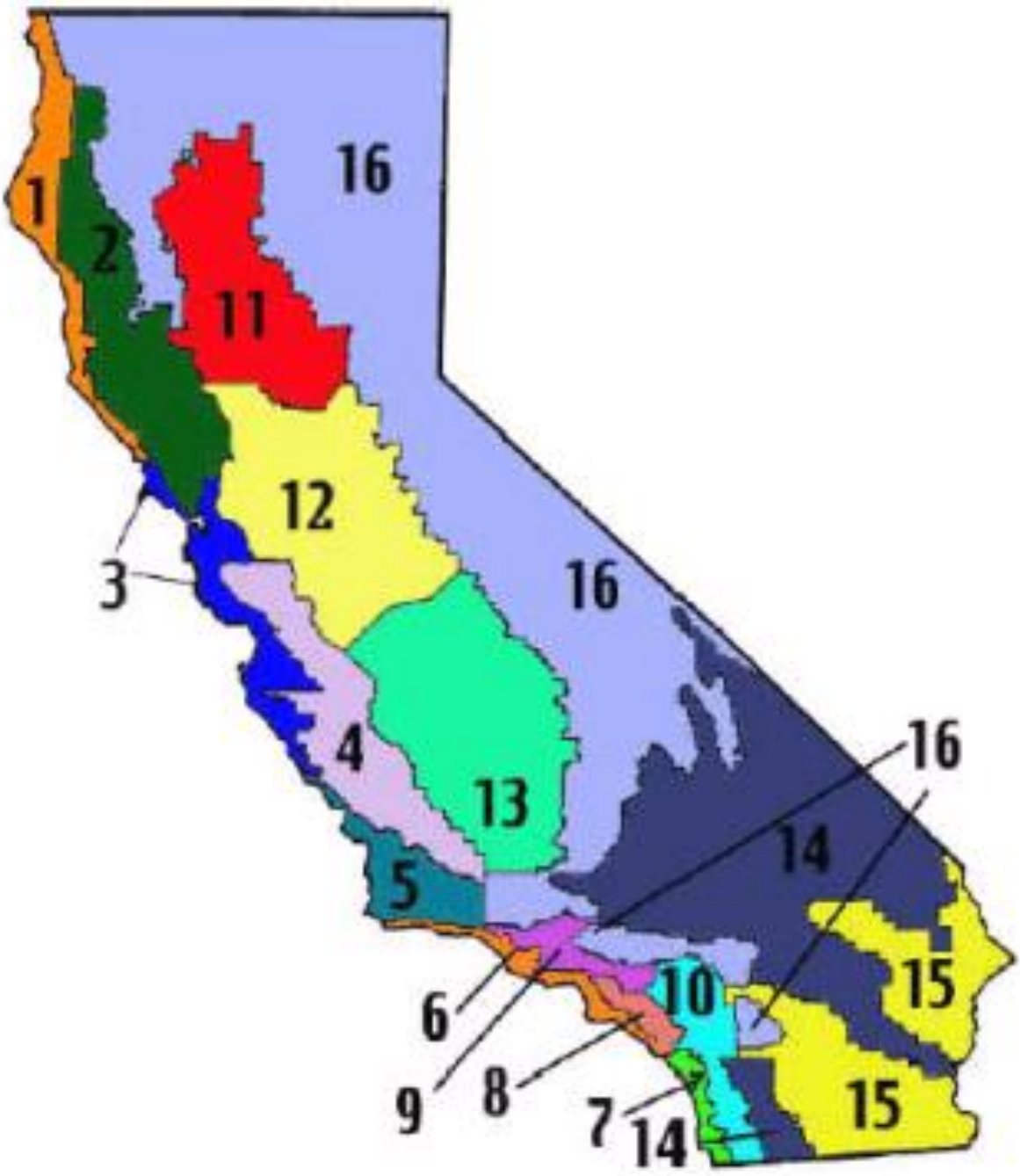
PA	Standard Report Group	Pass Through	% ER Ex-Ante	% ER Ex-Post	Average EUL (yr)	Ex-Post Lifecycle	Ex-Post First Year	Ex-Post Annualized
PGE	AHUP	0	0.0%	0.0%	15.3	0.2	0.0	0.0
PGE	HUP	0	1.9%	0.0%	15.4	11.3	0.8	0.8
SCE	AHUP	0	0.5%	0.0%	14.0	1,280.4	91.4	91.4
SCE	HUP	0	100.0%	0.0%	17.8	597.9	33.2	33.2
SCG	AHUP	0	0.0%	0.0%	16.5	984.7	59.7	59.7
SCG	HUP	0	0.8%	0.0%	19.6	9.4	0.6	0.6
SDGE	AHUP	0	0.0%	0.0%	16.5	190.5	11.5	11.5
SDGE	HUP	0	100.0%	0.0%	16.5	252.3	15.3	15.3
BAY	HUP	0	100.0%	0.0%	18.5	787.7	42.5	42.5
SCR	AHUP	0	100.0%	0.0%	17.9	359.6	20.1	20.1
SCR	HUP	0	75.3%	0.0%	13.6	286.6	15.7	15.7

7.3 Appendix AC Recommendations

Table 7-1. Home Upgrade Program PY 2017 Recommendations

Study ID	Study Type	Study Title/Program	Study Manager
CALMAC ID: CPU0191.01	Impact Evaluation	Home Upgrade Program Impact Evaluation PY 2017 (Residential)	CPUC Energy Division
Recommendations (Recipients - All IOUs)	**Summary of Findings**	**Additional Supporting Information**	**Best Practice / Recommendations**
1	Free-ridership continues to be a significant issue for the program. Overall free-ridership for HUP and AHUP for program year 2017 is estimated at 38%.	Section 5.2.2	The level of free riders at 38% has implications for targeting future participants. Program savings can be improved by targeting customers who fit the following descriptors: live inland, implement larger upgrades with 7 measures or more, and are candidates for the advanced path program.
2	Percent savings for electricity are consistently lower than for gas and have remained largely unchanged over time. Program staff interviews, and customer responses indicate increased heating/cooling load to improve comfort. Electrification trends such as heat pumps that deliver both heating and cooling further add to electric load for fuel switching customers, resulting in lower than forecasted program savings.	Section 4.1, 5.2.3, 5.2.4, 5.2.5	Forecasted savings calculations should factor in implementation of HVAC measures. Any departures from default hours of use assumptions and potential changes to households' baseline use should be factored in as well.
3	Realization rates for AHUP do not show much change over time. The tools approved under CalTest that were supposed to address the problem of inflated energy savings provided by EnergyPro still provide inflated forecasts.	Section 4.3	Forecasted savings calculations should factor in implementation of HVAC measures. Any departures from default hours of use assumptions and potential changes to households' baseline use should be factored into forecasts as well.
4	The trend of increasing solar photovoltaic (PV) adoption has implications for future evaluations of HUP and AHUP and pay for performance programs (programs with incentives based on normalized metered energy consumption). Billing data does not currently provide a measure of energy consumption that includes the share from self-generation.	Section 4.5	PAs/program implementers should consider devices to measure energy production at the customer site and linking measurements to billing data. This will enable an accurate measurement of energy consumption from the household load for net-metered customers. Future waves should factor in solar and EV adoption when forecasting expected savings and in the models to estimate savings.

7.4 Appendix A: Climate zone map



7.5 Appendix B: Matching results

7.5.1 Additional matching details

We provide further detail on the matching algorithm we used as well as matching results in this section. The propensity score matching (PSM) process involves the following general steps:

- Select households' characteristics that are related to program participation
- Examine the distribution of these characteristics and exclude observations of the comparison group that do not overlap with those of participants' as a first round of identifying common support for matching
- Fit a logistic regression using these variables to estimate the probability of program participation
- Conduct a second round of trimming or common support identification based on propensity scores
- Select a matching method, the number of comparators in the many-to-one matching, and whether to match with or without replacement; match participant households' scores to comparison households based on these selections
- Conduct diagnostic checks to see selected matches are well-balanced

To avoid correlation between dependent variable and regression errors, by construction, we need to match using variables other than the dependent variable (consumption in our case). Such variables can include any characteristics such as household size, heating and cooling source, and rate groups that may affect treatment assignment. They can also include variables measured before participation, such pre-program consumption.

The latter is the approach we take as comprehensive data on household characteristics are not readily available. We match participant households in each IOU's service territory using monthly electric and gas use prior to any program implementation. In this evaluation the matching period is November 2014 until October 2015.

We also use climate zone information to stratify the data for matching. This involves implementing the matching procedure within three pre-defined climate zones defined as inland, desert and mild. Table 7-2 illustrates this climate zone grouping and the distribution of participant households over the zones by PA.

Table 7-2. Climate zone groups for stratified matching

Climate zone group	Title 24 climate zone	Percent program participant					
		BayREN	PG&E	SCE	SoCalGas	SDG&E	SoCalREN
Mild/Coastal	1,2,3,4,5,6,7,16	50%	13%	8%	8%	65%	5%
Inland	8,9,10,11,12,12,14	50%	87%	92%	90%	35%	95%
Desert	15	0%	0%	1%	2%	0%	0%

7.5.2 Matching results

We use two metrics, standardized difference of the mean and the ratio of the variance of matched-comparison and participant households, to check that the selected matches are well-balanced and appropriate for analysis. The mean and the variance fully character size the distribution of consumption

among the two groups, and the two metrics provide a good indication of the condition of balance. A standardized difference value that exceeds 0.2 or 20% indicates great imbalance as does a variance ratio that is 2 or great or 0.5 or less. Values of standardized means differences that are close to 0 and ratios that are close to 1 indicate well-matched samples.

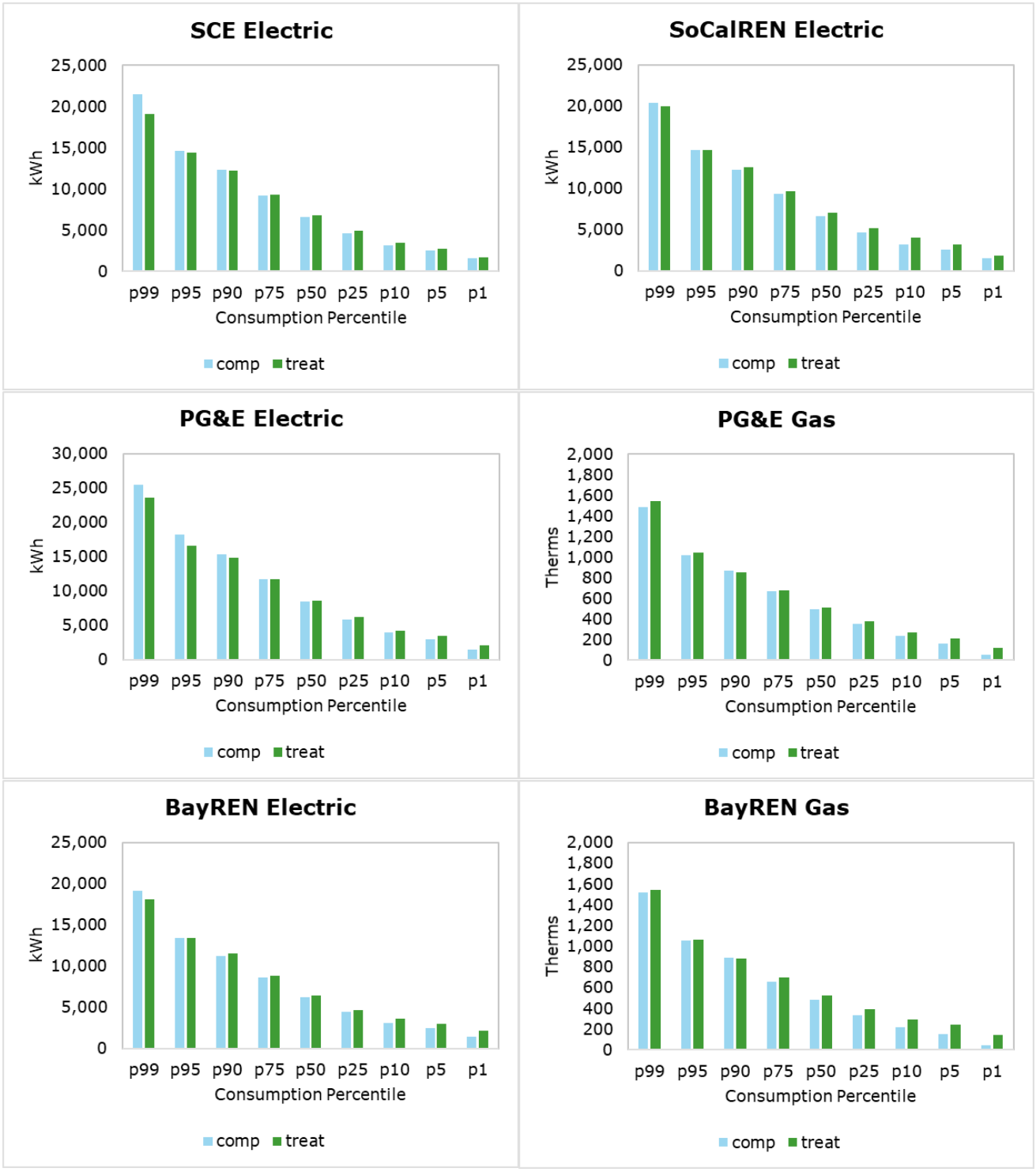
Table 7-3 provides the value of these metrics for total consumption before and after matching participant to matched comparison households. We note severe imbalance prior to matching with standardized difference means ranging in value from 0.2 to 0.9. All matched datasets, on the other hand, have a value of zero for this metric. The variance of the ratios of the total consumption of two groups, which are also close to 1 post matching, indicate good balance.

Table 7-3. Test of balance for matched datasets

Fuel Group	standardized difference		variance ratio	
	unmatched	matched	unmatched	matched
PG&E				
dual fuel electric use	0.5	0.0	1.1	0.8
electric-only use	0.9	0.0	1.1	0.9
dual fuel gas use	0.2	0.0	0.6	0.9
gas-only use	0.2	0.0	1.0	1.0
SDG&E				
dual fuel electric use	0.4	0.0	1.0	0.8
electric-only use	0.5	0.0	1.2	0.7
dual fuel gas use	0.1	0.0	0.7	0.7
SCE				
electric-only use	0.3	0.0	0.9	0.8
SoCalGas				
gas-only use	0.1	0.0	0.7	0.8

Further, we also provide a visual demonstration of the condition of matches using distribution plots of the consumption of participant and matched comparison households. We provide a plot of the distribution of a few the matched datasets in Figure 7-1.

Figure 7-1. Distribution of select matched groups



7.5.3 Data preparation

In this section we provide a brief outline of the data preparation steps we undertook. Table 7-4 indicates starting household counts from the tracking data considered for use in the evaluation, the number of

customers that had 12 months of pre and post data and are used in matching, customers counts with matched data, and finally customers with AMI data that we were able to use for the analysis. The table does not give the breakdown by fuel but indicates the magnitudes of the datasets used in matching and had interval data available for modeling.

Table 7-4. Analysis data preparation

Data preparation counts	BayREN	PG&E	SCE	SoCalGas	SoCalREN	SDG&E
Customers in tracking data	3,561	8,085	6,390	8,361	2,349	1,065
Customers with 12 months pre/post billing data	2,491	6,136	4,500	5,416	1,956	722
Customers with matched data	2,384	5,829	4,488	5,356	1,946	716
Customers with AMI data	2,320	5,737	4,302	732	961	642

In Table 7-5, we provide the final counts of customers used in the analysis.

Table 7-5. Household counts used in analysis, Q3 2016 – Q2 2017

Program Administrator	Number of participants used in analysis	
	Electric	Gas
BayREN	1,132	1,250
PG&E	1,343	1,406
SCE	1,417	NA
SoCalGas	NA	1,268
SoCalREN	358	241
SDG&E	194	264
Overall	**4,444**	**4,429**

7.6 Appendix C: Site-level model results

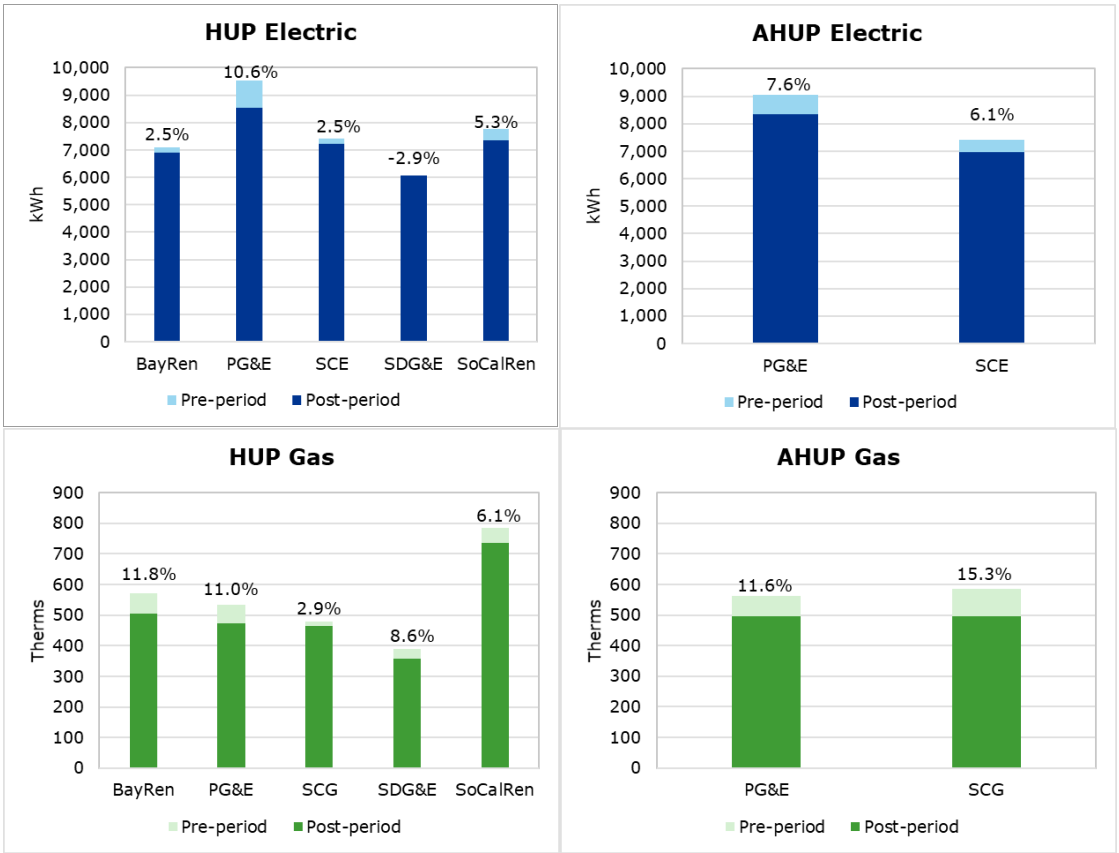
Site-level models provide energy use that reflect normal or typical year weather conditions. DNV GL estimates weather normalized annual consumption (NAC) in the pre- and post-program periods using the optimal degree-day base for each site. Optimal degree day base or balance point estimates reflect the temperatures at which each household uses heating or cooling. Such points are a function of the level of insulation, solar gains and thermostat set points.

Figure 7-2 provides a comparison of NAC levels pre- and post-installation for program participants by PA. The panels in the figure provide percent change in NAC above the bar for each PA. Results for electric NAC changes for HUP and AHUP are in the top panel while the bottom panel provides the gas results.

Pre-post NAC differences reflect unadjusted gross changes and indicate the extent of weather-normalized energy use adjustments in the post-installation period. If post-period unadjusted gross changes are positive, they reflect energy use reductions that are due to weather and other factors including the program. In other words, they incorporate general energy use trends that reflect weather, program and non-program effects.

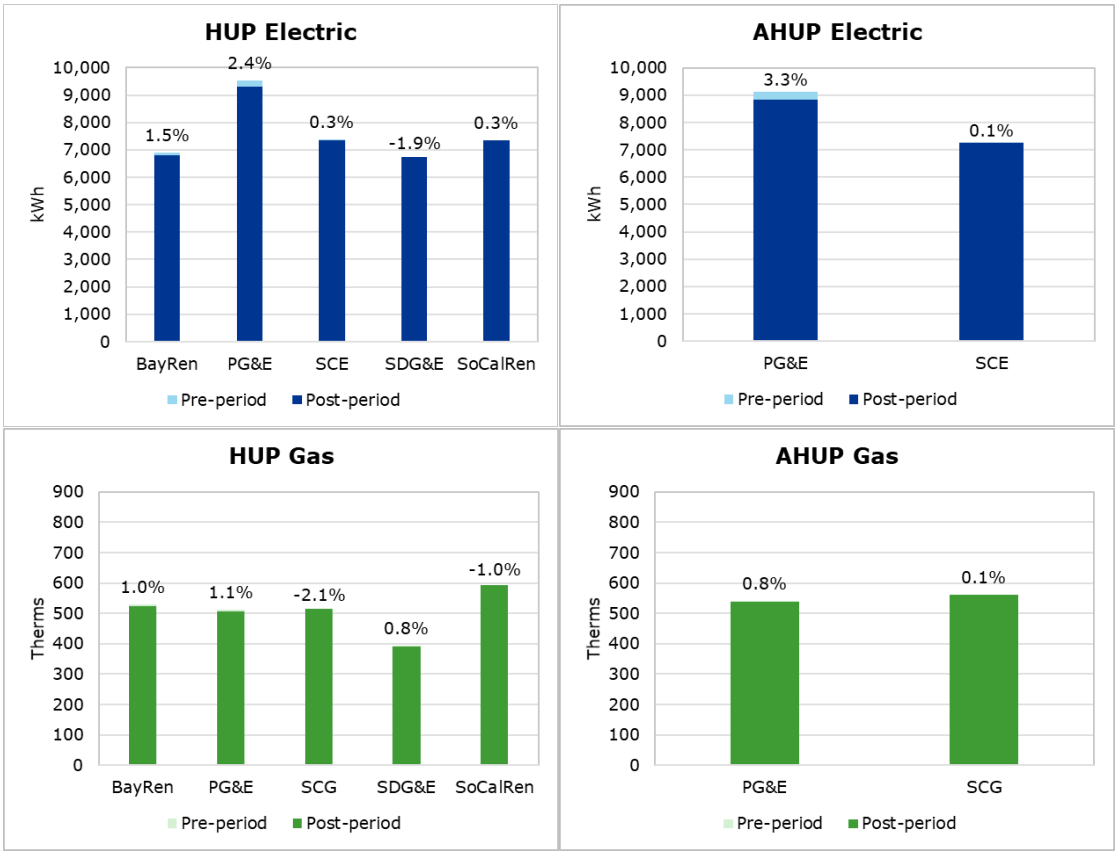
Unadjusted gross electric use reductions range from 2.5% (BayREN) to 10.6% (PG&E) for HUP, and 6.1% and 7.6% for AHUP. Gas reductions are greater and range from 2.9% to 11.8% for HUP, and 11.6% to 15.3% for AHUP. SDG&E experienced increases in unadjusted gross energy use in the post-program period except for gas for HUP.

Figure 7-2. Change in normalized annual consumption (NAC) for participants



Note: AHUP figures exclude SDG&E results because the small number of observations did not make it possible to obtain robust savings estimates.

Figure 7-3. Change in normalized annual consumption (NAC) for the comparison group



Note: AHUP figures exclude SDG&E results because the small number of observations did not make it possible to obtain robust savings estimates.

Figure 7-3 provides the pre- and post-period NAC changes for the comparison group. In most cases, comparison groups experienced post-period weather-normalized energy use reductions. However, these reductions were generally lower than for program participants.

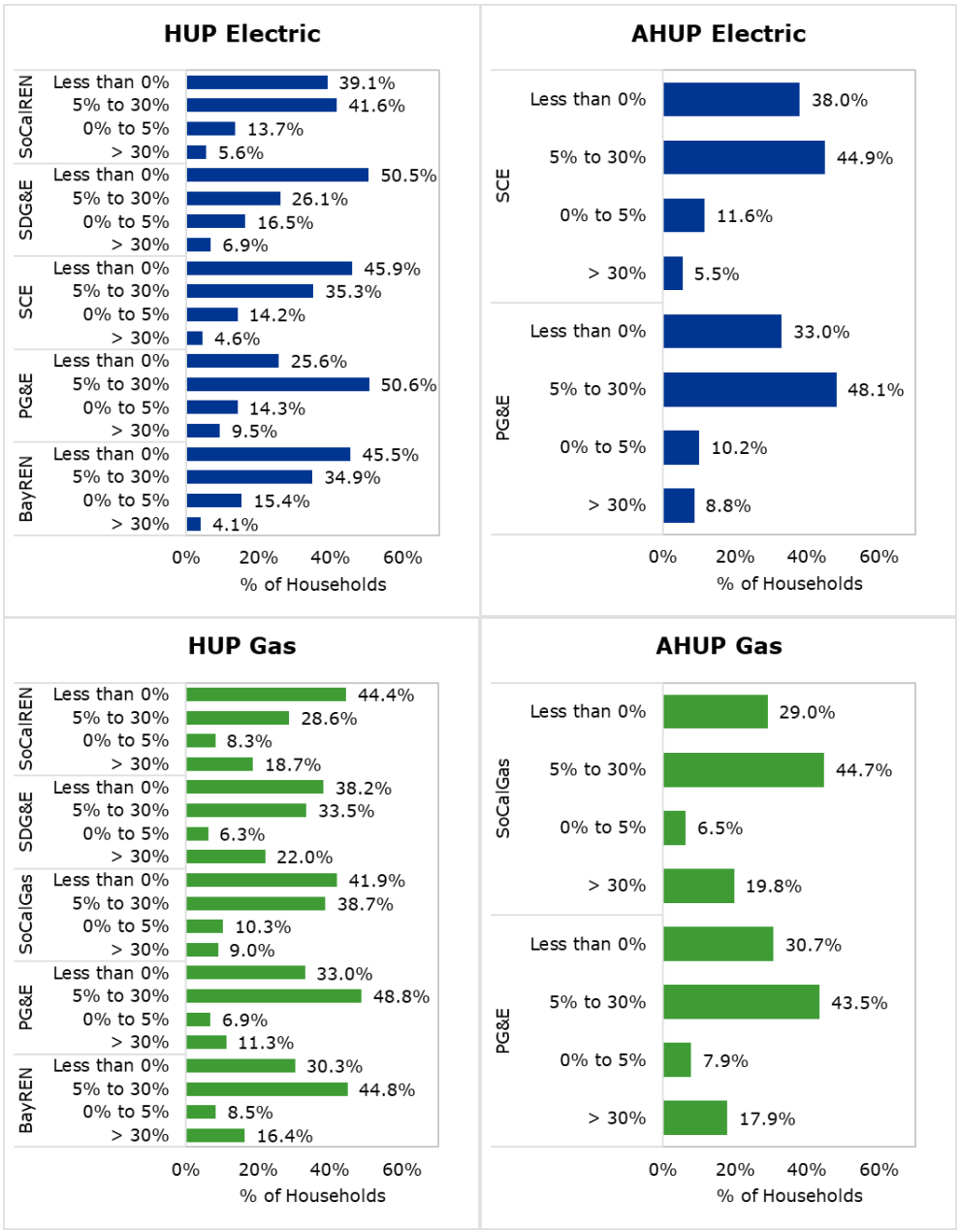
Without program intervention, we expect the treatment households' consumption patterns to be like the comparison groups', with a similar percent reduction or increase in energy use from the pre- to the post-period. In the presence of program intervention, the comparison groups' energy use consumption changes in the post-period provide controls for non-program related changes. Therefore, to calculate the percent savings due to program, we subtract the percent change in comparison households' energy use from treatment households' energy use. As an example, PG&E HUP treatment households reduced their electricity consumption by 10.6% and comparison group households reduced their electricity consumption by 2.4% in the post period, resulting in a program impact of about 8.0%.

The models reported in Table 7-6 through Table 7-9 provide similar information in therm and kWh terms. The intercept terms in these models provide non-program related energy use changes for each program pathway by PA and fuel. The value of unadjusted gross changes are the sum of the intercept term and the treatment coefficient. For instance, for PG&E's HUP program the unadjusted gross change is estimated to be about 1,000 kWh per household and includes non-program related reductions of 300 kWh per household

captured by the intercept term. The adjusted gross saving value of 706 kWh reflects an estimate of program-induced electric use reductions among PG&E's HUP households.

Figure 7-4 presents the distribution of percent NAC changes from pre- to post-program period by PA. Except for SDG&E, less than 50% of all participants have an increase in NAC from the pre- to the post-period (are in the less than 0% category). This indicates that the majority of participants have unadjusted gross energy use reductions. For those with unadjusted gross reductions, the percent of customers is highest in the 5% to 30% bin for both gas and electric NAC changes for all PAs.

Figure 7-4. Distribution of participant normalized annual consumption (NAC) changes



Note: AHUP figures exclude SDG&E results because the small number of observations did not make it possible to obtain robust savings estimates.

7.7 Appendix D: Difference-in-difference model results

Table 7-6 through Table 7-9 present the parameters from the difference-in-difference models.

Table 7-6. Electric HUP different-in-difference parameters

Program Administrator	Parameters	N	Estimates	StdErr	t-stat	p-value
BayREN	Intercept	1,132	-105.9	29.1	-3.6	0.00
	Treatment		-74.2	78.7	-0.9	0.35
PG&E	Intercept	433	-301.1	45.7	-6.6	0.00
	Treatment		-705.5	126.8	-5.6	0.00
SCE	Intercept	1,071	-24.6	21.3	-1.2	0.25
	Treatment		-153.2	55.7	-2.8	0.01
SDG&E	Intercept	183	125.8	40.3	3.1	0.00
	Treatment		22.0	105.3	0.2	0.83
SoCalREN	Intercept	358	-23.8	36.3	-0.7	0.51
	Treatment		-385.4	97.3	-4.0	0.00

Table 7-7. Electric AHUP difference-in-difference parameters

Program Administrator	Parameters	N	Estimates	StdErr	t-stat	p-value
PG&E	Intercept	910	-297.9	34.1	-8.7	0.00
	Treatment		-412.0	96.4	-4.3	0.00
SCE	Intercept	346	-6.8	35.8	-0.2	0.85
	Treatment		-455.8	108.7	-4.2	0.00
SDG&E	Intercept	11	-103.7	177.4	-0.6	0.56
	Treatment		683.5	407.4	1.7	0.10

Table 7-8. Gas HUP difference-in-difference parameters

Program Administrator	Parameters	N	Estimates	StdErr	t-stat	p-value
BayREN	Intercept	1,250	-5.5	1.7	-3.3	0.00
	Treatment		-61.6	4.4	-14.1	0.00
PG&E	Intercept	451	-5.6	2.7	-2.1	0.04
	Treatment		-53.0	6.9	-7.6	0.00
SoCalGas	Intercept	763	10.5	4.3	2.4	0.01
	Treatment		-24.5	8.7	-2.8	0.00
SDG&E	Intercept	251	-3.0	3.7	-0.8	0.42
	Treatment		-31.6	8.7	-3.7	0.00
SoCalREN	Intercept	241	5.9	18.9	0.3	0.76
	Treatment		-53.9	26.7	-2.0	0.04

Table 7-9. Gas AHUP difference-in-difference parameters

Program Administrator	Parameters	N	Estimates	StdErr	t-stat	p-value
PG&E	Intercept	955	-4.3	2.5	-1.7	0.09
	Treatment		-57.0	6.6	-8.6	0.00
SoCalGas	Intercept	505	-0.5	5.0	-0.1	0.93
	Treatment		-84.5	10.1	-8.3	0.00
SDG&E	Intercept	13	-49.3	15.6	-3.2	0.00
	Treatment		93.5	37.5	2.5	0.01

7.8 Appendix E: Peak demand model results

Table 7-10 through Table 7-17 present the parameters for the peak demand models.

Table 7-10. BayREN peak demand parameters

Parameter	Estimate	StdErr	t-stat	p-value
h1	-0.2	0.0	-53.1	0.0
h2	-0.2	0.0	-53.2	0.0
h3	-0.3	0.0	-60.3	0.0
h4	-0.3	0.0	-63.7	0.0
h5	-0.4	0.0	-64.4	0.0
h6	-0.4	0.0	-62.9	0.0
h7	-0.3	0.0	-55.4	0.0
h8	-0.3	0.0	-42.1	0.0
h9	-0.2	0.0	-31.3	0.0
h10	-0.2	0.0	-30.6	0.0
h11	-0.2	0.0	-28.0	0.0
h12	-0.2	0.0	-25.2	0.0
h13	-0.2	0.0	-22.8	0.0
h14	-0.2	0.0	-20.6	0.0
h15	-0.2	0.0	-17.8	0.0
h16	-0.1	0.0	-12.2	0.0
h17	0.0	0.0	-3.7	0.0
h18	0.1	0.0	5.6	0.0
h19	0.1	0.0	15.2	0.0
h20	0.2	0.0	22.5	0.0
h21	0.2	0.0	27.4	0.0
h22	0.2	0.0	38.3	0.0
h23	0.1	0.0	46.7	0.0
ph1	0.0	0.0	-1.1	0.3
ph2	0.0	0.0	0.0	1.0
ph3	0.0	0.0	0.4	0.7
ph4	0.0	0.0	0.6	0.5
ph5	0.0	0.0	0.7	0.5
ph6	0.0	0.0	0.7	0.5
ph7	0.0	0.0	0.7	0.5
ph8	0.0	0.0	0.7	0.5
ph9	0.0	0.0	-0.3	0.8
ph10	0.0	0.0	-0.5	0.6
ph11	0.0	0.0	-1.0	0.3
ph12	0.0	0.0	-1.3	0.2
ph13	0.0	0.0	-1.6	0.1
ph14	0.0	0.0	-1.9	0.1
ph15	0.0	0.0	-1.4	0.2
ph16	0.0	0.0	-0.4	0.7
ph17	0.0	0.0	0.6	0.5
ph18	0.0	0.0	1.3	0.2
ph19	0.0	0.0	1.6	0.1
ph20	0.0	0.0	1.3	0.2
ph21	0.0	0.0	1.0	0.3
ph22	0.0	0.0	-0.8	0.4
ph23	0.0	0.0	-2.8	0.0
ph24	0.0	0.0	-2.6	0.0
cddh1	0.0	0.0	52.1	0.0
cddh2	0.0	0.0	45.3	0.0

Parameter	Estimate	StdErr	t-stat	p-value
cddh3	0.0	0.0	40.6	0.0
cddh4	0.0	0.0	35.6	0.0
cddh5	0.0	0.0	31.3	0.0
cddh6	0.0	0.0	28.1	0.0
cddh7	0.0	0.0	24.1	0.0
cddh8	0.0	0.0	20.5	0.0
cddh9	0.0	0.0	17.2	0.0
cddh10	0.0	0.0	20.1	0.0
cddh11	0.0	0.0	27.2	0.0
cddh12	0.0	0.0	34.4	0.0
cddh13	0.0	0.0	42.7	0.0
cddh14	0.0	0.0	51.3	0.0
cddh15	0.1	0.0	58.5	0.0
cddh16	0.1	0.0	64.0	0.0
cddh17	0.1	0.0	68.1	0.0
cddh18	0.1	0.0	71.3	0.0
cddh19	0.1	0.0	73.0	0.0
cddh20	0.1	0.0	73.9	0.0
cddh21	0.1	0.0	72.8	0.0
cddh22	0.1	0.0	69.6	0.0
cddh23	0.1	0.0	64.6	0.0
cddh24	0.0	0.0	57.7	0.0
pcddh1	0.0	0.0	2.4	0.0
pcddh2	0.0	0.0	2.9	0.0
pcddh3	0.0	0.0	2.7	0.0
pcddh4	0.0	0.0	2.7	0.0
pcddh5	0.0	0.0	2.8	0.0
pcddh6	0.0	0.0	2.1	0.0
pcddh7	0.0	0.0	1.9	0.1
pcddh8	0.0	0.0	1.8	0.1
pcddh9	0.0	0.0	3.9	0.0
pcddh10	0.0	0.0	3.8	0.0
pcddh11	0.0	0.0	4.1	0.0
pcddh12	0.0	0.0	4.3	0.0
pcddh13	0.0	0.0	4.5	0.0
pcddh14	0.0	0.0	4.4	0.0
pcddh15	0.0	0.0	3.3	0.0
pcddh16	0.0	0.0	1.8	0.1
pcddh17	0.0	0.0	-0.1	0.9
pcddh18	0.0	0.0	-1.8	0.1
pcddh19	0.0	0.0	-3.4	0.0
pcddh20	0.0	0.0	-3.6	0.0
pcddh21	0.0	0.0	-3.6	0.0
pcddh22	0.0	0.0	-1.3	0.2
pcddh23	0.0	0.0	0.9	0.4
pcddh24	0.0	0.0	2.1	0.0
tcddh1	0.0	0.0	-5.7	0.0
tcddh2	0.0	0.0	-7.9	0.0
tcddh3	0.0	0.0	-8.1	0.0
tcddh4	0.0	0.0	-8.4	0.0
tcddh5	0.0	0.0	-8.7	0.0
tcddh6	0.0	0.0	-10.7	0.0
tcddh7	0.0	0.0	-9.1	0.0
tcddh8	0.0	0.0	-6.3	0.0

Parameter	Estimate	StdErr	t-stat	p-value
tcddh9	0.0	0.0	-3.4	0.0
tcddh10	0.0	0.0	-3.3	0.0
tcddh11	0.0	0.0	-4.5	0.0
tcddh12	0.0	0.0	-3.6	0.0
tcddh13	0.0	0.0	-1.4	0.2
tcddh14	0.0	0.0	1.0	0.3
tcddh15	0.0	0.0	2.6	0.0
tcddh16	0.0	0.0	4.2	0.0
tcddh17	0.0	0.0	5.2	0.0
tcddh18	0.0	0.0	5.7	0.0
tcddh19	0.0	0.0	6.3	0.0
tcddh20	0.0	0.0	6.4	0.0
tcddh21	0.0	0.0	5.6	0.0
tcddh22	0.0	0.0	3.6	0.0
tcddh23	0.0	0.0	1.1	0.3
tcddh24	0.0	0.0	-2.7	0.0
tph1	0.0	0.0	-0.7	0.5
tph2	0.0	0.0	-0.9	0.4
tph3	0.0	0.0	-1.3	0.2
tph4	0.0	0.0	-1.9	0.1
tph5	0.0	0.0	-1.9	0.1
tph6	0.0	0.0	-2.6	0.0
tph7	0.0	0.0	-3.0	0.0
tph8	0.0	0.0	-3.0	0.0
tph9	0.0	0.0	-2.3	0.0
tph10	0.0	0.0	-0.5	0.6
tph11	0.0	0.0	-0.3	0.8
tph12	0.0	0.0	0.4	0.7
tph13	0.0	0.0	1.9	0.1
tph14	0.0	0.0	2.5	0.0
tph15	0.1	0.0	3.3	0.0
tph16	0.1	0.0	4.2	0.0
tph17	0.1	0.0	5.5	0.0
tph18	0.1	0.0	6.9	0.0
tph19	0.1	0.0	7.5	0.0
tph20	0.1	0.0	6.0	0.0
tph21	0.1	0.0	3.5	0.0
tph22	0.0	0.0	1.0	0.3
tph23	0.0	0.0	0.5	0.6
tph24	0.0	0.0	-0.4	0.7
tpcddh1	0.0	0.0	0.8	0.4
tpcddh2	0.0	0.0	0.6	0.6
tpcddh3	0.0	0.0	0.8	0.4
tpcddh4	0.0	0.0	0.9	0.4
tpcddh5	0.0	0.0	0.8	0.4
tpcddh6	0.0	0.0	3.0	0.0
tpcddh7	0.0	0.0	3.3	0.0
tpcddh8	0.0	0.0	1.6	0.1
tpcddh9	0.0	0.0	0.5	0.6
tpcddh10	0.0	0.0	-0.2	0.8
tpcddh11	0.0	0.0	0.0	1.0
tpcddh12	0.0	0.0	-0.2	0.9
tpcddh13	0.0	0.0	-1.5	0.1
tpcddh14	0.0	0.0	-1.4	0.2

Parameter	Estimate	StdErr	t-stat	p-value
tpcddh15	0.0	0.0	-1.5	0.1
tpcddh16	0.0	0.0	-2.4	0.0
tpcddh17	0.0	0.0	-3.0	0.0
tpcddh18	0.0	0.0	-3.6	0.0
tpcddh19	0.0	0.0	-4.0	0.0
tpcddh20	0.0	0.0	-4.9	0.0
tpcddh21	0.0	0.0	-4.6	0.0
tpcddh22	0.0	0.0	-4.3	0.0
tpcddh23	0.0	0.0	-3.2	0.0
tpcddh24	0.0	0.0	-1.5	0.1

Table 7-11. PG&E HUP peak demand parameters

Parameter	Estimate	StdErr	t-stat	p-value
h1	-0.2	0.0	-18.4	0.0
h2	-0.3	0.0	-23.3	0.0
h3	-0.4	0.0	-29.1	0.0
h4	-0.4	0.0	-32.2	0.0
h5	-0.4	0.0	-32.0	0.0
h6	-0.4	0.0	-30.3	0.0
h7	-0.4	0.0	-23.8	0.0
h8	-0.3	0.0	-16.4	0.0
h9	-0.2	0.0	-12.8	0.0
h10	-0.2	0.0	-12.7	0.0
h11	-0.2	0.0	-12.5	0.0
h12	-0.2	0.0	-11.6	0.0
h13	-0.2	0.0	-10.1	0.0
h14	-0.2	0.0	-8.0	0.0
h15	-0.1	0.0	-4.0	0.0
h16	0.0	0.0	1.8	0.1
h17	0.2	0.0	8.4	0.0
h18	0.4	0.0	15.1	0.0
h19	0.5	0.0	20.6	0.0
h20	0.6	0.0	24.2	0.0
h21	0.5	0.0	25.3	0.0
h22	0.4	0.0	27.1	0.0
h23	0.2	0.0	26.9	0.0
ph1	0.0	0.0	1.4	0.2
ph2	0.0	0.0	1.4	0.2
ph3	0.0	0.0	1.6	0.1
ph4	0.0	0.0	1.7	0.1
ph5	0.0	0.0	1.2	0.2
ph6	0.0	0.0	1.0	0.3
ph7	0.0	0.0	0.8	0.4
ph8	0.0	0.0	0.9	0.4
ph9	0.0	0.0	0.4	0.7
ph10	0.0	0.0	-0.7	0.5
ph11	0.0	0.0	-1.0	0.3
ph12	0.0	0.0	-0.7	0.5
ph13	0.0	0.0	-0.4	0.7
ph14	0.0	0.0	0.2	0.9
ph15	0.0	0.0	0.3	0.8
ph16	0.0	0.0	-0.2	0.8

Parameter	Estimate	StdErr	t-stat	p-value
ph17	0.0	0.0	0.5	0.6
ph18	0.0	0.0	1.0	0.3
ph19	0.0	0.0	0.8	0.4
ph20	0.0	0.0	1.0	0.3
ph21	0.0	0.0	1.3	0.2
ph22	0.0	0.0	1.5	0.1
ph23	0.0	0.0	1.6	0.1
ph24	0.0	0.0	1.3	0.2
cddh1	0.1	0.0	45.9	0.0
cddh2	0.0	0.0	40.0	0.0
cddh3	0.0	0.0	37.2	0.0
cddh4	0.0	0.0	34.6	0.0
cddh5	0.0	0.0	31.7	0.0
cddh6	0.0	0.0	29.8	0.0
cddh7	0.0	0.0	26.7	0.0
cddh8	0.0	0.0	23.8	0.0
cddh9	0.0	0.0	23.7	0.0
cddh10	0.0	0.0	26.5	0.0
cddh11	0.0	0.0	31.1	0.0
cddh12	0.0	0.0	37.8	0.0
cddh13	0.1	0.0	42.8	0.0
cddh14	0.1	0.0	48.3	0.0
cddh15	0.1	0.0	52.7	0.0
cddh16	0.1	0.0	55.0	0.0
cddh17	0.1	0.0	55.4	0.0
cddh18	0.1	0.0	55.8	0.0
cddh19	0.1	0.0	56.2	0.0
cddh20	0.1	0.0	57.6	0.0
cddh21	0.1	0.0	60.0	0.0
cddh22	0.1	0.0	60.6	0.0
cddh23	0.1	0.0	58.2	0.0
cddh24	0.1	0.0	52.6	0.0
pcddh1	0.0	0.0	-2.6	0.0
pcddh2	0.0	0.0	-1.3	0.2
pcddh3	0.0	0.0	-0.9	0.4
pcddh4	0.0	0.0	-1.0	0.3
pcddh5	0.0	0.0	-0.8	0.4
pcddh6	0.0	0.0	-0.4	0.7
pcddh7	0.0	0.0	-0.4	0.7
pcddh8	0.0	0.0	-0.7	0.5
pcddh9	0.0	0.0	-0.5	0.6
pcddh10	0.0	0.0	0.3	0.8
pcddh11	0.0	0.0	0.5	0.6
pcddh12	0.0	0.0	-0.1	0.9
pcddh13	0.0	0.0	-0.6	0.5
pcddh14	0.0	0.0	-1.2	0.2
pcddh15	0.0	0.0	-1.9	0.1
pcddh16	0.0	0.0	-2.2	0.0
pcddh17	0.0	0.0	-3.6	0.0
pcddh18	0.0	0.0	-4.4	0.0
pcddh19	0.0	0.0	-4.2	0.0
pcddh20	0.0	0.0	-4.6	0.0
pcddh21	0.0	0.0	-4.8	0.0
pcddh22	0.0	0.0	-4.8	0.0

Parameter	Estimate	StdErr	t-stat	p-value
pcddh23	0.0	0.0	-4.5	0.0
pcddh24	0.0	0.0	-3.5	0.0
tcddh1	0.0	0.0	-1.8	0.1
tcddh2	0.0	0.0	-1.8	0.1
tcddh3	0.0	0.0	-1.1	0.3
tcddh4	0.0	0.0	-1.1	0.3
tcddh5	0.0	0.0	-0.6	0.5
tcddh6	0.0	0.0	-0.5	0.6
tcddh7	0.0	0.0	0.2	0.8
tcddh8	0.0	0.0	1.4	0.2
tcddh9	0.0	0.0	1.1	0.3
tcddh10	0.0	0.0	0.6	0.5
tcddh11	0.0	0.0	0.0	1.0
tcddh12	0.0	0.0	-1.4	0.1
tcddh13	0.0	0.0	-3.0	0.0
tcddh14	0.0	0.0	-2.7	0.0
tcddh15	0.0	0.0	-1.8	0.1
tcddh16	0.0	0.0	-1.8	0.1
tcddh17	0.0	0.0	-1.7	0.1
tcddh18	0.0	0.0	-0.8	0.4
tcddh19	0.0	0.0	0.0	1.0
tcddh20	0.0	0.0	0.9	0.4
tcddh21	0.0	0.0	2.1	0.0
tcddh22	0.0	0.0	1.6	0.1
tcddh23	0.0	0.0	0.6	0.5
tcddh24	0.0	0.0	-0.8	0.4
tph1	-0.1	0.0	-1.9	0.1
tph2	0.0	0.0	-1.2	0.2
tph3	0.0	0.0	-0.5	0.6
tph4	0.0	0.0	0.4	0.7
tph5	0.1	0.0	1.3	0.2
tph6	0.0	0.0	1.1	0.3
tph7	0.1	0.0	2.0	0.0
tph8	0.1	0.0	2.5	0.0
tph9	0.1	0.0	2.9	0.0
tph10	0.1	0.0	2.9	0.0
tph11	0.1	0.0	2.7	0.0
tph12	0.1	0.0	1.6	0.1
tph13	0.0	0.0	0.2	0.8
tph14	-0.1	0.0	-1.1	0.3
tph15	-0.1	0.0	-2.3	0.0
tph16	-0.2	0.0	-3.9	0.0
tph17	-0.3	0.0	-5.8	0.0
tph18	-0.3	0.0	-6.9	0.0
tph19	-0.3	0.0	-6.5	0.0
tph20	-0.3	0.0	-6.7	0.0
tph21	-0.2	0.0	-5.7	0.0
tph22	-0.2	0.0	-4.6	0.0
tph23	-0.1	0.0	-3.5	0.0
tph24	-0.1	0.0	-2.4	0.0
tpcddh1	0.0	0.0	-1.8	0.1
tpcddh2	0.0	0.0	-2.3	0.0
tpcddh3	0.0	0.0	-3.0	0.0
tpcddh4	0.0	0.0	-3.0	0.0

Parameter	Estimate	StdErr	t-stat	p-value
tpcddh5	0.0	0.0	-3.4	0.0
tpcddh6	0.0	0.0	-3.1	0.0
tpcddh7	0.0	0.0	-3.6	0.0
tpcddh8	0.0	0.0	-4.1	0.0
tpcddh9	0.0	0.0	-4.1	0.0
tpcddh10	0.0	0.0	-4.1	0.0
tpcddh11	0.0	0.0	-3.8	0.0
tpcddh12	0.0	0.0	-3.0	0.0
tpcddh13	0.0	0.0	-1.7	0.1
tpcddh14	0.0	0.0	-1.3	0.2
tpcddh15	0.0	0.0	-1.1	0.3
tpcddh16	0.0	0.0	0.0	1.0
tpcddh17	0.0	0.0	0.7	0.5
tpcddh18	0.0	0.0	0.3	0.8
tpcddh19	0.0	0.0	-0.6	0.5
tpcddh20	0.0	0.0	-1.0	0.3
tpcddh21	0.0	0.0	-3.1	0.0
tpcddh22	0.0	0.0	-2.9	0.0
tpcddh23	0.0	0.0	-2.5	0.0
tpcddh24	0.0	0.0	-2.4	0.0

Table 7-12. PG&E AHUP peak demand parameters

Parameter	Estimate	StdErr	t-stat	p-value
h1	-0.2	0.0	-44.5	0.0
h2	-0.2	0.0	-44.0	0.0
h3	-0.3	0.0	-47.1	0.0
h4	-0.3	0.0	-48.1	0.0
h5	-0.4	0.0	-47.1	0.0
h6	-0.3	0.0	-43.4	0.0
h7	-0.3	0.0	-37.1	0.0
h8	-0.2	0.0	-25.8	0.0
h9	-0.2	0.0	-18.5	0.0
h10	-0.2	0.0	-19.7	0.0
h11	-0.2	0.0	-19.1	0.0
h12	-0.2	0.0	-16.4	0.0
h13	-0.2	0.0	-15.0	0.0
h14	-0.1	0.0	-12.3	0.0
h15	-0.1	0.0	-8.9	0.0
h16	0.0	0.0	-3.1	0.0
h17	0.1	0.0	4.7	0.0
h18	0.2	0.0	12.2	0.0
h19	0.2	0.0	19.1	0.0
h20	0.3	0.0	23.6	0.0
h21	0.2	0.0	27.0	0.0
h22	0.2	0.0	34.0	0.0
h23	0.2	0.0	36.7	0.0
ph1	0.0	0.0	-2.0	0.0
ph2	0.0	0.0	-3.0	0.0
ph3	0.0	0.0	-3.3	0.0
ph4	0.0	0.0	-3.4	0.0
ph5	0.0	0.0	-3.6	0.0
ph6	0.0	0.0	-3.6	0.0

Parameter	Estimate	StdErr	t-stat	p-value
ph7	0.0	0.0	-3.3	0.0
ph8	0.0	0.0	-4.4	0.0
ph9	0.0	0.0	-4.5	0.0
ph10	0.0	0.0	-5.7	0.0
ph11	0.0	0.0	-5.6	0.0
ph12	0.0	0.0	-6.4	0.0
ph13	0.0	0.0	-5.2	0.0
ph14	0.0	0.0	-3.8	0.0
ph15	0.0	0.0	-1.0	0.3
ph16	0.0	0.0	0.3	0.8
ph17	0.0	0.0	0.6	0.6
ph18	0.0	0.0	1.6	0.1
ph19	0.0	0.0	2.0	0.0
ph20	0.0	0.0	1.1	0.3
ph21	0.0	0.0	0.9	0.4
ph22	0.0	0.0	-1.8	0.1
ph23	0.0	0.0	-3.5	0.0
ph24	0.0	0.0	-3.5	0.0
cddh1	0.1	0.0	66.1	0.0
cddh2	0.0	0.0	56.6	0.0
cddh3	0.0	0.0	49.0	0.0
cddh4	0.0	0.0	42.3	0.0
cddh5	0.0	0.0	36.2	0.0
cddh6	0.0	0.0	32.2	0.0
cddh7	0.0	0.0	29.3	0.0
cddh8	0.0	0.0	26.4	0.0
cddh9	0.0	0.0	26.0	0.0
cddh10	0.0	0.0	31.1	0.0
cddh11	0.0	0.0	40.2	0.0
cddh12	0.0	0.0	48.7	0.0
cddh13	0.1	0.0	56.0	0.0
cddh14	0.1	0.0	63.4	0.0
cddh15	0.1	0.0	70.7	0.0
cddh16	0.1	0.0	77.7	0.0
cddh17	0.1	0.0	83.9	0.0
cddh18	0.1	0.0	89.8	0.0
cddh19	0.1	0.0	93.9	0.0
cddh20	0.1	0.0	98.6	0.0
cddh21	0.1	0.0	99.2	0.0
cddh22	0.1	0.0	94.5	0.0
cddh23	0.1	0.0	86.3	0.0
cddh24	0.1	0.0	75.3	0.0
pcddh1	0.0	0.0	-2.1	0.0
pcddh2	0.0	0.0	1.7	0.1
pcddh3	0.0	0.0	2.7	0.0
pcddh4	0.0	0.0	3.4	0.0
pcddh5	0.0	0.0	3.9	0.0
pcddh6	0.0	0.0	3.6	0.0
pcddh7	0.0	0.0	2.8	0.0
pcddh8	0.0	0.0	2.0	0.1
pcddh9	0.0	0.0	2.7	0.0
pcddh10	0.0	0.0	3.6	0.0
pcddh11	0.0	0.0	3.8	0.0
pcddh12	0.0	0.0	5.0	0.0

Parameter	Estimate	StdErr	t-stat	p-value
pcddh13	0.0	0.0	3.9	0.0
pcddh14	0.0	0.0	1.5	0.1
pcddh15	0.0	0.0	-1.5	0.1
pcddh16	0.0	0.0	-4.1	0.0
pcddh17	0.0	0.0	-6.4	0.0
pcddh18	0.0	0.0	-9.5	0.0
pcddh19	0.0	0.0	-11.2	0.0
pcddh20	0.0	0.0	-10.8	0.0
pcddh21	0.0	0.0	-10.9	0.0
pcddh22	0.0	0.0	-8.9	0.0
pcddh23	0.0	0.0	-6.3	0.0
pcddh24	0.0	0.0	-3.9	0.0
tcddh1	0.0	0.0	0.6	0.5
tcddh2	0.0	0.0	0.7	0.5
tcddh3	0.0	0.0	1.5	0.1
tcddh4	0.0	0.0	2.3	0.0
tcddh5	0.0	0.0	2.9	0.0
tcddh6	0.0	0.0	3.2	0.0
tcddh7	0.0	0.0	4.6	0.0
tcddh8	0.0	0.0	5.8	0.0
tcddh9	0.0	0.0	5.1	0.0
tcddh10	0.0	0.0	2.8	0.0
tcddh11	0.0	0.0	0.6	0.6
tcddh12	0.0	0.0	-1.0	0.3
tcddh13	0.0	0.0	-2.4	0.0
tcddh14	0.0	0.0	-3.0	0.0
tcddh15	0.0	0.0	-2.8	0.0
tcddh16	0.0	0.0	-2.5	0.0
tcddh17	0.0	0.0	-1.9	0.1
tcddh18	0.0	0.0	-1.1	0.3
tcddh19	0.0	0.0	0.0	1.0
tcddh20	0.0	0.0	1.6	0.1
tcddh21	0.0	0.0	2.0	0.0
tcddh22	0.0	0.0	2.8	0.0
tcddh23	0.0	0.0	2.6	0.0
tcddh24	0.0	0.0	1.8	0.1
tph1	0.1	0.0	2.6	0.0
tph2	0.1	0.0	3.1	0.0
tph3	0.1	0.0	3.4	0.0
tph4	0.1	0.0	3.6	0.0
tph5	0.1	0.0	3.9	0.0
tph6	0.1	0.0	3.9	0.0
tph7	0.1	0.0	3.9	0.0
tph8	0.1	0.0	6.5	0.0
tph9	0.1	0.0	7.7	0.0
tph10	0.1	0.0	7.7	0.0
tph11	0.1	0.0	6.7	0.0
tph12	0.1	0.0	5.7	0.0
tph13	0.1	0.0	3.8	0.0
tph14	0.1	0.0	2.3	0.0
tph15	0.0	0.0	0.3	0.8
tph16	0.0	0.0	-1.8	0.1
tph17	-0.1	0.0	-3.7	0.0
tph18	-0.1	0.0	-4.9	0.0

Parameter	Estimate	StdErr	t-stat	p-value
tph19	-0.1	0.0	-4.8	0.0
tph20	-0.1	0.0	-3.6	0.0
tph21	0.0	0.0	-1.4	0.2
tph22	0.0	0.0	0.2	0.8
tph23	0.0	0.0	1.2	0.2
tph24	0.0	0.0	1.8	0.1
tpcddh1	0.0	0.0	-6.1	0.0
tpcddh2	0.0	0.0	-6.1	0.0
tpcddh3	0.0	0.0	-6.5	0.0
tpcddh4	0.0	0.0	-6.9	0.0
tpcddh5	0.0	0.0	-6.5	0.0
tpcddh6	0.0	0.0	-5.5	0.0
tpcddh7	0.0	0.0	-4.8	0.0
tpcddh8	0.0	0.0	-5.9	0.0
tpcddh9	0.0	0.0	-6.6	0.0
tpcddh10	0.0	0.0	-6.7	0.0
tpcddh11	0.0	0.0	-5.8	0.0
tpcddh12	0.0	0.0	-6.9	0.0
tpcddh13	0.0	0.0	-5.7	0.0
tpcddh14	0.0	0.0	-5.4	0.0
tpcddh15	0.0	0.0	-5.3	0.0
tpcddh16	0.0	0.0	-4.6	0.0
tpcddh17	0.0	0.0	-4.4	0.0
tpcddh18	0.0	0.0	-4.1	0.0
tpcddh19	0.0	0.0	-4.6	0.0
tpcddh20	0.0	0.0	-6.2	0.0
tpcddh21	0.0	0.0	-7.7	0.0
tpcddh22	0.0	0.0	-8.6	0.0
tpcddh23	0.0	0.0	-7.8	0.0
tpcddh24	0.0	0.0	-6.8	0.0

Table 7-13. SCE HUP peak demand parameters

Parameter	Estimate	StdErr	t-stat	p-value
h1	0.0	0.0	-13.9	0.0
h2	-0.1	0.0	-18.1	0.0
h3	-0.1	0.0	-18.1	0.0
h4	-0.1	0.0	-15.3	0.0
h5	-0.1	0.0	-9.6	0.0
h6	0.0	0.0	-1.6	0.1
h7	0.0	0.0	0.1	0.9
h8	0.0	0.0	-2.5	0.0
h9	0.0	0.0	-3.5	0.0
h10	0.0	0.0	-3.8	0.0
h11	0.0	0.0	-3.1	0.0
h12	0.0	0.0	-0.5	0.6
h13	0.0	0.0	2.8	0.0
h14	0.1	0.0	6.8	0.0
h15	0.2	0.0	11.5	0.0
h16	0.3	0.0	17.2	0.0
h17	0.4	0.0	22.3	0.0
h18	0.4	0.0	25.6	0.0
h19	0.4	0.0	27.9	0.0

Parameter	Estimate	StdErr	t-stat	p-value
h20	0.4	0.0	31.8	0.0
h21	0.4	0.0	34.2	0.0
h22	0.3	0.0	31.7	0.0
h23	0.1	0.0	25.5	0.0
ph1	0.0	0.0	-2.1	0.0
ph2	0.0	0.0	-2.2	0.0
ph3	0.0	0.0	-1.8	0.1
ph4	0.0	0.0	-2.1	0.0
ph5	0.0	0.0	-2.0	0.0
ph6	0.0	0.0	-1.3	0.2
ph7	0.0	0.0	-1.2	0.2
ph8	0.0	0.0	-2.2	0.0
ph9	0.0	0.0	-1.3	0.2
ph10	0.0	0.0	-0.5	0.6
ph11	0.0	0.0	0.9	0.4
ph12	0.0	0.0	1.5	0.1
ph13	0.0	0.0	2.1	0.0
ph14	0.0	0.0	1.8	0.1
ph15	0.0	0.0	2.0	0.0
ph16	0.0	0.0	0.8	0.4
ph17	0.0	0.0	-1.0	0.3
ph18	0.0	0.0	-2.0	0.0
ph19	0.0	0.0	-0.2	0.9
ph20	0.0	0.0	-0.3	0.8
ph21	0.0	0.0	-2.7	0.0
ph22	0.0	0.0	-2.3	0.0
ph23	0.0	0.0	-1.9	0.1
ph24	0.0	0.0	-0.9	0.4
cddh1	0.0	0.0	42.8	0.0
cddh2	0.0	0.0	37.6	0.0
cddh3	0.0	0.0	32.7	0.0
cddh4	0.0	0.0	29.3	0.0
cddh5	0.0	0.0	26.1	0.0
cddh6	0.0	0.0	24.5	0.0
cddh7	0.0	0.0	24.6	0.0
cddh8	0.0	0.0	30.1	0.0
cddh9	0.0	0.0	39.0	0.0
cddh10	0.0	0.0	48.8	0.0
cddh11	0.1	0.0	55.9	0.0
cddh12	0.1	0.0	59.2	0.0
cddh13	0.1	0.0	59.3	0.0
cddh14	0.1	0.0	59.0	0.0
cddh15	0.1	0.0	58.7	0.0
cddh16	0.1	0.0	59.6	0.0
cddh17	0.1	0.0	60.6	0.0
cddh18	0.1	0.0	62.5	0.0
cddh19	0.1	0.0	61.7	0.0
cddh20	0.1	0.0	59.3	0.0
cddh21	0.1	0.0	60.2	0.0
cddh22	0.1	0.0	56.1	0.0
cddh23	0.0	0.0	54.9	0.0
cddh24	0.0	0.0	50.4	0.0
pcddh1	0.0	0.0	3.0	0.0
pcddh2	0.0	0.0	3.3	0.0

Parameter	Estimate	StdErr	t-stat	p-value
pcddh3	0.0	0.0	3.0	0.0
pcddh4	0.0	0.0	3.4	0.0
pcddh5	0.0	0.0	3.0	0.0
pcddh6	0.0	0.0	2.2	0.0
pcddh7	0.0	0.0	1.5	0.1
pcddh8	0.0	0.0	2.7	0.0
pcddh9	0.0	0.0	2.5	0.0
pcddh10	0.0	0.0	2.6	0.0
pcddh11	0.0	0.0	2.2	0.0
pcddh12	0.0	0.0	2.4	0.0
pcddh13	0.0	0.0	2.0	0.0
pcddh14	0.0	0.0	1.7	0.1
pcddh15	0.0	0.0	1.0	0.3
pcddh16	0.0	0.0	2.4	0.0
pcddh17	0.0	0.0	3.3	0.0
pcddh18	0.0	0.0	3.7	0.0
pcddh19	0.0	0.0	1.1	0.3
pcddh20	0.0	0.0	-0.2	0.8
pcddh21	0.0	0.0	1.4	0.1
pcddh22	0.0	0.0	1.4	0.2
pcddh23	0.0	0.0	2.4	0.0
pcddh24	0.0	0.0	2.0	0.0
tcddh1	0.0	0.0	0.1	0.9
tcddh2	0.0	0.0	0.7	0.5
tcddh3	0.0	0.0	0.9	0.4
tcddh4	0.0	0.0	0.8	0.4
tcddh5	0.0	0.0	1.2	0.2
tcddh6	0.0	0.0	2.6	0.0
tcddh7	0.0	0.0	2.8	0.0
tcddh8	0.0	0.0	2.4	0.0
tcddh9	0.0	0.0	2.3	0.0
tcddh10	0.0	0.0	2.0	0.0
tcddh11	0.0	0.0	1.6	0.1
tcddh12	0.0	0.0	1.3	0.2
tcddh13	0.0	0.0	1.5	0.1
tcddh14	0.0	0.0	1.5	0.1
tcddh15	0.0	0.0	1.7	0.1
tcddh16	0.0	0.0	1.8	0.1
tcddh17	0.0	0.0	2.2	0.0
tcddh18	0.0	0.0	2.7	0.0
tcddh19	0.0	0.0	2.8	0.0
tcddh20	0.0	0.0	2.8	0.0
tcddh21	0.0	0.0	1.6	0.1
tcddh22	0.0	0.0	0.1	0.9
tcddh23	0.0	0.0	-0.7	0.5
tcddh24	0.0	0.0	-0.5	0.6
tph1	0.1	0.0	2.8	0.0
tph2	0.1	0.0	3.1	0.0
tph3	0.1	0.0	3.4	0.0
tph4	0.1	0.0	3.9	0.0
tph5	0.1	0.0	4.2	0.0
tph6	0.1	0.0	4.6	0.0
tph7	0.1	0.0	4.3	0.0
tph8	0.1	0.0	4.2	0.0

Parameter	Estimate	StdErr	t-stat	p-value
tph9	0.1	0.0	3.1	0.0
tph10	0.1	0.0	2.2	0.0
tph11	0.0	0.0	1.3	0.2
tph12	0.0	0.0	0.5	0.6
tph13	0.0	0.0	0.4	0.7
tph14	0.0	0.0	0.4	0.7
tph15	0.0	0.0	0.4	0.7
tph16	0.0	0.0	0.1	0.9
tph17	0.0	0.0	0.7	0.5
tph18	0.0	0.0	0.8	0.4
tph19	0.0	0.0	0.8	0.4
tph20	0.0	0.0	0.1	1.0
tph21	0.0	0.0	0.2	0.8
tph22	0.0	0.0	1.3	0.2
tph23	0.1	0.0	2.2	0.0
tph24	0.1	0.0	2.2	0.0
tpcddh1	0.0	0.0	-4.6	0.0
tpcddh2	0.0	0.0	-4.7	0.0
tpcddh3	0.0	0.0	-4.7	0.0
tpcddh4	0.0	0.0	-4.7	0.0
tpcddh5	0.0	0.0	-4.7	0.0
tpcddh6	0.0	0.0	-5.2	0.0
tpcddh7	0.0	0.0	-4.3	0.0
tpcddh8	0.0	0.0	-3.7	0.0
tpcddh9	0.0	0.0	-3.4	0.0
tpcddh10	0.0	0.0	-3.0	0.0
tpcddh11	0.0	0.0	-2.7	0.0
tpcddh12	0.0	0.0	-2.4	0.0
tpcddh13	0.0	0.0	-2.5	0.0
tpcddh14	0.0	0.0	-2.7	0.0
tpcddh15	0.0	0.0	-3.0	0.0
tpcddh16	0.0	0.0	-3.3	0.0
tpcddh17	0.0	0.0	-4.3	0.0
tpcddh18	0.0	0.0	-5.1	0.0
tpcddh19	0.0	0.0	-5.3	0.0
tpcddh20	0.0	0.0	-5.1	0.0
tpcddh21	0.0	0.0	-4.6	0.0
tpcddh22	0.0	0.0	-4.2	0.0
tpcddh23	0.0	0.0	-4.7	0.0
tpcddh24	0.0	0.0	-4.4	0.0

Table 7-14. SCE AHUP peak demand parameters

Parameter	Estimate	StdErr	t-stat	p-value
h1	0.0	0.0	-9.6	0.0
h2	-0.1	0.0	-13.0	0.0
h3	-0.1	0.0	-13.1	0.0
h4	-0.1	0.0	-11.6	0.0
h5	-0.1	0.0	-8.3	0.0
h6	0.0	0.0	-2.8	0.0
h7	0.0	0.0	0.0	1.0
h8	0.0	0.0	-0.8	0.4
h9	0.0	0.0	-1.2	0.2

Parameter	Estimate	StdErr	t-stat	p-value
h10	0.0	0.0	-1.5	0.1
h11	0.0	0.0	-1.1	0.3
h12	0.0	0.0	1.2	0.2
h13	0.1	0.0	4.1	0.0
h14	0.2	0.0	8.1	0.0
h15	0.3	0.0	11.7	0.0
h16	0.4	0.0	15.4	0.0
h17	0.5	0.0	17.8	0.0
h18	0.5	0.0	19.0	0.0
h19	0.4	0.0	19.3	0.0
h20	0.4	0.0	22.4	0.0
h21	0.4	0.0	24.7	0.0
h22	0.3	0.0	23.9	0.0
h23	0.1	0.0	19.0	0.0
ph1	0.0	0.0	-0.4	0.7
ph2	0.0	0.0	-0.4	0.7
ph3	0.0	0.0	0.0	1.0
ph4	0.0	0.0	0.0	1.0
ph5	0.0	0.0	0.7	0.5
ph6	0.0	0.0	0.6	0.6
ph7	0.0	0.0	-0.2	0.9
ph8	0.0	0.0	-1.2	0.2
ph9	0.0	0.0	-0.7	0.5
ph10	0.0	0.0	-0.1	0.9
ph11	0.0	0.0	0.8	0.4
ph12	0.0	0.0	0.7	0.5
ph13	0.0	0.0	0.7	0.5
ph14	0.0	0.0	0.0	1.0
ph15	0.0	0.0	-0.3	0.8
ph16	0.0	0.0	-0.8	0.4
ph17	0.0	0.0	-1.5	0.1
ph18	0.0	0.0	-1.9	0.1
ph19	0.0	0.0	0.4	0.7
ph20	0.0	0.0	0.6	0.5
ph21	0.0	0.0	-1.2	0.2
ph22	0.0	0.0	-0.9	0.3
ph23	0.0	0.0	-0.7	0.5
ph24	0.0	0.0	-0.3	0.8
cddh1	0.0	0.0	32.6	0.0
cddh2	0.0	0.0	29.2	0.0
cddh3	0.0	0.0	26.4	0.0
cddh4	0.0	0.0	24.9	0.0
cddh5	0.0	0.0	22.5	0.0
cddh6	0.0	0.0	20.7	0.0
cddh7	0.0	0.0	22.0	0.0
cddh8	0.0	0.0	24.8	0.0
cddh9	0.0	0.0	28.8	0.0
cddh10	0.0	0.0	35.6	0.0
cddh11	0.1	0.0	42.9	0.0
cddh12	0.1	0.0	45.5	0.0
cddh13	0.1	0.0	45.1	0.0

Parameter	Estimate	StdErr	t-stat	p-value
cddh14	0.1	0.0	43.9	0.0
cddh15	0.1	0.0	43.2	0.0
cddh16	0.1	0.0	42.9	0.0
cddh17	0.1	0.0	43.0	0.0
cddh18	0.1	0.0	44.4	0.0
cddh19	0.1	0.0	46.1	0.0
cddh20	0.1	0.0	48.2	0.0
cddh21	0.1	0.0	48.9	0.0
cddh22	0.1	0.0	47.9	0.0
cddh23	0.0	0.0	44.3	0.0
cddh24	0.0	0.0	39.1	0.0
pcddh1	0.0	0.0	2.8	0.0
pcddh2	0.0	0.0	2.7	0.0
pcddh3	0.0	0.0	2.6	0.0
pcddh4	0.0	0.0	2.2	0.0
pcddh5	0.0	0.0	1.1	0.3
pcddh6	0.0	0.0	0.0	1.0
pcddh7	0.0	0.0	0.9	0.4
pcddh8	0.0	0.0	2.8	0.0
pcddh9	0.0	0.0	3.3	0.0
pcddh10	0.0	0.0	2.6	0.0
pcddh11	0.0	0.0	2.4	0.0
pcddh12	0.0	0.0	2.6	0.0
pcddh13	0.0	0.0	3.2	0.0
pcddh14	0.0	0.0	3.3	0.0
pcddh15	0.0	0.0	2.7	0.0
pcddh16	0.0	0.0	3.1	0.0
pcddh17	0.0	0.0	3.4	0.0
pcddh18	0.0	0.0	3.8	0.0
pcddh19	0.0	0.0	2.0	0.0
pcddh20	0.0	0.0	0.5	0.6
pcddh21	0.0	0.0	1.6	0.1
pcddh22	0.0	0.0	2.3	0.0
pcddh23	0.0	0.0	3.1	0.0
pcddh24	0.0	0.0	2.9	0.0
tcddh1	0.0	0.0	-0.8	0.5
tcddh2	0.0	0.0	-0.6	0.5
tcddh3	0.0	0.0	-0.4	0.7
tcddh4	0.0	0.0	-0.2	0.8
tcddh5	0.0	0.0	0.3	0.7
tcddh6	0.0	0.0	0.8	0.4
tcddh7	0.0	0.0	1.6	0.1
tcddh8	0.0	0.0	1.7	0.1
tcddh9	0.0	0.0	1.7	0.1
tcddh10	0.0	0.0	2.5	0.0
tcddh11	0.0	0.0	3.7	0.0
tcddh12	0.0	0.0	4.8	0.0
tcddh13	0.0	0.0	5.5	0.0
tcddh14	0.0	0.0	5.4	0.0
tcddh15	0.0	0.0	5.4	0.0
tcddh16	0.0	0.0	5.2	0.0

Parameter	Estimate	StdErr	t-stat	p-value
tcddh17	0.0	0.0	5.3	0.0
tcddh18	0.0	0.0	4.9	0.0
tcddh19	0.0	0.0	4.4	0.0
tcddh20	0.0	0.0	3.5	0.0
tcddh21	0.0	0.0	2.2	0.0
tcddh22	0.0	0.0	1.2	0.2
tcddh23	0.0	0.0	0.5	0.7
tcddh24	0.0	0.0	-0.3	0.7
tph1	0.1	0.0	2.7	0.0
tph2	0.1	0.0	3.1	0.0
tph3	0.1	0.0	3.1	0.0
tph4	0.1	0.0	3.0	0.0
tph5	0.1	0.0	2.7	0.0
tph6	0.1	0.0	2.9	0.0
tph7	0.1	0.0	2.9	0.0
tph8	0.1	0.0	3.0	0.0
tph9	0.1	0.0	2.4	0.0
tph10	0.1	0.1	1.0	0.3
tph11	0.0	0.1	0.2	0.8
tph12	0.0	0.1	-0.5	0.6
tph13	-0.1	0.1	-1.6	0.1
tph14	-0.1	0.0	-2.3	0.0
tph15	-0.1	0.1	-2.5	0.0
tph16	-0.1	0.1	-1.9	0.1
tph17	-0.1	0.1	-1.5	0.1
tph18	0.0	0.0	-0.8	0.4
tph19	0.0	0.0	-0.2	0.8
tph20	0.0	0.0	-0.2	0.9
tph21	0.0	0.0	0.2	0.8
tph22	0.0	0.0	0.5	0.6
tph23	0.1	0.0	1.3	0.2
tph24	0.1	0.0	1.8	0.1
tpcddh1	0.0	0.0	-4.0	0.0
tpcddh2	0.0	0.0	-4.5	0.0
tpcddh3	0.0	0.0	-4.8	0.0
tpcddh4	0.0	0.0	-4.5	0.0
tpcddh5	0.0	0.0	-3.9	0.0
tpcddh6	0.0	0.0	-3.5	0.0
tpcddh7	0.0	0.0	-3.4	0.0
tpcddh8	0.0	0.0	-3.2	0.0
tpcddh9	0.0	0.0	-2.3	0.0
tpcddh10	0.0	0.0	-1.7	0.1
tpcddh11	0.0	0.0	-1.8	0.1
tpcddh12	0.0	0.0	-2.0	0.0
tpcddh13	0.0	0.0	-2.4	0.0
tpcddh14	0.0	0.0	-2.3	0.0
tpcddh15	0.0	0.0	-2.5	0.0
tpcddh16	0.0	0.0	-2.8	0.0
tpcddh17	0.0	0.0	-3.4	0.0
tpcddh18	0.0	0.0	-3.6	0.0
tpcddh19	0.0	0.0	-4.7	0.0

Parameter	Estimate	StdErr	t-stat	p-value
tpcddh20	0.0	0.0	-4.6	0.0
tpcddh21	0.0	0.0	-4.1	0.0
tpcddh22	0.0	0.0	-4.0	0.0
tpcddh23	0.0	0.0	-4.4	0.0
tpcddh24	0.0	0.0	-3.7	0.0

Table 7-15. SDG&E HUP peak demand parameter

Parameter	Estimate	StdErr	t-stat	p-value
h1	-0.1	0.0	-7.0	0.0
h2	-0.1	0.0	-9.5	0.0
h3	-0.2	0.0	-13.2	0.0
h4	-0.2	0.0	-14.0	0.0
h5	-0.2	0.0	-12.6	0.0
h6	-0.1	0.0	-8.3	0.0
h7	-0.1	0.0	-4.1	0.0
h8	0.0	0.0	-1.5	0.1
h9	0.0	0.0	-1.0	0.3
h10	0.0	0.0	-1.3	0.2
h11	0.0	0.0	-1.3	0.2
h12	0.0	0.0	-1.0	0.3
h13	0.0	0.0	0.3	0.8
h14	0.1	0.0	2.0	0.0
h15	0.1	0.0	3.7	0.0
h16	0.2	0.0	5.7	0.0
h17	0.3	0.0	8.3	0.0
h18	0.3	0.0	11.3	0.0
h19	0.3	0.0	13.7	0.0
h20	0.3	0.0	16.7	0.0
h21	0.3	0.0	22.2	0.0
h22	0.3	0.0	23.5	0.0
h23	0.2	0.0	19.8	0.0
ph1	0.1	0.0	6.2	0.0
ph2	0.1	0.0	4.9	0.0
ph3	0.1	0.0	4.1	0.0
ph4	0.1	0.0	3.7	0.0
ph5	0.0	0.0	2.9	0.0
ph6	0.0	0.0	1.9	0.1
ph7	0.0	0.0	2.0	0.0
ph8	0.0	0.0	1.7	0.1
ph9	0.0	0.0	1.7	0.1
ph10	0.1	0.0	2.9	0.0
ph11	0.1	0.0	3.0	0.0
ph12	0.1	0.0	4.3	0.0
ph13	0.2	0.0	6.0	0.0
ph14	0.2	0.0	7.0	0.0
ph15	0.3	0.0	8.0	0.0
ph16	0.3	0.0	8.7	0.0
ph17	0.3	0.0	9.0	0.0
ph18	0.3	0.0	8.5	0.0
ph19	0.3	0.0	8.8	0.0
ph20	0.3	0.0	8.7	0.0
ph21	0.2	0.0	7.2	0.0
ph22	0.2	0.0	6.2	0.0
ph23	0.2	0.0	7.8	0.0

Parameter	Estimate	StdErr	t-stat	p-value
ph24	0.2	0.0	8.3	0.0
cddh1	0.0	0.0	13.3	0.0
cddh2	0.0	0.0	11.4	0.0
cddh3	0.0	0.0	10.5	0.0
cddh4	0.0	0.0	9.8	0.0
cddh5	0.0	0.0	9.4	0.0
cddh6	0.0	0.0	8.0	0.0
cddh7	0.0	0.0	8.4	0.0
cddh8	0.0	0.0	8.9	0.0
cddh9	0.0	0.0	9.9	0.0
cddh10	0.0	0.0	12.2	0.0
cddh11	0.0	0.0	15.1	0.0
cddh12	0.0	0.0	18.6	0.0
cddh13	0.1	0.0	20.6	0.0
cddh14	0.1	0.0	21.6	0.0
cddh15	0.1	0.0	22.6	0.0
cddh16	0.1	0.0	22.9	0.0
cddh17	0.1	0.0	22.5	0.0
cddh18	0.1	0.0	23.5	0.0
cddh19	0.1	0.0	24.9	0.0
cddh20	0.1	0.0	24.3	0.0
cddh21	0.1	0.0	21.3	0.0
cddh22	0.1	0.0	19.6	0.0
cddh23	0.0	0.0	18.5	0.0
cddh24	0.0	0.0	17.2	0.0
pcddh1	0.0	0.0	-6.1	0.0
pcddh2	0.0	0.0	-3.8	0.0
pcddh3	0.0	0.0	-2.4	0.0
pcddh4	0.0	0.0	-1.6	0.1
pcddh5	0.0	0.0	-0.3	0.8
pcddh6	0.0	0.0	0.3	0.7
pcddh7	0.0	0.0	0.3	0.8
pcddh8	0.0	0.0	0.3	0.8
pcddh9	0.0	0.0	-0.1	0.9
pcddh10	0.0	0.0	-2.1	0.0
pcddh11	0.0	0.0	-1.3	0.2
pcddh12	0.0	0.0	-2.3	0.0
pcddh13	0.0	0.0	-3.7	0.0
pcddh14	0.0	0.0	-4.3	0.0
pcddh15	0.0	0.0	-5.0	0.0
pcddh16	0.0	0.0	-5.5	0.0
pcddh17	0.0	0.0	-5.8	0.0
pcddh18	0.0	0.0	-5.6	0.0
pcddh19	0.0	0.0	-5.6	0.0
pcddh20	0.0	0.0	-5.5	0.0
pcddh21	0.0	0.0	-5.2	0.0
pcddh22	0.0	0.0	-4.9	0.0
pcddh23	0.0	0.0	-9.3	0.0
pcddh24	0.0	0.0	-9.0	0.0
tcddh1	0.0	0.0	1.3	0.2
tcddh2	0.0	0.0	2.3	0.0
tcddh3	0.0	0.0	2.9	0.0
tcddh4	0.0	0.0	2.9	0.0
tcddh5	0.0	0.0	3.4	0.0

Parameter	Estimate	StdErr	t-stat	p-value
tcddh6	0.0	0.0	3.6	0.0
tcddh7	0.0	0.0	4.2	0.0
tcddh8	0.0	0.0	3.3	0.0
tcddh9	0.0	0.0	1.9	0.1
tcddh10	0.0	0.0	0.1	0.9
tcddh11	0.0	0.0	-0.8	0.4
tcddh12	0.0	0.0	-0.7	0.5
tcddh13	0.0	0.0	-0.1	0.9
tcddh14	0.0	0.0	0.4	0.7
tcddh15	0.0	0.0	0.6	0.6
tcddh16	0.0	0.0	0.6	0.5
tcddh17	0.0	0.0	1.1	0.3
tcddh18	0.0	0.0	1.5	0.1
tcddh19	0.0	0.0	1.9	0.1
tcddh20	0.0	0.0	1.8	0.1
tcddh21	0.0	0.0	1.1	0.3
tcddh22	0.0	0.0	0.5	0.6
tcddh23	0.0	0.0	0.2	0.8
tcddh24	0.0	0.0	0.5	0.6
tph1	0.1	0.1	1.3	0.2
tph2	0.1	0.1	1.6	0.1
tph3	0.1	0.0	2.0	0.0
tph4	0.1	0.0	2.0	0.0
tph5	0.1	0.0	2.4	0.0
tph6	0.1	0.0	2.9	0.0
tph7	0.1	0.0	3.1	0.0
tph8	0.1	0.0	3.1	0.0
tph9	0.1	0.0	2.7	0.0
tph10	0.1	0.0	2.0	0.0
tph11	0.1	0.1	1.6	0.1
tph12	0.1	0.1	1.7	0.1
tph13	0.1	0.1	1.7	0.1
tph14	0.1	0.1	1.7	0.1
tph15	0.1	0.1	1.7	0.1
tph16	0.2	0.1	2.1	0.0
tph17	0.2	0.1	2.2	0.0
tph18	0.2	0.1	2.4	0.0
tph19	0.1	0.1	1.9	0.1
tph20	0.1	0.1	1.4	0.2
tph21	0.0	0.1	0.5	0.6
tph22	0.0	0.1	0.5	0.6
tph23	0.0	0.0	0.2	0.8
tph24	0.0	0.0	0.7	0.5
tpcddh1	0.0	0.0	-0.6	0.6
tpcddh2	0.0	0.0	-1.2	0.2
tpcddh3	0.0	0.0	-2.0	0.1
tpcddh4	0.0	0.0	-1.8	0.1
tpcddh5	0.0	0.0	-2.4	0.0
tpcddh6	0.0	0.0	-2.5	0.0
tpcddh7	0.0	0.0	-2.7	0.0
tpcddh8	0.0	0.0	-2.8	0.0
tpcddh9	0.0	0.0	-2.1	0.0
tpcddh10	0.0	0.0	-1.1	0.3
tpcddh11	0.0	0.0	-0.6	0.6

Parameter	Estimate	StdErr	t-stat	p-value
tpcddh12	0.0	0.0	-0.4	0.7
tpcddh13	0.0	0.0	-0.4	0.7
tpcddh14	0.0	0.0	-0.6	0.6
tpcddh15	0.0	0.0	-0.6	0.5
tpcddh16	0.0	0.0	-0.5	0.6
tpcddh17	0.0	0.0	-0.7	0.5
tpcddh18	0.0	0.0	-0.7	0.5
tpcddh19	0.0	0.0	-0.9	0.4
tpcddh20	0.0	0.0	-0.9	0.4
tpcddh21	0.0	0.0	-0.1	0.9
tpcddh22	0.0	0.0	0.1	0.9
tpcddh23	0.0	0.0	0.4	0.7
tpcddh24	0.0	0.0	-0.4	0.7

Table 7-16. SDG&E AHUP peak demand parameters

Parameter	Estimate	StdErr	t-stat	p-value
h1	-0.1	0.0	-3.9	0.0
h2	-0.1	0.0	-4.4	0.0
h3	-0.1	0.0	-4.2	0.0
h4	-0.1	0.0	-3.8	0.0
h5	-0.1	0.0	-3.7	0.0
h6	-0.1	0.0	-1.8	0.1
h7	0.0	0.0	-0.8	0.4
h8	0.0	0.1	0.1	0.9
h9	0.0	0.1	0.1	0.9
h10	0.0	0.1	-0.2	0.9
h11	0.0	0.1	0.2	0.8
h12	0.1	0.1	0.7	0.5
h13	0.2	0.1	1.3	0.2
h14	0.3	0.1	2.0	0.1
h15	0.4	0.1	2.9	0.0
h16	0.5	0.1	3.5	0.0
h17	0.6	0.1	4.3	0.0
h18	0.6	0.1	5.0	0.0
h19	0.5	0.1	5.4	0.0
h20	0.5	0.1	6.6	0.0
h21	0.5	0.1	8.0	0.0
h22	0.3	0.0	8.7	0.0
h23	0.2	0.0	6.8	0.0
ph1	0.1	0.0	2.2	0.0
ph2	0.1	0.0	1.7	0.1
ph3	0.0	0.0	1.0	0.3
ph4	0.0	0.0	0.8	0.4
ph5	0.0	0.0	0.4	0.7
ph6	0.0	0.0	-0.7	0.5
ph7	0.0	0.0	0.8	0.4
ph8	0.1	0.1	1.9	0.1
ph9	0.1	0.1	2.3	0.0
ph10	0.1	0.0	3.1	0.0
ph11	0.2	0.0	3.7	0.0
ph12	0.2	0.1	3.5	0.0
ph13	0.3	0.1	5.2	0.0
ph14	0.4	0.1	5.0	0.0
ph15	0.4	0.1	4.9	0.0

Parameter	Estimate	StdErr	t-stat	p-value
ph16	0.5	0.1	5.4	0.0
ph17	0.4	0.1	5.0	0.0
ph18	0.4	0.1	4.9	0.0
ph19	0.4	0.1	4.7	0.0
ph20	0.4	0.1	5.2	0.0
ph21	0.4	0.1	5.0	0.0
ph22	0.3	0.1	4.5	0.0
ph23	0.2	0.1	4.2	0.0
ph24	0.2	0.0	3.7	0.0
cddh1	0.0	0.0	4.7	0.0
cddh2	0.0	0.0	3.9	0.0
cddh3	0.0	0.0	3.4	0.0
cddh4	0.0	0.0	3.8	0.0
cddh5	0.0	0.0	3.5	0.0
cddh6	0.0	0.0	3.4	0.0
cddh7	0.0	0.0	3.9	0.0
cddh8	0.0	0.0	3.8	0.0
cddh9	0.0	0.0	4.2	0.0
cddh10	0.0	0.0	5.1	0.0
cddh11	0.0	0.0	5.7	0.0
cddh12	0.1	0.0	6.5	0.0
cddh13	0.1	0.0	6.1	0.0
cddh14	0.1	0.0	6.5	0.0
cddh15	0.1	0.0	6.7	0.0
cddh16	0.1	0.0	7.0	0.0
cddh17	0.1	0.0	6.3	0.0
cddh18	0.1	0.0	6.3	0.0
cddh19	0.1	0.0	6.8	0.0
cddh20	0.1	0.0	7.3	0.0
cddh21	0.1	0.0	7.6	0.0
cddh22	0.1	0.0	7.3	0.0
cddh23	0.0	0.0	6.3	0.0
cddh24	0.0	0.0	5.5	0.0
pcddh1	0.0	0.0	-1.7	0.1
pcddh2	0.0	0.0	-1.1	0.3
pcddh3	0.0	0.0	-0.4	0.7
pcddh4	0.0	0.0	0.1	0.9
pcddh5	0.0	0.0	1.0	0.3
pcddh6	0.0	0.0	1.7	0.1
pcddh7	0.0	0.0	1.2	0.2
pcddh8	0.0	0.0	-0.6	0.5
pcddh9	0.0	0.0	-1.8	0.1
pcddh10	0.0	0.0	-2.5	0.0
pcddh11	0.0	0.0	-2.6	0.0
pcddh12	0.0	0.0	-4.3	0.0
pcddh13	0.0	0.0	-4.1	0.0
pcddh14	-0.1	0.0	-5.0	0.0
pcddh15	-0.1	0.0	-5.0	0.0
pcddh16	-0.1	0.0	-4.7	0.0
pcddh17	-0.1	0.0	-4.6	0.0
pcddh18	0.0	0.0	-4.1	0.0
pcddh19	0.0	0.0	-4.1	0.0
pcddh20	0.0	0.0	-4.5	0.0
pcddh21	0.0	0.0	-4.2	0.0

Parameter	Estimate	StdErr	t-stat	p-value
pcddh22	0.0	0.0	-4.4	0.0
pcddh23	0.0	0.0	-3.5	0.0
pcddh24	0.0	0.0	-3.3	0.0
tcddh1	0.0	0.0	1.3	0.2
tcddh2	0.0	0.0	1.6	0.1
tcddh3	0.0	0.0	2.1	0.0
tcddh4	0.0	0.0	2.2	0.0
tcddh5	0.0	0.0	2.5	0.0
tcddh6	0.0	0.0	2.8	0.0
tcddh7	0.0	0.0	2.3	0.0
tcddh8	0.0	0.0	2.0	0.0
tcddh9	0.0	0.0	1.5	0.1
tcddh10	0.0	0.0	1.2	0.3
tcddh11	0.0	0.0	0.6	0.6
tcddh12	0.0	0.0	0.2	0.8
tcddh13	0.0	0.0	0.0	1.0
tcddh14	0.0	0.0	0.2	0.8
tcddh15	0.0	0.0	0.4	0.7
tcddh16	0.0	0.0	0.6	0.5
tcddh17	0.0	0.0	0.8	0.5
tcddh18	0.0	0.0	0.7	0.5
tcddh19	0.0	0.0	0.5	0.6
tcddh20	0.0	0.0	0.3	0.8
tcddh21	0.0	0.0	0.2	0.9
tcddh22	0.0	0.0	0.3	0.7
tcddh23	0.0	0.0	1.0	0.3
tcddh24	0.0	0.0	1.3	0.2
tph1	0.2	0.1	1.8	0.1
tph2	0.2	0.1	1.8	0.1
tph3	0.2	0.1	1.8	0.1
tph4	0.2	0.1	1.7	0.1
tph5	0.2	0.1	1.9	0.1
tph6	0.2	0.1	2.0	0.0
tph7	0.2	0.1	1.7	0.1
tph8	0.1	0.1	0.7	0.5
tph9	0.1	0.1	0.6	0.5
tph10	0.1	0.1	1.2	0.2
tph11	0.2	0.1	1.4	0.2
tph12	0.2	0.1	1.4	0.2
tph13	0.0	0.1	0.2	0.8
tph14	-0.1	0.2	-0.4	0.7
tph15	-0.1	0.2	-0.6	0.6
tph16	-0.1	0.2	-0.3	0.8
tph17	0.0	0.2	0.0	1.0
tph18	-0.1	0.2	-0.3	0.8
tph19	0.1	0.2	0.5	0.6
tph20	0.0	0.1	-0.2	0.9
tph21	0.0	0.1	-0.4	0.7
tph22	0.1	0.1	0.5	0.6
tph23	0.1	0.1	1.0	0.3
tph24	0.2	0.1	1.6	0.1
tpcddh1	0.0	0.0	-1.8	0.1
tpcddh2	0.0	0.0	-1.9	0.1
tpcddh3	0.0	0.0	-2.1	0.0

Parameter	Estimate	StdErr	t-stat	p-value
tpcddh4	0.0	0.0	-2.2	0.0
tpcddh5	0.0	0.0	-2.7	0.0
tpcddh6	0.0	0.0	-2.9	0.0
tpcddh7	0.0	0.0	-2.7	0.0
tpcddh8	0.0	0.0	-2.1	0.0
tpcddh9	0.0	0.0	-0.6	0.5
tpcddh10	0.0	0.0	-0.6	0.6
tpcddh11	0.0	0.0	-0.1	0.9
tpcddh12	0.0	0.0	0.0	1.0
tpcddh13	0.0	0.0	0.7	0.5
tpcddh14	0.0	0.0	0.8	0.4
tpcddh15	0.0	0.0	0.6	0.6
tpcddh16	0.0	0.0	0.4	0.7
tpcddh17	0.0	0.0	0.0	1.0
tpcddh18	0.0	0.0	-0.1	0.9
tpcddh19	0.0	0.0	-0.6	0.6
tpcddh20	0.0	0.0	-0.6	0.5
tpcddh21	0.0	0.0	-0.6	0.6
tpcddh22	0.0	0.0	-0.9	0.3
tpcddh23	0.0	0.0	-1.1	0.3
tpcddh24	0.0	0.0	-1.8	0.1

Table 7-17. SoCalREN HUP peak demand parameters

Parameter	Estimate	StdErr	t-stat	p-value
h1	0.0	0.0	-7.7	0.0
h2	-0.1	0.0	-11.3	0.0
h3	-0.1	0.0	-11.7	0.0
h4	-0.1	0.0	-10.4	0.0
h5	-0.1	0.0	-6.8	0.0
h6	0.0	0.0	-1.4	0.2
h7	0.0	0.0	1.4	0.2
h8	0.0	0.0	0.3	0.8
h9	0.0	0.0	-0.4	0.7
h10	0.0	0.0	-0.9	0.4
h11	0.0	0.0	-0.3	0.8
h12	0.0	0.0	1.7	0.1
h13	0.1	0.0	4.3	0.0
h14	0.2	0.0	7.6	0.0
h15	0.3	0.0	11.2	0.0
h16	0.5	0.0	14.5	0.0
h17	0.5	0.0	16.9	0.0
h18	0.5	0.0	18.1	0.0
h19	0.4	0.0	19.0	0.0
h20	0.4	0.0	21.2	0.0
h21	0.4	0.0	23.4	0.0
h22	0.3	0.0	22.8	0.0
h23	0.1	0.0	17.3	0.0
ph1	0.0	0.0	-0.2	0.8
ph2	0.0	0.0	0.1	0.9
ph3	0.0	0.0	0.5	0.6
ph4	0.0	0.0	0.9	0.4
ph5	0.0	0.0	1.1	0.3

Parameter	Estimate	StdErr	t-stat	p-value
ph6	0.0	0.0	2.3	0.0
ph7	0.0	0.0	0.7	0.5
ph8	0.0	0.0	-0.2	0.8
ph9	0.0	0.0	0.5	0.6
ph10	0.0	0.0	1.6	0.1
ph11	0.0	0.0	1.6	0.1
ph12	0.0	0.0	0.1	0.9
ph13	0.0	0.0	-0.1	0.9
ph14	0.0	0.0	-1.3	0.2
ph15	0.0	0.0	-2.3	0.0
ph16	-0.1	0.0	-4.0	0.0
ph17	-0.1	0.0	-4.5	0.0
ph18	-0.1	0.0	-4.1	0.0
ph19	0.0	0.0	-1.5	0.1
ph20	0.0	0.0	-1.6	0.1
ph21	0.0	0.0	-2.6	0.0
ph22	0.0	0.0	-2.0	0.0
ph23	0.0	0.0	-1.3	0.2
ph24	0.0	0.0	0.1	0.9
cddh1	0.0	0.0	29.7	0.0
cddh2	0.0	0.0	25.9	0.0
cddh3	0.0	0.0	22.6	0.0
cddh4	0.0	0.0	20.7	0.0
cddh5	0.0	0.0	19.1	0.0
cddh6	0.0	0.0	18.0	0.0
cddh7	0.0	0.0	17.6	0.0
cddh8	0.0	0.0	19.8	0.0
cddh9	0.0	0.0	25.4	0.0
cddh10	0.0	0.0	32.3	0.0
cddh11	0.1	0.0	37.2	0.0
cddh12	0.1	0.0	39.6	0.0
cddh13	0.1	0.0	40.1	0.0
cddh14	0.1	0.0	38.7	0.0
cddh15	0.1	0.0	37.4	0.0
cddh16	0.1	0.0	36.9	0.0
cddh17	0.1	0.0	37.1	0.0
cddh18	0.1	0.0	37.9	0.0
cddh19	0.1	0.0	40.2	0.0
cddh20	0.1	0.0	41.6	0.0
cddh21	0.1	0.0	41.8	0.0
cddh22	0.1	0.0	41.0	0.0
cddh23	0.0	0.0	37.8	0.0
cddh24	0.0	0.0	34.9	0.0
pcddh1	0.0	0.0	2.1	0.0
pcddh2	0.0	0.0	2.1	0.0
pcddh3	0.0	0.0	1.7	0.1
pcddh4	0.0	0.0	1.5	0.1
pcddh5	0.0	0.0	1.1	0.3
pcddh6	0.0	0.0	-0.3	0.8
pcddh7	0.0	0.0	0.6	0.6
pcddh8	0.0	0.0	2.0	0.0
pcddh9	0.0	0.0	2.2	0.0
pcddh10	0.0	0.0	1.1	0.3
pcddh11	0.0	0.0	1.1	0.3

Parameter	Estimate	StdErr	t-stat	p-value
pcddh12	0.0	0.0	2.1	0.0
pcddh13	0.0	0.0	2.1	0.0
pcddh14	0.0	0.0	2.7	0.0
pcddh15	0.0	0.0	2.5	0.0
pcddh16	0.0	0.0	3.7	0.0
pcddh17	0.0	0.0	4.1	0.0
pcddh18	0.0	0.0	4.1	0.0
pcddh19	0.0	0.0	1.9	0.1
pcddh20	0.0	0.0	1.4	0.2
pcddh21	0.0	0.0	2.4	0.0
pcddh22	0.0	0.0	2.7	0.0
pcddh23	0.0	0.0	2.9	0.0
pcddh24	0.0	0.0	1.9	0.1
tcddh1	0.0	0.0	1.1	0.3
tcddh2	0.0	0.0	0.9	0.4
tcddh3	0.0	0.0	0.9	0.4
tcddh4	0.0	0.0	0.7	0.5
tcddh5	0.0	0.0	1.1	0.3
tcddh6	0.0	0.0	0.9	0.3
tcddh7	0.0	0.0	1.1	0.3
tcddh8	0.0	0.0	0.9	0.4
tcddh9	0.0	0.0	0.8	0.4
tcddh10	0.0	0.0	1.0	0.3
tcddh11	0.0	0.0	1.5	0.1
tcddh12	0.0	0.0	2.1	0.0
tcddh13	0.0	0.0	2.5	0.0
tcddh14	0.0	0.0	2.5	0.0
tcddh15	0.0	0.0	2.7	0.0
tcddh16	0.0	0.0	2.6	0.0
tcddh17	0.0	0.0	2.9	0.0
tcddh18	0.0	0.0	3.3	0.0
tcddh19	0.0	0.0	4.1	0.0
tcddh20	0.0	0.0	5.7	0.0
tcddh21	0.0	0.0	5.7	0.0
tcddh22	0.0	0.0	4.6	0.0
tcddh23	0.0	0.0	3.2	0.0
tcddh24	0.0	0.0	2.1	0.0
tph1	0.0	0.0	-0.6	0.6
tph2	0.0	0.0	-0.1	0.9
tph3	0.0	0.0	0.1	0.9
tph4	0.0	0.0	0.4	0.7
tph5	0.0	0.0	0.8	0.4
tph6	0.1	0.0	1.4	0.2
tph7	0.1	0.0	1.7	0.1
tph8	0.1	0.0	1.9	0.1
tph9	0.0	0.0	1.1	0.3
tph10	0.0	0.0	0.5	0.6
tph11	0.0	0.1	-0.2	0.8
tph12	-0.1	0.1	-1.0	0.3
tph13	-0.1	0.1	-2.1	0.0
tph14	-0.2	0.1	-2.9	0.0
tph15	-0.2	0.1	-2.9	0.0
tph16	-0.2	0.1	-3.0	0.0
tph17	-0.2	0.1	-2.7	0.0

Parameter	Estimate	StdErr	t-stat	p-value
tph18	-0.1	0.1	-2.2	0.0
tph19	-0.1	0.1	-1.3	0.2
tph20	0.0	0.1	-0.4	0.7
tph21	0.0	0.1	-0.5	0.6
tph22	0.0	0.1	-0.5	0.6
tph23	0.0	0.0	-0.8	0.5
tph24	0.0	0.0	-0.8	0.4
tpcddh1	0.0	0.0	-2.1	0.0
tpcddh2	0.0	0.0	-2.3	0.0
tpcddh3	0.0	0.0	-2.2	0.0
tpcddh4	0.0	0.0	-2.3	0.0
tpcddh5	0.0	0.0	-2.7	0.0
tpcddh6	0.0	0.0	-3.0	0.0
tpcddh7	0.0	0.0	-2.6	0.0
tpcddh8	0.0	0.0	-2.7	0.0
tpcddh9	0.0	0.0	-2.0	0.0
tpcddh10	0.0	0.0	-1.2	0.2
tpcddh11	0.0	0.0	-0.9	0.4
tpcddh12	0.0	0.0	-0.3	0.8
tpcddh13	0.0	0.0	0.1	0.9
tpcddh14	0.0	0.0	0.8	0.4
tpcddh15	0.0	0.0	0.8	0.4
tpcddh16	0.0	0.0	0.6	0.5
tpcddh17	0.0	0.0	-0.3	0.8
tpcddh18	0.0	0.0	-1.1	0.3
tpcddh19	0.0	0.0	-2.3	0.0
tpcddh20	0.0	0.0	-3.8	0.0
tpcddh21	0.0	0.0	-3.6	0.0
tpcddh22	0.0	0.0	-3.0	0.0
tpcddh23	0.0	0.0	-2.4	0.0
tpcddh24	0.0	0.0	-2.2	0.0

7.9 Appendix F: Free-ridership scoring

7.9.1 Single decision

The scoring process for respondent level free-ridership for participants who made a single decision for the whole package is summarized below. If the overall respondent level free-ridership is not determined by the first question on likelihood to implement the program, respondent level free-ridership score is the product of the timing and efficiency free-ridership scores. Responses in this scoring example are shaded light blue. **The overall respondent level free-ridership in this case will equal .25*.5=.125**

OF1. Without the program, how likely would you have been to undertake this project?	
Response option	**Overall respondent level free-ridership score**
Very likely	Next question on Timing
Somewhat likely	Next question on Timing
Somewhat unlikely	0.25
Very unlikely	0
Don't know	., Next question on Timing

OF2. Without the program, when would you have undertaken this project?	
Response option	**Timing free-ridership score**
At the same time or sooner	1
1 to 24 months later: Please specify the number of months = 18	1-(number of months/24) = 1-(18/24) = .25
More than 24 months later	0
Never	0
Don't know	.

OF3. Without the program, would you have installed insulation and equipment …?	
Response option	**Efficiency free-ridership score**
That was the same or higher efficiency as what you installed	1
Above minimum standards/ building code but lower efficiency than what you installed	0.5

Minimum standards/building code	0
Don't know	.

7.9.2 Measure by measure

The scoring process for respondent level free-ridership for participants who made decisions by measure is summarized below. If the overall respondent level free-ridership is not determined by the first question on likelihood to implement the program, respondent level free-ridership score is the product of the quantity, efficiency, and timing free-ridership scores. Responses in this scoring example are shaded light blue. The overall respondent level free-ridership in this case will equal .25*.5=.125

AINS1. Without the program, would you say your likelihood of installing attic or ceiling insulation was…?	
Response option	**Overall respondent level free-ridership score**
Very likely	Next question on Timing
Somewhat likely	Next question on Timing
Somewhat unlikely	.25, Next applicable measure
Very unlikely	0, Next applicable measure
Don't know	., Next question on Timing

AINS2. Without the program, when would you have installed attic or ceiling insulation…?	
Response option	**Timing free-ridership score**
At the same time or sooner	1
1 to 24 months later: Please specify the number of months	1-(number of months/24)
More than 24 months later	0
Never [GO TO NEXT APPLICABLE MEASURE]	0
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…?

Response option	Efficiency free-ridership score
Same or higher R value	1
Lower R value but above minimum standards/code	0.5
Minimum standards/code	0
Would NOT have installed any insulation [GO TO NEXT APPLICABLE MEASURE]	0
Don't know	.

AINS4. Without the program, would you have…?	
Response option	**Quantity free-ridership score**
Covered the same area/square feet (100%)	1
Covered < 100% but more than 0% = 60% (record response, slider)	1-(response percent/100) = 1-.6= .4
Would **NOT** have installed attic or ceiling insulation (0%)	0
Don't know	0
	.

The measure level free-ridership score for attic insulation in the above example is the product of timing, efficiency, and quantity free-ridership for attic insulation = 0*1*.4=0. If any of the three free-ridership scores in the product are zero, then measure-level free-ridership is zero. **i.e. The program gets full credit for the participant implementing the measure.**

Measure level free-ridership scores for a respondent are averaged to arrive at that respondent's overall free-ridership score.

7.10 Appendix G: Survey sample weights

Weights for the participant and non-participant survey samples are presented in this appendix.

Table 7-18. HUP/AHUP participant survey sample weights for free-ridership responses

PA	Climate zone	Fuel	Sample frame - Frequency	Sample frame - Percent	Survey sample - Frequency	Survey sample - Percent	Proportional sample weight
PGE	1	dual, electric, gas	1129	10%	77	19%	0.52
PGE	2	dual, electric, gas	3124	28%	96	24%	1.15
SCE	1	electric, gas	389	3%	29	7%	0.47
SCE	2, 3	electric	2006	18%	53	13%	1.34
SCE	2	gas	2308	20%	43	11%	1.90
SCG	1, 2, 3	gas	1751	16%	65	16%	0.95
SDG&E	1, 2, 3	dual, electric, gas	578	5%	36	9%	0.57

Table 7-19. HUP/AHUP participant survey sample weights for total sample

PA	Climate zone	Fuel	Sample frame - Frequency	Sample frame - percent	Survey sample - Frequency	Survey sample - Percent	Proportional sample weight
PGE	1	dual, electric, gas	1129	10%	92	18%	0.55
PGE	2	dual, electric, gas	3124	28%	128	25%	1.10
SCE	1	electric, gas	389	3%	33	6%	0.53
SCE	2, 3	electric	2006	18%	75	15%	1.21
SCE	2	gas	2308	20%	57	11%	1.83
SCG	1, 2, 3	gas	1751	16%	79	15%	1.00
SDG&E	1, 2, 3	dual, electric, gas	578	5%	46	9%	0.57

Table 7-20. HUP/AHUP non-participant survey sample weights for total sample

PA	Climate zone	Fuel	Sample frame - Frequency	Sample frame - Percent	Survey sample - Frequency	Survey sample - Percent	Proportional sample weight
PGE	1	dual, electric, gas	11244	9.1%	270	13.1%	0.69
PGE	2	dual	25998	20.9%	462	22.5%	0.93
PGE	2	electric	3570	2.9%	64	3.1%	0.92
PGE	2	gas	8466	6.8%	128	6.2%	1.10
SCE	1, 2, 3	electric, gas	32876	26.5%	357	17.4%	1.53
SCG	.	gas	37718	30.4%	673	32.7%	0.93
SDG&E	. 1 2 3	dual, electric, gas	4302	3.5%	103	5.0%	0.69

7.11 Appendix H: Survey instruments

7.11.1 Participant survey

Invitation

This section presents the email invite issued to participants.

From: homeupgradesurvey@dnvgl.com

Subject line: Take our Home Upgrade Survey for a chance to win $100!

Home Upgrade
Energy Upgrade California®

Dear Customer,
As a participant in the **Home Upgrade program**, your opinions are important. Your utility and the California Public Utilities Commission (CPUC) would like your input and perspectives to understand how to best structure future programs.

To be entered into a drawing to **win a $100 prepaid credit card, complete this 10 minute online survey** by **midnight on Monday, December 31, 2018**. You have a 1:100 chance to win! The information gathered will be used solely for research purposes and your individual responses will be kept completely confidential.

DNV GL is the research provider retained by the CPUC to help administer this survey. If you'd like to validate the legitimacy of this survey, you may contact the CPUC study manager, Peter Franzese, at Peter.Franzese@cpuc.ca.gov.

Thank you for helping to improve energy efficiency programs in California.

DNV·GL

155 Grand Ave. Suite 500
Oakland, CA 94107

If you would like to be removed from this survey, click on this link [remove].

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 (CPUC).

The CPUC 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.

To validate the legitimacy of this survey, visit the CPUC website for a listing of this and other CPUC approved research efforts underway: http://cpuc.ca.gov/validsurvey

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

Screener

S1. **When did you complete the project under the Energy Upgrade California Home Upgrade program? Your best guess is fine**.

1. Prior to 2015
2. In 2015
3. In 2016
4. In 2017
5. After 2017

98. Don't know

To remind you, the Energy Upgrade California® Home Upgrade program provides assistance and incentives for home improvement projects/upgrades that can reduce energy use and make homes more comfortable.

[IF S1 IN (1, 5, 98) THEN SCREEN OUT]

Project details-warm up

Energy audit

A1. **Prior to undertaking this project, did you have an energy assessment/energy audit done of your home to identify measures that would save energy and reduce energy costs?**
(Hover text over **energy assessment/energy audit:** An energy audit is an assessment of your home that takes a look at your current energy consumption and then identifies energy efficiency actions that you can undertake to make your home more efficient, such as installing insulation or upgrading your heater)

1. Yes
2. No ➔ **GO TO PP1**

98. Don't know ➔ **GO TO PP1**

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 (Hover text over **blower door**: A blower door is a machine used to measure the airtightness of buildings and to help physically locate air leakage sites in the building envelope)
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 (Hover text over **combustion efficiency**: Combustion efficiency tests measure how effectively your heating system is converting fuel into heat)
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

Program participation

PP1. **What triggered your decision to undertake this home upgrade?**

_____ [OPEN-END]

PP2. **What is the *main reason* why you undertook this home upgrade? [CHECK ONE, RANDOMIZE] [AHUP ONLY] [AHUP ONLY]**

1. Saving money
2. Maintaining health
3. Improving comfort (house was too hot in summer, too cold/drafty in winter)
4. Protecting the environment
5. For the benefit of future generations
6. Saving energy
7. Helping California lead the way on saving energy
8. Other (specify) _____

PP3. **How many bids did you get for your energy retrofit project?**

1. 1
2. 2
3. 3
4. 4 or more
5. Don't recall

PP4. **What is the *main reason* you selected your contractor instead of the other(s)? [CHECK ONE]**

1. Lowest cost
2. Most experience
3. Strong referral

4. Positive third-party review (Yelp, Angie's List, etc.)
5. Shortest project timeline

PP5. **Which of the following did your contractor bring up when discussing plans and expected results from your home upgrade? [CHECK ALL THAT APPLY, RANDOMIZE]**

1. Energy savings on your monthly bill
2. Rebates on equipment purchases and contractor services
3. Improved comfort in your home due to elimination of hot or cold spots
4. Improved air quality in your home
5. Improved safety of heating and cooling equipment
6. Improved moisture and mold control
7. None of the above [EXCLUSIVE]
8. Other (specify):

PP6. **What, if anything, prevented you from improving the energy efficiency of your home before you participated in this home upgrade program?**

_____ [OPEN-END]

Measures installed

M1. **Please indicate which of the following home improvements your contractor/auditor recommended and which of the recommend improvements you installed?** [CHECK ALL THAT APPLY]

Measure	Description	A: Contractor recommended	B: Actually installed
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		
9	Insulate HVAC ducts		
10	Install a new high efficiency water heater		
11	Insulate hot water pipes e.g. domestic hot water distribution		
12	Replace windows		
13	Install low flow showerheads and/or thermostatic shut-off valve		

[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-ridership module

In this section, we would like to identify the influence, if any, that information or incentives provided by the program had on your decision to install the energy saving improvements.

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

OF2. Without the program, when would you have undertaken this project?
1. At the same time or sooner
2. 1 to 24 months later: Please specify the number of months
3. More than 24 months later *(full program credit, OF3)*
4. Never *(full program credit, OF3)*
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

[GO TO PROGRAM BENEFITS].

Measure-specific free-ridership 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. More than 24 months later
4. 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. more than 24 months later
4. 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. more than 24 months later
4. 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. more than 24 months later
4. Never **[GO TO NEXT APPLICABLE MEASURE]**
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. more than 24 months later
4. 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…?

1. Same or higher than program requirements (>= *14 SEER or 12 EER)*
2. Lower than program requirements but above minimum standards/code
3. Minimum standards/code
4. Would not have installed a 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. more than 24 months later
4. 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…?

1. Same or higher than program requirements (>= *92% AFUE)*
2. Lower than program requirements but above minimum standards/code
3. Minimum standards/code
4. Would not have installed a 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. more than 24 months later
4. 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…?

1. Same or higher than program requirements (>= 14 SEER or 12 EER)
2. Lower than program requirements 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

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

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

98. Don't know

[GO TO NEXT APPLICABLE MEASURE]

HVAC duct insulation

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 your ducts… [READ LIST, SINGLE RESPONSE]?

1. at the same time or sooner
2. 1 to 24 months later _____ (record response, slider)
3. more than 24 months later
4. Never **[GO TO NEXT APPLICABLE MEASURE]**
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. more than 24 months later
4. 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)

[*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 than program requirements (EF >= .62)
2. Lower than program requirements 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]

Hot water distribution

HWD1. Without the program, how likely were you to replace your hot water distribution system?

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

[IF HWD1 in (3, 4) GO TO next applicable measure section]
FR note: 3 or 4 get 100% program attribution for this measure

HWD2. Without the program, when would you have installed a hot water distribution system?

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

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. more than 24 months later
4. 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

Low-flow showerhead

SHO1. Without the program, how likely were you to install low flow showerheads and/or thermostatic shut-off valves?

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

SHO2. Without the program, when would you have installed low flow showerheads and/or thermostatic shut-off valves?

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

SHO3. Without the program, would you have installed more or fewer low flow showerheads and/or thermostatic shut-off valves …? [HIDE IF SHO2 = 1 or 2]

1. Same or more (100%)
2. Upgraded less than 100% but more than 0% _____ (record response, slider)
3. Would NOT have installed showerheads and/or thermostatic shut-off valves (0%)
98. Don't know

Program Benefits

BEN1. **Please indicate your level of agreement with the following [RANDOMIZE]:**

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

BEN2. **Considering the cost of your home upgrade and these main benefits that you may have experienced, if you were to express the value of each of these benefits by distributing 100 dollars across your list – how much out of 100 dollars would you pay for…? [RANDOMIZE]**

1. Home comfort _____
2. Saving money on energy bill _____
3. Saving energy _____
4. Helping the environment _____

5. Increased home market value _____

[RESPONDENT TYPES IN WHOLE NUMBERS, MUST ADD TO 100]

Cross program participation

SE01. Your utility provides customers with additional information on rates and technologies like solar. Which of the following have you either sought information on, received information on or used from or your utility?

1. **Rate plan options:** To learn about alternate electric rates and time-of-use pricing options.
2. **Solar estimator:** Used your utility's solar calculator to evaluate the right size solar electric system for your home
3. **Neither of these**

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)	13	Decreased living area/square footage of your home (converted a bedroom to a store room, for example)
Heating-areas	2	Heating **additional areas** in your home	14	Heating **fewer areas** in your home
Heating-usage	3	Using **more heating** in your home	15	Using **less heating** in your home
Cooling-areas	4	Cooling **additional areas** in your home	16	Cooling **fewer areas** in your home
Cooling-usage	5	Using **more cooling** in your home	17	Using **less cooling** in your home
Lighting	6	Using **more lighting**	18	Using **less lighting**
Refrigerator	7	Using an **additional** refrigerator	19	Got rid of/recycled/stopped using an additional refrigerator
Pool	8	**Added** a pool	20	Eliminated/**stopped** using your pool
Spa	9	**Added** a spa	21	Eliminated/**stopped** using your spa
Occupancy	10	Occupied your home for **more** days in the year compared to previous years	22	Occupied your home for **fewer** days in the year compared to previous years
	11	**Increased** number of visits and/or long-term guests	23	**Decreased** number of visits and/or long-term guests

Thermostat	12	Installed a learning/smart thermostat (e.g. Nest or Ecobee)	24	Installed a home automation system or home energy management (e.g. Amazon's Echo/Alexa or Apple's Home Kit)
25 No changes made		**No changes**		

Respondent and household characteristics

These 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?

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

HH3. Roughly, how large was your home **before** the upgrade?
_____ (square feet)

HH4. And, how large is your home **after** the upgrade?

1. Same as before
2. Changed to _____ (square feet)

HH5. How many floors in your home **before** the upgrade? _____ (floors)

HH6. How many floors in your home **after** the upgrade? _____ (floors)

1. Same as before
2. Changed to _____ (number of floors)

Research shows that home occupancy strongly influences household energy use. In the next few questions, we would like to better understand how many people were living in your home for all or part of the year. Individual responses will be kept confidential and will be averaged to understand occupancy trends across all survey respondents.

HH7. **How many people, including yourself, lived year-round in your household at [address]?**

**If were not at your current residence in the years 2016 or 2017, please select "not applicable".

- In 2016 [Repeat for each list option for each row]
- In 2017 [Repeat for each list option for each row]
- In 2018 [Repeat for each list option for each row]

List option:
1.None
2.1
3.2
4.3
5.4
6.5
7.6 or more
8.Prefer not to answer
9.Not applicable

HH8. **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

HH9. **Which of the following categories best describes your employment status?**
[SINGLE RESPONSE]
1. Employed full-time
2. Employed part-time
3. Unemployed
4. Retired
5. Homemaker
6. Temporarily laid off
7. Student
96. Other, please specify: [OPEN-ENDED RESPONSE]
98. Don't know

HH10. **Which of the following categories best describe your family's total household income in 2017 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.

7.11.2Non-participant survey

Invitation

This section presents the email invitation HUP non-participants received in their email box.

From: evaluation@survey.dnvgl.com

Send Replies to: homeupgradesurvey@dnvgl.com

Subject line: Take the CPUC's Energy Survey for a chance to win $100!

Dear [F1],
Your opinions are important! Your utility and the California Public Utilities Commission (CPUC) would like your input and perspectives to understand how to best structure residential energy efficiency programs in the future. Your household has been selected to participate in a survey to learn about household energy using equipment.

To be entered into a drawing to win a $100 prepaid cash incentive card, please complete this 5 minute online survey by midnight December 31, 2018. Winners will be notified by email. The information gathered will be used solely for research purposes and your individual response will be kept completely confidential.

DNV GL is the research provider retained by the CPUC to help administer this survey. The above survey link is unique to your household, please do not forward it. To validate the legitimacy of this survey, visit the CPUC website for a listing of this and other CPUC approved research efforts underway: http://cpuc.ca.gov/validsurvey

Thank you in advance for your participation! You are helping to improve energy efficiency programs in California.

155 Grand Ave. Suite 500
Oakland, CA 94107

If you would like to be removed from this survey request please click on this link here: [remove]

Introduction

Hello {Q1},

This brief 5-minute survey is being conducted with households in California as part of a study sponsored by the California Public Utilities Commission (CPUC). The CPUC 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. To validate the legitimacy of this survey, visit the CPUC website for a listing of this and other CPUC approved research efforts underway: http://cpuc.ca.gov/validsurvey

Screener

1. **First, we want to ask you a few background questions before we proceed to energy use questions. Does anyone in your household currently work for an electric or gas company (e.g. PG&E, SCE or SDG&E)?**

   Yes
   No

2. **Do you live at this location: {import address field}?**

   Yes
   No

3. [Show if Q2 = No otherwise skip] **What is your home address?**

   Answer options: [self-report]

Cross-Program Participation

SE01. Your utility provides customers with additional information on rates and technologies like solar. Which of the following have you either sought information on, received information on or used from or your utility?

4. **Rate plan options:** To learn about alternate electric rates and time-of-use pricing options.
5. **Solar estimator:** Used your utility's solar calculator to evaluate the right size solar electric system for your home
6. **Neither of these** [EXCLUSIVE]

Household Changes

CH2. 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)	12	Decreased living area/square footage of your home (converted a bedroom to a store room, for example)
Heating-space	2	Heating **additional areas** in your home	13	Heating **fewer areas** in your home
Heating-usage	3	Using **more heating** in your home	14	Using **less heating** in your home
Cooling-space	4	Cooling **additional areas** in your home	15	Cooling **fewer areas** in your home
Cooling-usage	5	Using **more cooling** in your home	16	Using **less cooling** in your home
Lighting	6	Using **more lighting**	17	Using **less lighting**

Refrigerator	7	Using an **additional** refrigerator	18	Got rid of/recycled/stopped using an additional refrigerator
Pool	8	**Added** a pool	19	Eliminated/**stopped** using your pool
Spa	9	**Added** a spa	20	Eliminated/**stopped** using your spa
Occupancy	10	Occupied your home for **more** days in the year compared to previous years	21	Occupied your home for **fewer** days in the year compared to previous years
Thermostat or home automation	11	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		**No changes**		

Respondent and Household Characteristics

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

HH11. **What year was your home built? [SINGLE RESPONSE]**

7. Before the 1970s
8. 1970s
9. 1980s
10. 1990-1994
11. 1994-1999
12. 2000s
99. Don't know

HH12. **How many bedrooms are there in your home?**

5. 1
6. 2
7. 3
8. 4 or more

HH13. **How many floors, above ground, is in your home?**

1. (number of floors):

Research shows that home occupancy strongly influences household energy use. In the next few questions, we would like to better understand how many people were living in your home for all or part of the year. Individual responses will be kept confidential and will be averaged to understand occupancy trends across all survey respondents.

HH14. **How many people, including yourself, lived year-round in your household at [address]?**

**If were not at your current residence in the years 2016 or 2017, please select "not applicable".

- In 2016 [Repeat for each list option for each row]
- In 2017 [Repeat for each list option for each row]
- In 2018 [Repeat for each list option for each row]

List option:
1.None
2.1
3.2
4.3
5.4
6.5
7.6 or more
8.Prefer not to answer
9.Not applicable

HH15. **[HIDE IF HH8 IS 8 OR 9] You mentioned that {HH8.2017} people lived at your home year-round in 2017. Did anyone stay/visit or leave for a month or longer? For example: students leaving home for college, elderly family members moving in part-way through the year etc.**

Scale: None - 1 - 2 - 3 - 4 - 5 - 6 or more - prefer not to answer - not applicable
Number of additional members in summer
Number of fewer members in summer
Number of additional members in winter
Number of fewer members in winter

HH16. **Which of the following best describes your education?**
[SINGLE RESPONSE]

8. Some high school or less
9. Graduated high school
10. Trade or technical school
11. Some college
12. College graduate
13. Post graduate work or degree
99. Don't know

HH17. **Which of the following categories best describe your family's total household income in 2017 before taxes?**
[SINGLE RESPONSE]

8. Under $25,000
9. $25,000 to under $50,000
10. $50,000 to under $75,000
11. $75,000 to under $100,000
12. $100,000 to under $150,000
13. $150,000 to under $200,000
14. $200,000 or more
99. Don't know

Wrap-up

T&T (used when respondent completes the survey)

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

7.12 Appendix I: Triggers and main reasons for program participation

The following tables provide a more detailed summary of open-ended survey responses on the triggers and main reasons for participation in HUP/AHUP.

Trigger Category and Number of Responses	Example Trigger Quotes
More than 200 of 400 open-ended responses listed at least 2 factors as the main trigger (multifactorial)	• High power bills, hot weather in the summer, cold weather in the winter, upgrade to new efficient heater, installation of air conditioning, and installation of solar panels. • The climate is getting warmer the past few years and it is becoming unbearable in the summer without A/C system. This home upgrade program gave me a chance to obtain an affordable solution which otherwise will be beyond my means. • HVAC was 22 years old, and I knew it would need replacing before too long. Plus, a friend had recently taken classes on residential energy efficiency and was educating me on the results of this kind of work. I knew it would pay off over a relatively short number of years.
Replacement/Repair/Upgrade of Existing (for existing old/poor performing/dead/equipment or measures) n=176	• My 30-year-old AC died during hottest week of summer, and I didn't want to fix an old AC and just upgraded everything. • Old furnace broke. • LEDs are brighter and last longer. Refrigerator is more efficient and works better. • My air conditioning needed repair. The technician explained benefits of improved air ducts and insulation. • Failure of an 18-year-old heat pump. • Our heater was no longer functioning properly. The blower fan would not turn off unless the entire unit was manually turned off. • Our home is 30% windows which were installed in 1983-we knew the house was inefficient-we also need to replace our pool pump. • It didn't make sense to invest in solar when the AC unit was ancient, and the windows & doors were drafty.
Saving Energy/Helping Environment n=113	• I want a better energy future without money going to Saudi Arabia. I want to end climate change. I want to stop wasting energy. • It was the right thing to do for the planet and for us. • Wanted green energy savings. • Wanted to do my part in energy conservation. • Opportunity to improve our home and help the environment.

Trigger Category and Number of Responses	Example Trigger Quotes
Saving Money on Energy Costs n=98	• High utility bills. • Wanted to lower my energy bills. • High energy bills, uninsulated walls, wanting to do some improvements but not sure what to do for best effort. • Wanted to cut my electrical costs for long term. • Save money.
Comfort/Health/Safety/Convenience (e.g., indoor temperature, air quality, reduced maintenance) n=81	• A desire to make the house more comfortable, primarily by evening out the temperature gradient from the north to the south side. • My home, built in 1940, was too cold in winter & too hot in summer. • Main reason was comfort, but we discovered a whole section of ductwork that was collapsed. • Total package, plus asbestos abatement was included. • My son has severe allergies, so I wanted to install an air purification system.
Free Equipment/Rebates/Discounts/Credits/Program Benefits n=62	• Decided to use the program to help lower costs of doing new insulation. • To make home improvements without having to pay for it all at once. • The loan repayment plan. • Federal tax credits. • Wanting to improve building envelope; financial incentives. • It was free.
Was Planning to Replace/Repair/Upgrade Anyway (or was in middle of doing it when made choice) n=31	• I was planning on doing a renovation, so I thought this would be a good time to look at energy savings. • We were adding square footage and the upgrade was part of the HVAC work.
Referral/Recommendations/Advertisement (friend, family, utility, contractor, store/sales rep, media ad) n=26	• Friends of ours had it done and told us about it, so I called myself and they came out and we qualified for it. • Knock on door from company performing upgrades in the area. • Referral from my uncle and person calling us.
Didn't Have heating and/or Cooling at all Before & Wanted It n=18	• Wanting to upgrade insulation and add AC. • Home did not have air conditioning and summers were getting hotter. • We didn't have central air. • Needed AC. • I needed a new furnace and decided to add air conditioning.

Trigger Category and Number of Responses	Example Trigger Quotes
For a Backup Energy Source/Wanted Solar n=11	• It wasn't an advertisement or flier, I always wanted to go with solar electricity and the company we picked knew about the home upgrade program. • We wanted to assure we have electrical service in a natural disaster.
Improved Resale Value n=2	• Added resale value; deferred payments.

Main Reason "Other" Category	Main Reason Quotes
Replacement/Repair/Upgrade of Existing (for existing old/poor performing/dead/equipment or measures)	• Aged furnace and AC systems wasting money. • The program offered more than I was looking for. I didn't realize my house was not insulated. • Unit failure. • Replacement of the original ~35-year-old forced air gas furnace. • Leaky roof. • Furnace cracked, and AC is too old to work properly.
Better Energy Efficiency (of Appliance or Room or Home)/Help Environment/Response to Environmental Changes	• Upgrade energy flow and equipment (AC, Heating, Roof). • To see IF there was a way to be more energy efficient. • I support renewable sources of energy and want to do my part. • Increased number of days of intense heat during summer.
Save Money on Energy Costs/Spend Less on Energy Costs/Response to Energy Costs	• Future energy cost mitigation. • Save money over AC. • Save on running AC. • Lower heating cost. • Energy efficient for the environment and to save money. • Rising energy costs. • High electric bills. • I'm a low-income person. • Lifetime savings.

Main Reason "Other" Category	Main Reason Quotes
Comfort/Convenience/Safety/Health (e.g., indoor air quality-removal of asbestos)	• I wanted a trouble-free system. • Heater died, dead of winter! • Make the home safer and more efficient. • Noise reduction and insulation. • To ensure we had heat in the winter. • Comfort and convenience. • To save energy and add sound proofing. • To make the electrical box safer. There were fuses and now has switches. • Asbestos abatement.
Free Equipment/Rebates/Discounts/ Credits/Program Benefits	• There was no upfront cost. • Tax benefits. • Rebates for Home HVAC upgrade. • Able to replace/upgrade HVAC without having to pay upfront. • Energy saving and free work. • Financially affordable.
Was Planning to Remodel/Upgrade/Repair Equipment/Home Anyway (or was in middle of doing it when made choice)	• We were looking at new windows and the window company suggested the audit.
Didn't Have heating and/or Cooling at all Before & Wanted It	• Replace 40-year-old furnace and add A/C.
For a Backup Energy Source/Wanted Solar	• I support renewable sources of energy and want to do my part.
Improved Resale Value	• Will be selling in a few years and wanted to be up to code.

7.13 Appendix J: Response to Comments

Table 7-21. Response to comments

Comment ID	Commenter	Page (as shown in Word document footer)	Comment	Response
1	PG&E		The draft report does not include an Executive Summary, which is a critical part of the report. When will stakeholders be provided a complete draft for review and comment, including executive summary, before the final report is published?	We were awaiting feedback on the Executive summary from the CPUC. The final report includes the Executive Summary and the IESR tables.
2	PG&E		The report is represented as a "Year 2017" evaluation although the evaluation covers all of 2016 and the first half of 2017. Would the CPUC and DNV GL consider changing the report sub-title to "Home Upgrade Program - Residential Program Years 2016 and Q1/Q2 2017" or something similar to reflect the period of time for which this evaluation covers so as to correctly characterize its contents and to avoid potential confusion?	The study has been updated to focus on 2017. It uses data from the second half of 2016 and first half of 2017 to estimate 2017 program impact. The following statements, which are included in the report, provide the reasons for this choice. Activity and outcome for these participants were used as a proxy for 2017 program performance. There are several important reasons for this choice. First, the analysis that we use requires a year of pre- and post-installation data to analyze program outcome. At the time of this study, only data up to the summer of 2018 was available and, thus, we could only include those who participated prior to the summer of 2017. Only such participants in 2017 would have a year of post-installation data needed for the analysis. In addition, data from the first half of 2017 was not sufficient to obtain robust and statistically precise estimates requiring that we include participant data from the second half of 2016. The hybrid year is the best possible data that we could use to estimate program activity in 2017.

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3	PG&E		The results of impact evaluations may be used by the CPUC to update ex-ante NTG values and will factor into the ex-post portion of Efficiency Savings and Performance Incentive (ESPI) mechanism. Given that energy savings presented for 2017 assess program performance for the first half of the year but some other metrics, many aspects of the report as presented may be mislabeled. For example:-Are the program expenditures listed in Table 2-1 for all of 2017? -Are the savings listed in Table 2-2 for all of 2017? -Is the tracking data summary (and introductory text) for Table 3-2 only for the first half of 2017? -Are the number of participants (and introductory text) for Table 3-3 only for the first half of 2017? Could DNV GL please clarify the table and figure headings throughout the report so that the casual reader does not misinterpret any information when figures for 2016 and 2017 are presented side by side?	The report has been rewritten to clarify these issues. However, Table 2-1 and 2-2 are still included and reflect savings and expenditures for all of 2016 and 2017. The headings indicate that. The values in Table 2-3 are for all of 2017, again as indicated in the heading. We focus only on 2017 in this report and headings and discussion reflect that.
4	PG&E		The IOUs have used the term "unadjusted gross" to refer to the difference in observed energy use prior to and after the implementation period in a group of treated customers, adjusted for weather. "Unadjusted gross" is a term that is used to distinguish this pre/post difference from gross savings, the latter having been adjusted for exogenous changes by a "difference-of-differences" method through the use of a constructed comparison group. We note that site-level modeling was used in the first stage of this evaluation prior to the pooled fixed-effects model as the second stage, but that the draft report does not provide an explicit mention of the impact of exogenous changes have on the estimates of gross savings (that is, the delta between the "unadjusted gross" and the gross savings estimates resulting from the second stage models). We acknowledge that the impact of exogenous changes will vary over time and vary depending on the specific composition of a comparison group. Because PG&E is using the output of version 2 of the CalTRACK methodology to compensate some implementers of residential whole building programs, could DNV GL please provide a table with estimates of the adjustments made for exogenous changes in the matched comparison groups used in this study? These estimates may assist PG&E and the other IOUs in developing "discount" from savings observed using CalTRACK computations that we can use as a starting point for settlement purposes with implementers of programs similar to HUP/AHUP in the near future. To the extent that it is possible, could DNV GL please explain what factors in the composition of the	Unadjusted gross can be calculated using regression estimates provided in the appendix. Unadjusted gross is the sum of the intercept and treatment parameters. (Savings are negative - if the intercept is negative, the comparison group decreased consumption. If the intercept is positive, the comparison group increased consumption.) The whole purpose of the comparison group is to capture otherwise unknown exogenous, non-program-related change. Almost by definition, we do not know what is going on there. If we did, then we, as evaluators, might be able to address it more directly. What we do know is that if you look at non-program participants over time, they fluctuate up and down and there is no reason to believe that these natural fluctuations - driven by any number of economic, geographic or social trends, are not also occurring in the program participant group. The comparison group is a proxy for that change in the participant group.

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			comparison groups might account for any differences observed in the adjustments provided in the table (that is, by program type and/or by IOU)? See PG&E's analysis of weather adjusted gross savings using the CalTRACK V2 methods in the attached file. How do these savings estimates compare to the results in this analysis? Could DNV GL assess the likely reasons for the similarities or differences between the site-level estimates from its analyses and the analyses contained in this document?	Another useful way to think about the comparison group that is provided in the literature is that the comparison group protects against specification bias. Regressions are always imperfect, especially when independent variables that track change over time for households are unavailable, as is the case with billing data. Treating the participant and comparison groups identically and including in a difference in difference limits the potential bias of specification error.
5	PG&E		Energy Division staff (Jeorge Tagnipes) confirmed at the December 11, 2018 Quarterly Stakeholder meeting that all energy efficiency impact evaluations will contain IESR tables, i. tables in accordance with the CPUC Energy Division Impact Evaluation Standard Reporting Guidelines (November 2015, https://pda.energydataweb.com/api/view/1399/IESR_Guidelines_Memo_FINAL_11_30_2015 pdf). However, the draft report does not contain any IESR tables. D15 Most of this information does not appear in the draft report. When will stakeholders be provided a complete draft, including IESR tables, for review before the final report is published?	This version of the report includes these tables.

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6	PG&E		One concern we have regarding this draft report is that its title (and several of the title of the charts and tables contained in the document) may mischaracterize the scope of the effort. Although it is titled as covering the Program Year 2017, this evaluation covers an 18-month timeframe from January 2016 through June 2017. While we understand that the title of this document may be driven by contractual considerations the bulk of the evaluation effort is focused on the 2016 calendar year. For the sake of precision, may we suggest that the work be retitled to reflect this fact?	We have changed the labeling in table 4-1, table 4-2, figure 4-1, figure 4-2, figure 4-3, table 4-3, and table 4-4 to clarify the evaluation period. The program summary tables in the introduction as well as the overall savings tables do reflect the counts and savings for all of 2016 and 2017.
7	PG&E		A second concern we have is that the report provides no possible explanation(s) as to the dramatic surge in Gross Realization Rates (GRRs) for PG&E's Home Upgrade Program. Improving GRRs was key to several recommendations in the 2015 HUP/AHUP impact evaluation, and—while we understand that this was not a process evaluation—we would appreciate any insight that DNV GL could provide as to the source(s) for the dramatic improvement to PG&E's GRRs for this program.	PG&E's ex ante average savings per household has decreased from 2015, while the evaluated savings per household has increased. As indicated in the 2015 evaluation (Appendix L, which provides responses to comments), DNV GL used AHUP/HUP classification provided by PG&E that was incorrect for a large number of participants. This became evident only after the evaluation was concluded and the results including the high average ex ante savings value of 1,315 for HUP reflect this error. Therefore, the gross realization rate for PG&E's HUP in 2015 may not be an appropriate benchmark for the 2017 finding. In future evaluations, we will use tracking data and possibly include survey questions to gauge changes in the program that could explain variations in realization rates.
8	PG&E		Finally, we note that there are two key items are missing from this draft, namely the executive summary and so-called IESR tables, the acronym which refers to the CPUC Energy Division Impact Evaluation Standard Reporting Guidelines. The executive summary is the single "go-to" source that most readers turn to for a quick understanding of the key findings of an evaluation. IESR tables provide critical information for more experienced readers of evaluations that ensure: 1. Comprehensive evaluation results are documented 2. Ex Ante vs. Ex Post savings are comparable 3. Readers can easily access and identify	DNV GL was/is awaiting CPUC review and feedback on the Executive summary and these will be included in the final report. IESR tables were not completed prior to the March 1 deadline due to the truncated timeline for this evaluation period.

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			important results, and 4. Results from different impact evaluations are comparable.	
9	PG&E		While we appreciate the short timelines that DNV GL has operated under to produce impact evaluations to meet the "bus stop" requirements for 2019, we are concerned that the omission of the executive summary and IESR tables from this review draft may result in the publication of the final evaluation without the opportunity for PG&E and other key stakeholders to review them for accuracy. We request that IOUs and other stakeholders be given at least several business days to review and provide comments to these critical components prior to this evaluation being published as a public document.	We will include both the ExSum and the IESR tables and socialize with stakeholders prior to finalizing reports for HER and HUP PY 2017 impact evaluations.
10	BayREN	p5	The draft report states that in 2017, there were half as many program participants, but expected savings across all fuels were only a third less than in 2016. Please clarify 'expected' savings.	Expected' savings refer to ex ante or claimed savings. Edits are made in the report to clarify this.
11	BayREN	p6	It is not appropriate to use 2016 and partial 2017 data to adjust all of 2017 savings. Significant changes were made to the HUP program near the end of 2016 in order to boost per project savings. Our pre/post meter data analysis of a larger group of 2017 HUP participants indicates they are, on average, saving 2.76x as much electricity and 1.81x as much gas as 2016 participants. Please complete a separate analysis of 2017 participants now that a full year of post-implementation data is available. If a separate 2017 analysis is not possible, please distinguish 2017 data in all tables and figures and note the difference in data used.	Please see response to comment # 2.

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12	BayREN	p7 and p12	A comparison group and a NTG survey to adjust gross to net impacts was used. This is an over adjustment, because the prevalence of energy saving home improvements among the comparison group itself provides a measure of free-ridership. This double adjustment is also inconsistent with the CPUC's published evaluation protocols, which call for using either a comparison group or a NTG survey for the net impact protocol. Please adjust the study to use one or the other.	For a comparison group to provide a net savings estimate it would need to provide a proxy for the percentage of participants who would have done their home upgrade with energy efficiency installations without the program. While the comparison group may include some natural adoption of relevant EE program measures, there are multiple reasons to believe the concentration will be extremely low, and certainly not a reasonable estimate of the free-ridership among participants. Self-selection tells us that a disproportional percentage of potential installers will opt into the program leaving a reduced pool of natural adopters to locate in the general public. Timing further waters down the pool as, in the general public, major home upgrades occur in only a tiny subset of households in any given year, whereas the participants are all participants during this specific time frame. These two forces make it clear that the comparison group pre-post delta will address at best a tiny fraction of the free ridership present in the participant group. Just as importantly, a billing analysis requires the comparison group to account for the much more important issue of non-program-related exogenous change and that is why comparison groups invariably increase consumption as often as they decrease consumption. Thus, a comparison group may provide, at most, a very partial net adjustment. Not adjusting the billing analysis result with a survey NTG would grossly underestimate free ridership. With the survey NTG, there might may be a slight over-estimation of

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				free-ridership.
13	BayREN	p12, p17	In section 3.4, it is stated that "The net-to-gross ratio is the complement of free-ridership. This ratio is applied as an adjustment to gross savings to arrive at net savings and represents the portion of gross savings that is fully attributable to the program." Please specify if these gross savings are 'claimed gross savings' or 'evaluated gross savings'.	This refers to 'evaluated gross savings.' Edits are made in the report to clarify this.
14	BayREN	p14	The draft report states that both HUP and AHUP, estimated gas savings in program years 2016 and 2017 are lower than in 2015. Please clarify 'estimated' savings.	Estimated' savings refer to DNV GL's evaluated savings. They reflect savings estimates from the model DNV GL uses to evaluated savings. Edits made in the report clarify this.

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15	BayREN	p23	The report states that customers who acquired solar were excluded from the study. Please clarify whether they were excluded from both intervention and comparison groups. If they were not excluded from the comparison group, please also indicate how you expect that would impact the study's findings.	Customers that acquired solar during the study period were excluded both the intervention and comparison groups. This point will be emphasized for further clarity.
16	BayREN	p29	Higher energy savings actions among program participants versus non-participants was mentioned. Was there any indication these energy savings actions were a result of the Program itself, or other Program activities?	The energy savings actions summarized in the analysis refer to actions such as using more/less lighting, more/less heating, getting rid of an additional refrigerator etc. These activities are different from/do not overlap with the program measures such as installation of a furnace, heat pump, low flow showerheads etc.
17	BayREN	p30	It is noted that the sample was well over the minimum required to report results at 90/10 to estimate free-ridership, Is this statement true at the individual PA level? Please report the number of survey participants by PA and, if appropriate, adjust the statement to reflect the confidence in the PA-level results you are showing.	It is not true at the PA level for all PAs. Precision is 90/10 at the total level and is 90/20 for all PAs, except for SCE and SoCalREN where it is 90/27.
18	BayREN	p33	There is no graphic showing distribution of HUP participants in BayREN territory. Also, the 'PG&E HUP' distribution graphic (Figure 5-7) appears to include BayREN territory. Please indicate whether it is possible to include BayREN participant distribution data and adjust the PG&E graphic to exclude BayREN data, or clarify any limitations.	We have added maps that show the distribution of participants by PA.
19	OpenEE		In its current form, the Home Upgrade and Advanced Home upgrade report lacks adequate transparency in documenting methods. This has the effect of inhibiting basic understanding of the results and doesn't allow for replicability. We request that DNV-GL include more granular detail on the methods as well as include source code for billing analysis or other calculation tools used for this study to allow for review and serve as a record in the final report.	The report provides details including the two-stage approach used and the models specified in each step. It also provides details used for the peak demand estimates including details such the exact model specified, the peak period definition used and the CZ2010 TMY definitions. Overall, it provides details that are in line with or better than is typically provided for evaluations. We also want to note that the PRISM approach that this report uses is the basis of Caltrack, which is widely published. Code and data used are handed over to the CPUC upon completion of the project.

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20	OpenEE		The basis of ex ante savings claims appears to be absent from the report, and some tables are not labeled clearly, which doesn't enable readers to properly judge findings or to understand realization rates. Please ensure that any tables that detail savings in the report have clear labeling to indicate first year or lifecycle, ex ante or ex post, and gross or net. The required Impact Evaluation Standard Reporting (IESR) tables should be included in the final draft of the report and refer to those tables where needed for readers to understand a full picture of savings and realization rates.	These changes have been made. See response to comments #2 and #3 for more details.
21	OpenEE		Report recommendations should identify the specific changes in savings claims, or approaches to savings claims that would improve realization rates for the program implementation, for example embedded billing analysis as the basis of the savings claims.	The programs should adjust their savings claims based on ex-post evaluated savings, which reflect what the programs achieve based on how they are implemented. Imbedded billing analysis using data available at a given point in time can help in program design improvements, so PAs can achieve savings that they expect the programs to provide. A year of data is needed to get a full picture of program impact, particularly for measures with seasonal variations in savings.
22	OpenEE		To make the savings results of this impact evaluation more actionable, it would be extremely valuable to see the pre/post savings distributions for both the participant sample and the control group. This would help PAs understand if the program underperformed generally, or only among a subset of customers. This would also give DNV GL a start to figure out patterns among underperforming or over-performing customers, especially based on pre-program usage characteristics. Are they observing similar trends to the targeting studies that have been completed in the last few years (PG&E)? If it is not possible to do this with a pooled model, that would be yet another reason to also conduct a site-level analysis using CalTRACK or similar methods.	In response to the comment number # 3, we have included analysis of first-stage pre-post differences for both the comparison and treatment groups to help with this analysis. This discussion is provided in Appendix C. In addition, the delta between unadjusted gross and gross savings (the intercept terms of the models) presented in the Appendix D provide additional information that will similar analysis.

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23	OpenEE		The report is a reflection of 2017 program implementation and neglects consideration of current practice or opportunities in the findings and recommendations. We acknowledge that this a function of the highly delayed feedback loops in the current evaluation review system. However, the CPUC should take note that this marginalizes evaluation results and does not have to continue as the status quo.	This suggested approach is likely to reveal estimates of partial savings that can at best forecast what realized savings could be. They are likely to be useful to certain stakeholders (like PAs and implementers) since they could help in program design changes that can improve savings. But, the use of partial history is not likely to provide a full picture of the savings programs achieve for a given period, most typically a program year, which is required for a proper evaluation.
24	OpenEE		We recommend that program administrators include ongoing billing analysis as part of their HUP and AHUP program deployment and work with the CPUC to base savings claims on these results rather than current ex ante claims. This change would give program administrators better insight to their program performance and opportunities to course correct or modify the program, and it is also likely that the realization rates between a savings claim based on an embedded billing analysis would be much closer to the ex post evaluation results. This will also help streamline evaluation review (focus on verification and augment population level analysis) in addition to delivering actionable intelligence to optimize the programs in real time. Savings claims derived from meter-based outcomes, more like those in this report, should be a core part of CPUC's evaluation expectations and ongoing real time evaluation should be employed where possible.	As stated above, this sort of approach is useful for program design improvement but is not likely to be a substitute for a proper evaluation even if a pre-program baseline is used as there will likely a big trade off between speed the approach promises and accuracy that regulation requires.
25	OpenEE		As noted on the webinar, some parties are concerned that by using a comparison group and a NTG instrument, there is a likelihood of an unintentional double discount for free ridership. It has been widely recognized that use of a comparison group yields results that are in between gross and net. In the final report, please provide a quantitative discussion of their methods and the impacts of this combined comparison group/NTG survey that estimates the overlap.	Please see response to comment # 12.

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26	OpenEE		Please include more information about how DNV GL addressed the impact of outliers. We've seen repeatedly in billing analysis research that a small number of outliers can have a large impact on final savings results.	In the current evaluation, we examined the outliers and did sensitivity analysis with outliers. With sufficient N, we did not find they affected our estimated averages in a statistically meaningful manner. For instance, the removal of certain positive outliers from the comparison group reduced estimated savings per household, but the lower estimates were not statistically significantly different from the original.
27	OpenEE		Please provide more information in the section on customer generation regarding specifics about how DNV GL treated the savings from customers who installed solar during the intervention or measurement phases. It was unclear if these savings eliminated out of hand.	As we indicate in section 4.5 of the report, we exclude customers who installed solar during the intervention and measurement phases as we don't have data on self-generation and don't have visibility into energy consumed from self-generation to use in the analysis.
28	OpenEE		Please clarify in the final report if and how the non-participant survey was used to modify savings results.	The non-participant survey for HUP is a new addition in this evaluation. Prior HUP/AHUP evaluations have not included primary research with non-participants. In this evaluation, we simply juxtaposed a summary view of household energy use actions (saving or increasing) and demographics to provide a point of reference.