Transmittal Letter for the 2010-2012 Whole House Retrofit Impact Study

October 30, 2014

PUBLIC UTILITIES COMMISSION
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Energy Division staff commissioned this study in 2010 to examine the 2010-2012 impact of the Whole House Retrofit program (also known as the Energy Upgrade California-EUC).

In reviewing this study it is important to note that we have elected not to update the whole house ex ante workpaper based on these results given the ongoing changes with the program. The key outcomes will be used for ex post verification of the EUC program performance in terms of energy savings.

The impact report was limited in scope and did not examine programmatic IOU differences such as program delivery but did provide key findings that will be used to improve the program.

The key findings in the impact report include:

1. Gross savings realizations were lower than anticipated by estimates; realization rate were higher towards the coast compared to inland.

2. The energy simulation tool, EnergyPro, used by contractors over estimated savings and is well documented in the ex ante review and IOU process studies.

3. The majority of the participants scored as partial free-riders.

This program faced some challenge but is a work in progress and program changes will be implemented in 2015 and 2016.

Whole House Retrofit Impact Evaluation

Evaluation of Energy Upgrade California Programs

Work Order 46

California Public Utility Commission, Energy Division
Prepared by DNV GL - Energy
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Executive Summary

DNV GL, on behalf of the California Public Utilities Commission (CPUC), conducted an impact evaluation of the 2010-2012 Whole House Retrofit Program (also known as, Energy Upgrade California - EUC) implemented by the California Investor Owned Utilities (IOUs). The scope of the evaluation included conducting billing analysis to determine gross savings and realization rates and surveys to support estimating program free-ridership. The key outcomes from this study will meet the CPUC's requirement for ex post verification of EUC program performance in terms of energy savings and provide IOUs with feedback on areas for possible improvement as they continue with design enhancements.

Program Description

There are two main Whole House Retrofit program elements sponsored by the four California IOUs: (1) the Prescriptive Whole House Retrofit Program (PWHRP) or Basic Path, and (2) the Whole House Performance Program (WHPP) or Advanced Path. The overall structure of the programs is similar across the four IOUs, aiming to provide wide-ranging energy efficiency measures to existing California residential dwellings. The main objectives of the program are:

- Promote completion of retrofits based on preferred building science loading order
- Funnel participation to core Energy Efficiency (EE), Demand Response (DR), distributed generation (e.g., California Solar Initiative) portfolios,
- Increase awareness of energy savings retrofits through statewide coordinated marketing campaigns
- Coordinate with communities, local governments, and allied third-parties for outreach on local retrofit and available contractor training opportunities

Evaluation Approach

The evaluation approach included two components. The first component was a g*ross savings analysis* that followed a billing analysis approach that addressed the challenges of evaluating a program during the early stage of implementation. Some of the challenges included: (1) no prior cycle program activity, (2) program starting during the middle of the 2010-2012 CPUC program cycle, and (3) program overlap with similar American Recovery and Reinvestment Act (ARRA) funded efforts until late 2012. The billing analysis methods used followed the California Evaluation Protocols and the Evaluation Framework.

The second evaluation component was a *self-reported free-ridership analysis* used to adjust the gross savings estimates to net savings estimates. The approach used participant and stakeholder surveys, following best practices for self-report according to the *Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approach*[1]. The self-report analysis focused on determining savings attributable to IOU-funded projects and did not fully address the possible overlap with ARRA funding.

Key Findings

Below are key findings regarding how the program implementation in terms of the tools used and the current design/incentives are possibly influencing energy savings:

- The program used an energy simulation tool to estimate site specific savings. The tool's overestimation of energy consumption has been well documented in the ex ante review and IOU process evaluations. The evaluation team found that gross savings were less than expected despite the adjustments that the IOUs made to the ex ante savings. The actual energy consumption, especially electric consumption, is not normally distributed around the average. Therefore, the assumptions the tool made were based on an incorrect average and did not capture the true extremes of high and low usage. This means that for a given home the estimate of savings could be higher than the estimated usage. This idea is further described in the full report.

- The majority of survey respondents scored as partial free-riders. Survey responses support that many were planning to do a single measure regardless of incentive, and that the program was responsible for inducing additional measures. Estimated free-ridership would be lower if the program claimed only the savings for the additional measures the participants were not already considering prior to the retrofit. We include a sensitivity analysis to examine the bounds and the impacts of variable scoring for partial free-ridership on the final net-to-gross estimates.

- An analysis of the survey and demographic from the PG&E's Energy Upgrade California Process evaluation along with results from this study provided additional insight and context to the analysis of the program impacts. We found that when the ARRA funding ended, participation seemed to migrate toward the Pacific coast, toward areas that have

[1] Ridge, Richard, Ken Keating, Lori Megdal, and Nick Hall (2007). Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approaches. Prepared for the California Public Utilities Commission.

higher home values and incomes, but less potential electric savings. These homes tend to have lower savings and little need for financing to help fund projects.

Program Impacts

The evaluation results are presented in Table 1. We present results derived from estimating savings using a billing analysis with comparison group approach. We estimated total net savings by applying the gross realization rate and the net-to-gross ratio (NTGR) to the program's ex ante savings claims. The gross realization rates were different for 2010-11 and 2012 and thus were applied separately in the full report, while this summary provides the totals for the program cycle.

Key findings from the analysis indicated that realizations are very low. The possible reasons for such discrepancies in GRR are that the Advanced Path simulation tool overestimates usage and savings even more than that reflected in the ex ante adjustments. The Basic path which did not have ex ante adjustments had a higher realization rate, but the net savings of Basic was not evaluated as this study focused on Advanced Path. Overall SCE had the highest realization rates for both paths. One possibility is different QC and QA processes, but the programmatic differences by IOU were not studied. One overall factor for realization rates is participation was more towards the coast than inland so the simulation tool may do a worse job at estimating savings on the coast compared to inland. A hypothesis is that the model does a poor job accounting for operable window ventilation which would explain part of the issue that shows realization rates are worst for PG&E which had participation in areas with good opportunities for night cooling with ventilation.

We also note that gas realization rates are higher than electric. The incentives are based on relative savings of total site energy so the gas portion would be weighted more heavily than electric savings which may lead to more gas savings. The issues with the overestimation of consumption remain and gas realization rates are still relatively low. This cannot be explained by ventilation, but may have more to do with thermostat set points and homes being kept at lower temperatures than model assumptions.

Even though the IOUs may have different approaches for implementing the programs, the Net-to-Gross ratios do not vary that much across IOUs. Partial free-ridership appears to be prevalent, but for the Advanced Path the free-rider measures vary by site.

Table 1: Estimated Savings for the Whole House Retrofit Programs 1

IOU	Fuel (Unit)	Program Participants	Total Ex Ante Savings per Year (Adjusted for Advanced)	Gross Realization Rate (Relative to Claimed Savings)	Net to Gross Ratio (Ex Ante for Basic)	Total Gross Savings Per Year	Total Net Savings Per Year
Advanced							
PG&E	Electricity (kWh)	2,650	4,219,142	12.8%	0.58	538,429	312,289
	Gas (Therms)	3,618	749,510	35.6%	0.58	266,637	154,649
SDG&E	Electricity (kWh)	318	329,668	14.0%	0.64	46,173	29,551
	Gas (Therms)	311	53,712	36.5%	0.64	19,585	12,534
SCE	Electricity (kWh)	692	677,269	50.3%	0.68	340,397	231,470
SCG	Gas (Therms)	639	139,271	63.4%	0.68	88,237	60,001
Basic							
PG&E	Electricity (kWh)	92	12,466	Not Evaluated	0.80	12,466	9,973
	Gas (Therms)	92	2,254	Not Evaluated	0.80	2,254	1,803
SDG&E	Electricity (kWh)	402	346,529	30.8%	0.80	106,878	85,503
	Gas (Therms)	393	16,219	39.1%	0.80	6,336	5,069
SCE	Electricity (kWh)	1539	637,860	88.0%	0.80	561,149	448,919
SCG	Gas (Therms)	170	2,244	Not Evaluated	0.80	2,244	1,795

The evaluation team also made a direct comparison of ex post realization rates to compare to the ex ante disposition for Advanced Path. The ex ante review final disposition provided adjustment factors for Advanced Path claims which are applied to tracking data through ex ante realization rates. Table 2 compares the ex ante and ex post gross realization rates for Advanced Path participants.

Table 2: Realization Rate Comparison for Advanced Path

IOU	Fuel (unit)	Fixed Effects Model 2010-12					
		Program Participants	Average Ex Ante	Savings Estimate	Gross Realization Rate	Applied Ex Ante Gross Realization Rate	Approved Ex Ante Gross Realization Rate
Advanced Path							
PG&E	Electricity (kWh)	2,650	2,654	203	7.7%	60.0%	40.0%
	Gas (Therms)	3,618	345	74	21.4%	60.0%	80.0%
SDG&E	Electricity (kWh)	318	2,592	145	11.1%	40.0%	40.0%
	Gas (Therms)	311	216	63	34.0%	80.0%	80.0%
SCE	Electricity (kWh)	692	2,447	492	34.4%	40.0%	40.0%
SCG	Gas (Therms)	639	272	138	69.3%	80.0%	80.0%

Recommendations

The below recommendations are based on findings from this impact evaluation and from the Process Evaluations regarding targeted marketing. The impact evaluation showed energy savings to be lower than expected, with the gas savings across program delivery types and IOUs closer to expectations than electric savings which varied. The evaluation also determined that partial free-riders comprised a majority of program participants in the Advanced Path.

- The impact evaluation found that like the ex ante disposition and the first IOU process evaluation, the energy simulation software overestimates usage and savings. The evaluation team recommends support for statewide efforts via CALTEST to look at additional software options and program requirements that better predict consumption or that require using billing data to calibrate estimates. Some of the evaluation team members supported these efforts via technical working group. The recommendations in this section assume that future ex ante estimates will be more accurate than the ex ante estimates that were used in the first three program years. A comparison to recent billed

energy use for each program participant prior to approving program participation and rebate levels will reveal whether these estimates are realistic or not. When compared to actual energy use, a high percentage of the program's 2010-2012 projects claimed energy savings that were unrealistically high.

- Change from incentives based on percent savings for site energy and provide incentives similar to the non-residential custom programs on a dollar per unit of energy basis ($/kWh and $/therm). Currently the relative savings approach provides the same dollar amount to homes with low and high usage and does not align with the value of electric savings that is part of cost effectiveness calculations. Savings per unit of energy would provide more money to save more energy on an absolute basis and may increase program uptake in hotter climates by properly valuing electric savings.

- Only provide incentives and claim savings for measures that the customer was not already considering. Only modeling the measures the customer would not have done in absence of the program will reduce free-ridership. This documentation of which measures the customer would be doing can also support identifying early replacement measures and distinguishing them from replace on burnout. The incentives would also then support "deeper" retrofits as opposed to providing some funding for free rider measures and only partial funding for additional measures.

- Refocus the program toward inland areas with warmer temperatures (high use of cooling) and align financial support (additional incentives/financing) according to available household capital in order to achieve higher net savings.
- Homes with higher consumption near the coast have greater base load than cooling load. For these homes, the program should emphasize measures that focus on advanced lighting, appliances, and electronics to increase site specific savings.

Conclusions

Overall, the Whole House Retrofit program as currently implemented is not meeting its energy savings goals. This is caused by a combination of factors that include (a) overestimation of savings in the retrofit planning (building modeling) phase, (b) indications of substantial rebound (take-back), and (c) program deployment in mild weather areas where building shell and HVAC measures are less likely to generate large energy savings.

The process evaluations and this impact evaluation provide recommendations to improve gross and net savings. Many of the recommendations require improved energy estimating tools or estimates calibrated to actual consumption. The programs could consider a scenario of improved savings after implementing tool calibration or improvement, targeted marketing to

high users, targeted measures based on location (or more specifically the estimated weather-dependent load), and incentives per unit of energy saved. The normalized annual consumption from this evaluation can be used to review whether higher percent savings would then create substantial changes in program cost effectiveness.

1. Introduction

This document presents the impact evaluation of the California investor-owned utilities (IOUs) Program Year 2010-2012 Whole House Retrofit Programs, also known by their marketing name Energy Upgrade California.

The primary objectives of the 2010-12 Whole House Retrofit impact evaluation are to:

1. Evaluate the gross and net savings resulting from the 2010-12 whole house measures and programs
2. Provide feedback to the IOUs on the performance of these programs and their measures to support future program design improvements and future program ex ante impact estimation
3. Support the California Energy Efficiency Strategic Plan Goals

Section 1 of this report (this introduction) includes evaluation and program overviews. Section 2 describes the methodology and results of the gross savings estimates. Section 3 presents the estimation of free-ridership based on survey results, and the estimation of net savings. Section 4 summarizes conclusions and recommendations. Last, the Appendix contains materials that enable a deeper view of the evaluation's methodology and results, such as interim gross impact results, further analysis of free-ridership by different customer groups, and the survey instrument that was used to collect attribution data.

1.1 Evaluation Overview

The evaluation included two primary components that were designed to estimate savings while informing future program design.

The first one is a g*ross savings analysis*, which followed a billing analysis approach tailored to this stage of the program. Specifically, the approach addressed the following difficulties: (1) there was no prior cycle program activity, (2) the program started during the middle of the 2010-2012 CPUC program cycle, and (3) there was overlap with similar American Recovery and Reinvestment Act (ARRA) funded efforts until late 2012. The billing analysis methods adhered to the California Evaluation Protocols and the Evaluation Framework.

The second one is a *self-reported free-ridership analysis*, which was required to adjust the gross savings estimates to net savings estimates. The approach used best practices such as Guidelines

for Estimating Net-To-Gross Ratios Using the Self-Report Approach[2]. The self-reported analysis focused on attribution of savings to the investor-owned utility (IOU) funding and did not fully address the ARRA additional funding issues.

At the time this report was published, the evaluation team is conducting additional analysis of peak savings using interval (smart meter) data from program participants.

This program evaluation addresses the levels of gross and net energy savings achieved by these programs. It does not address other matters that the Energy Division will take into account as it shapes future portfolios, such as cost effectiveness and implementation issues.

1.2 Program Descriptions and Participation

The IOU Whole House Retrofit programs offer a multi-tiered approach for single family homes and two unique approaches for multi-family buildings. They use the Energy Upgrade California (EUC) branding, the IOU incentive programs, and private financing or the IOU financing pilots. In addition, they tie into California Assembly Bill 758 (AB758), which requires the California Energy Commission (CEC) to develop programs that provide and promote comprehensive retrofits for existing buildings.

The IOUs' statewide Whole-House Retrofit and Multi-family Programs operated concurrently in 2011 and early 2012 with the CEC ARRA Program. The IOU programs share common goals with the CEC program and AB758, including implementing energy-saving retrofit measures, developing the retrofit workforce, refining and enforcing quality assurance, and creating a market value through building energy ratings and labels for a home's energy performance.

The IOU and CEC ARRA programs offered packages of prescriptive measures (Basic Upgrade Package) as well as performance-based incentives (Advanced Upgrade Package). The market linkage points of the CEC and IOU programs are the Energy Upgrade California brand and website as well as contractors trained to market both programs to customers. Energy savings estimates, program quality assurance (QA), and program evaluation for IOU programs and ARRA programs were coordinated where practical by the CPUC Energy Division (CPUC-ED) and the CEC.

[2] Ridge, Richard, Ken Keating, Lori Megdal, and Nick Hall (2007). Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approaches. Prepared for the California Public Utilities Commission

During the ARRA period which ended March 2012, the IOU programs and the CEC programs offered matching rebates. In some cases, IOU rebates are paired with ARRA Whole House Programs rebates directly. In other cases, the ARRA Whole House Programs funds did not provide direct rebates, but paid to obtain an initial assessment that could lead customers to take advantage of IOU Basic and Advanced Upgrade Package rebates and Energy Upgrade California program financing.

CPUC Decision 09-09-047 required the IOUs to include a prescriptive whole-house retrofit program component in their statewide residential program, consistent with the Commission's guidance.

Pacific Gas & Electric's (PG&E's) Whole House Performance Program aims to deliver a set of energy efficiency measures geared to meet the needs of individual households that occupy existing homes. The program has both marketing and an educational component. The program also provides training to contractors through the Energy Training Centers, where the contractors can perform whole-house diagnostics, propose comprehensive residential retrofits, and install energy improvement measures.

Southern California Edison (SCE), San Diego Gas & Electric (SDG&E), and Southern California Gas (SCG) plan to achieve their goal of providing comprehensive energy efficiency improvements to a majority of existing homes in California by 2020.

Statewide Program Description

There are two main whole house retrofit paths that are being sponsored by the four California IOUs: (1) the Prescriptive Whole House Retrofit Program (PWHRP) or Basic Path, and (2) the Whole House Performance Program (WHPP) or Advanced Path.

The overall structure of the programs is similar across the four IOUs, aiming to provide wide-ranging energy efficiency measures to existing California residential dwellings to reduce energy consumption. The following descriptions were compiled and summarized from the available program implementation plans. The Basic Path plans to accomplish the following:

- Promote completion of retrofits based on preferred building science loading order
- Offer a holistic path towards home performance by aggregating key elements of a dwelling into its core elements: building envelope and fixed lighting, heating, cooling, hot water, and appliances

- Continuously engage customers over time as they progress toward a home performance approach
- Funnel participation from core Energy Efficiency (EE), Demand Response (DR), distributed generation (e.g., California Solar Initiative) portfolios, increase awareness through statewide coordinated marketing campaigns, and contribute to education and outreach activities with local government partners
- Coordinate with communities, local governments, and allied third-parties for outreach on local retrofit and available contractor training opportunities
- Coordinate with local financing opportunities, as appropriate
- Utilize no-cost (to the consumer) Home Energy Efficiency Surveys (HEES) as an entry point to identify opportunities for efficiency improvements[3]
- Coordinate with the extensive network of heating ventilation and air conditioning (HVAC) contractors already participating in IOU programs
- Provide rigorous Quality Assurance and Quality Control, consistent with the Home Performance with ENERGY STAR® (HPwES) program for elements completed within the prescriptive work scope
- Define the project baseline for existing household energy usage, and
- Be compatible with Home Energy Rating System (HERS) requirements.[4]

Some eligible measures that qualify for PWHRP or Basic Path are:

- Air sealing
- Attic insulation
- Duct sealing
- Insulation of domestic hot water pipes, and

[3] The HEES program provides residential customers with entry-level energy surveys online, over the phone, or by mail. The surveys are not intended to serve as an audit but are meant to provide consistent messaging and an easy on-ramp to the Whole House Retrofit Program. The HEES surveys are also a link between the California Solar Initiative (CSI) and the Whole House Retrofit Program.

The HEES program is not the same as the Universal Audit Tool (UAT), also known as the Progressive Energy Audit Tool (PEAT) program.

[4] The Basic Path will not require a HERS rating or a performance-level audit upon completion of work. Participating contractors are encouraged to coordinate with HERS raters to provide customers with ratings upon completion of work as a method of educating the marketplace and leveraging an opportunity to draw customers to the Advanced Path.

- Combustion safety (no savings)

The Advanced Path builds off the Basic Path and, because it is more customized than the Basic Path, it also accomplishes the following:

- Requires higher levels of contractor training and qualifications
- Requires a commercially available and approved building simulation software and methodology to model site-specific performance and estimate energy savings for the project
- Establishes a project baseline by a "test-in" and "test-out" method compatible with the requirements of the CEC HERS assessments and the national Home Performance with ENERGY STAR® (HPwES) program
- Typically completed in a condensed timeframe
- Provides greater incentives than the Basic Path
- Includes additional measures such as:
  - HVAC systems
  - Wall insulation
  - Floor insulation
  - Permanent lighting fixtures and controls, and
  - Appliances

As mentioned previously, the residential retrofit programs being offered by the four utilities very closely mirror one another. Both the Basic ("Prescriptive") Path and the Advanced Path aim to deliver a set of energy efficiency measures geared to meet the needs of individual households in existing homes and reduce energy consumption.

Core Programs Budgets and Accomplishments

The Statewide Whole House Retrofit Program is being independently implemented by PG&E, SCE, SCG, and SDG&E under the overall program IDs PGE21008, SCE-SW-001H, SCG 3600 and 3618, and SDG&E 3156 and 3116, respectively. Table 3 below presents the program budget and expenditures for each IOU's whole house retrofit offering.[5]

[5] Final Energy-Efficiency Groupware Application (EEGA) monthly report, December 2012.

Table 3: Program Budgets and Spending by IOU Program through December 2012

Utility	Program	2010-2012 Program Revised Budget	2010-12 Program Expenditure
PG&E	PGE21008	$28,562,757	$25,310,500
SCE	SCE-SW-001H	$26,125,000	$7,015,300
	SCE-TP-003	$10,205,994	$10,664,321
SCG	SCG3618	$8,000,000	$2,961,632
	SCG3600	$5,656,350	$3,375,428
SDG&E	SDGE3156	$13,000,000	$5,753,260
	SDGE3116	$2,011,633	$1,166,401

1.3 Final 2010-12 Tracking Savings and Ex Ante Savings Disposition

There were two levels of ex ante savings that the IOUs reported for this program: (a) the energy savings estimates obtained directly from EnergyPro, the software utilized for building energy use modeling, and (b) claimed savings: the EnergyPro results adjusted by the IOUs for the purposes of computing expected energy savings. The utilities applied the following factors to Advanced Path ex ante savings estimates from EnergyPro:

Table 4: Claimed Savings Factors (Gross Realization Rates) Applied to Advanced Path (Custom Measures) EnergyPro Estimates

	Approved[6]		Applied	
Utility	kWh	Therms	kWh	Therms
PG&E	0.40	0.80	0.60	0.60
SCE	0.40	-	0.40	-
SDG&E	0.40	0.80	0.40	0.80
SCG	-	0.80	-	0.80

Table 5 provides energy and demand savings targets and final accomplishments for each utility's whole house program offerings.[7] The table differentiates between the non-lighting measures,

[6] Skala, Peter. California Public Utilities Commission, Energy Division. 2013-2014_EnergyUpgradeCalifornia-AdvancedPath_CoverLetter_1March2013_Final.doc

which were the focus of this evaluation, and the lighting measures assessed under the Residential Advanced and Upstream Lighting Impact Evaluation (Work Order 28).

Table 5: 2010-2012 Savings by IOU Program and Measure Group

		Number of Homes (estimate)	Envelope, HVAC, Water Heat Measures			Lighting Measures		
Utility and Program	Program Name		Installed kWh Savings	Installed kW Savings	Installed Therm Savings	Installed kWh Savings	Installed kW Savings	Installed Therm Savings
PG&E PGE21008	Whole House Performance Program	3,837	6,948,112	8,658	1,249,183	83,791	6	-
SCE SCE-SW-001H	Whole House Prescriptive Program	1,556	498,689	140	2,780	139,171	15	(2,131)
SCE SCE-TP-003	Comprehensive Home Performance	693	677,269	1,309	54,520	-	-	-
SoCalGas SCG3618	Prescriptive Whole House Retrofit	23	-	-	1,480	-	-	-
SoCalGas SCG3600	Local Whole Home Performance	181	-	-	26,734	-	-	-
SDG&E SDGE3156	Prescriptive Whole House Retrofit	406	355,179	120	32,429	120,086	7	(670)
SDG&E SDGE3116	Local Whole Home Performance	314	411,665	392	44,089	-	-	-

[7] 2010-12 Quarterly Tracking Data Claims. The number of homes was estimated from unique tracking accounts.

1.4 2010-2012 Program Participants

This section describes Energy Upgrade California Whole House program participants in terms of their geographical distribution, timing of participation, and energy consumption. A brief description of the program's ex ante savings is also included.

1.4.1 Geographical Distribution

Figure 1 to **Figure 4** show the geographical distribution of program participants by zip code in the IOU service territories. Shades of green represent one to 3 participants in a zip code, shades of yellow represent 4 to 20, orange represents 21 to 40, and red represents 41 or more participants in the same zip code. There are 1,300 zip codes with at least one program participant in California. The top six zip codes have 50 program participants or more. The influence of ARRA-funded program on the IOU programs is clear. The concentrations for PG&E Advanced Path coincide with the geographies of the ARRA programs and SCE Basic and Flex Path have concentrations in LA County.

Figure 1: Distribution of 2010-2012 Program Participants in the PG&E Service Territory

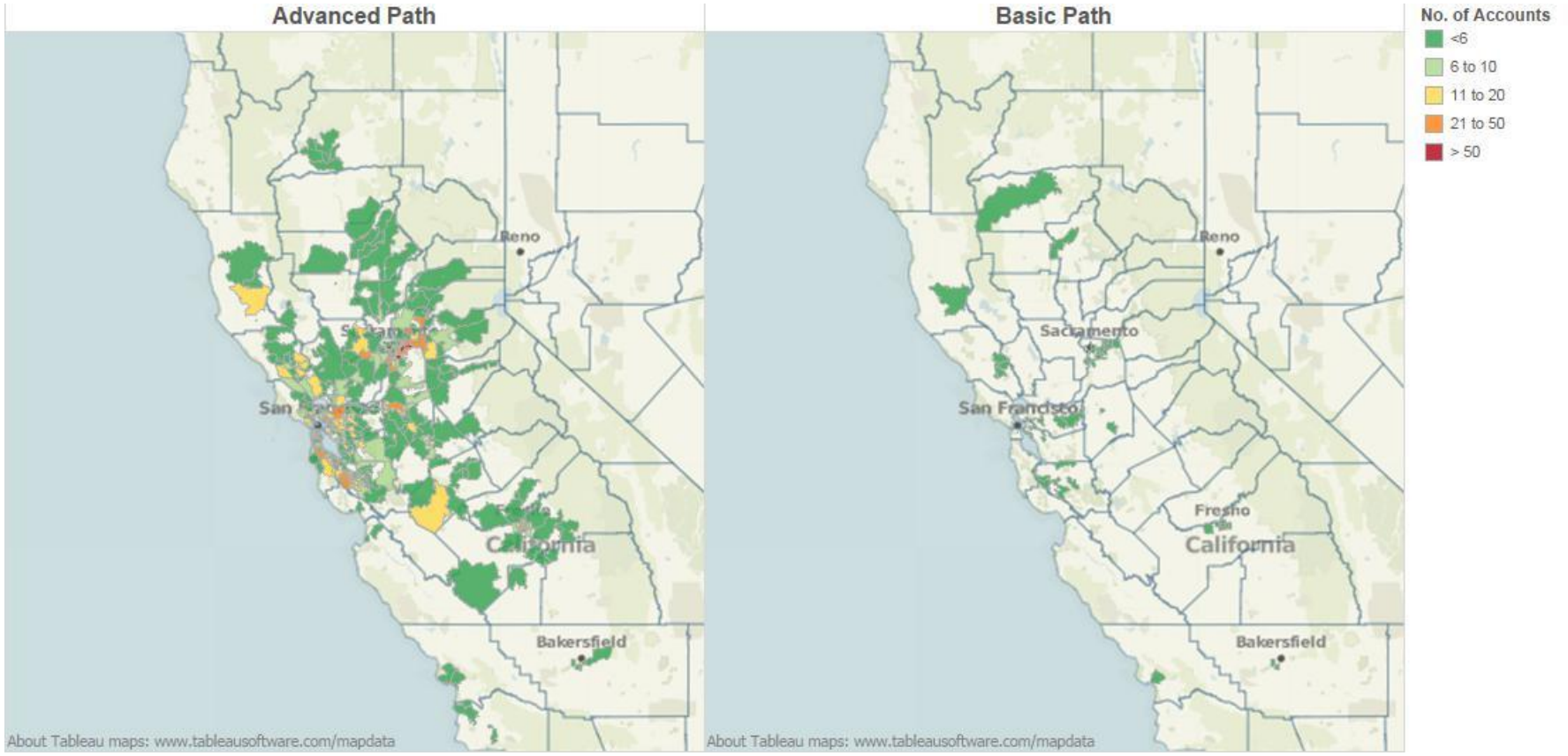


Figure 2: Distribution of 2010-2012 Program Participants in the SCE Service Territory

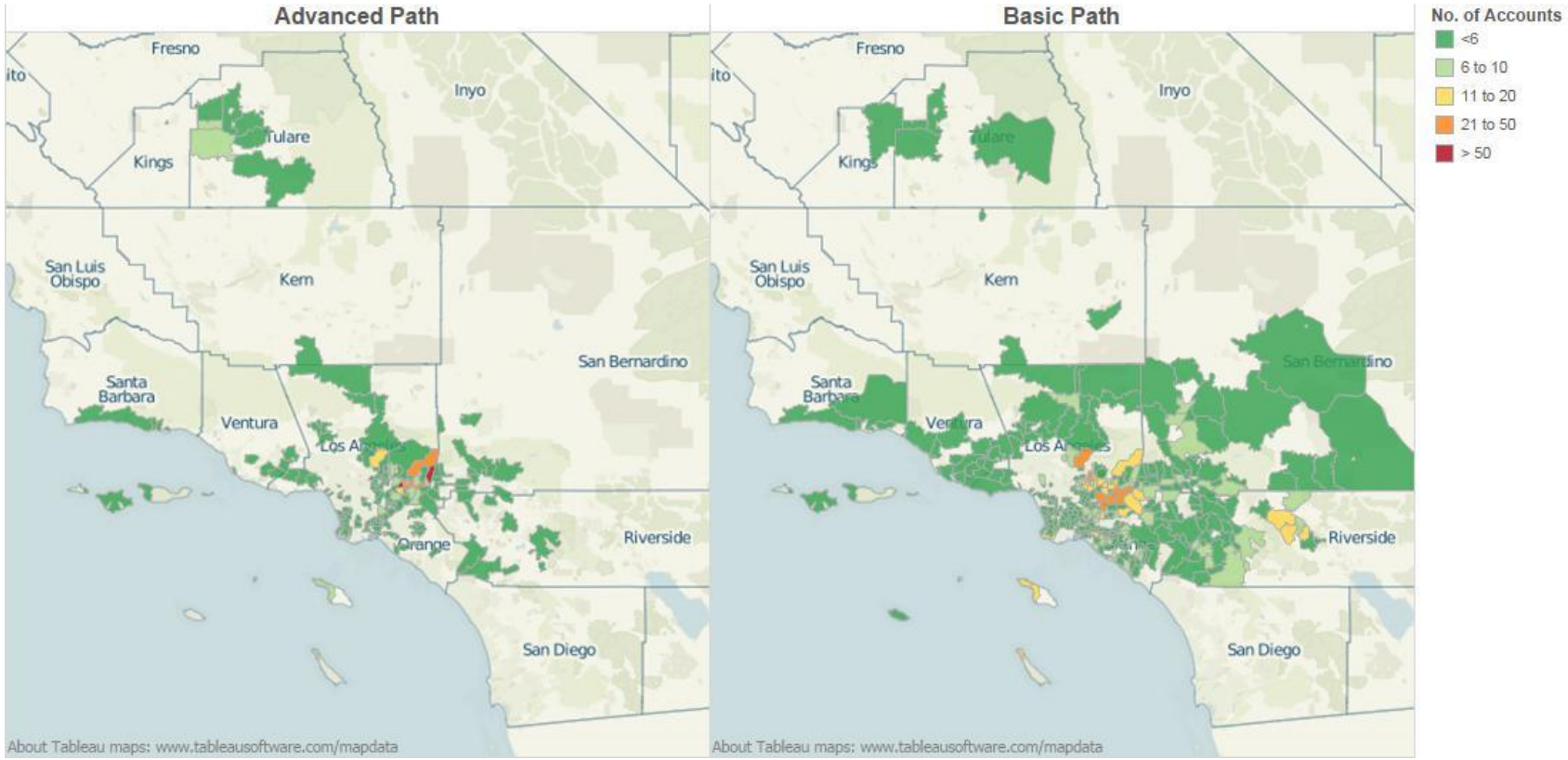


Figure 3: Distribution of 2010-2012 Program Participants in the SDG&E Service Territory

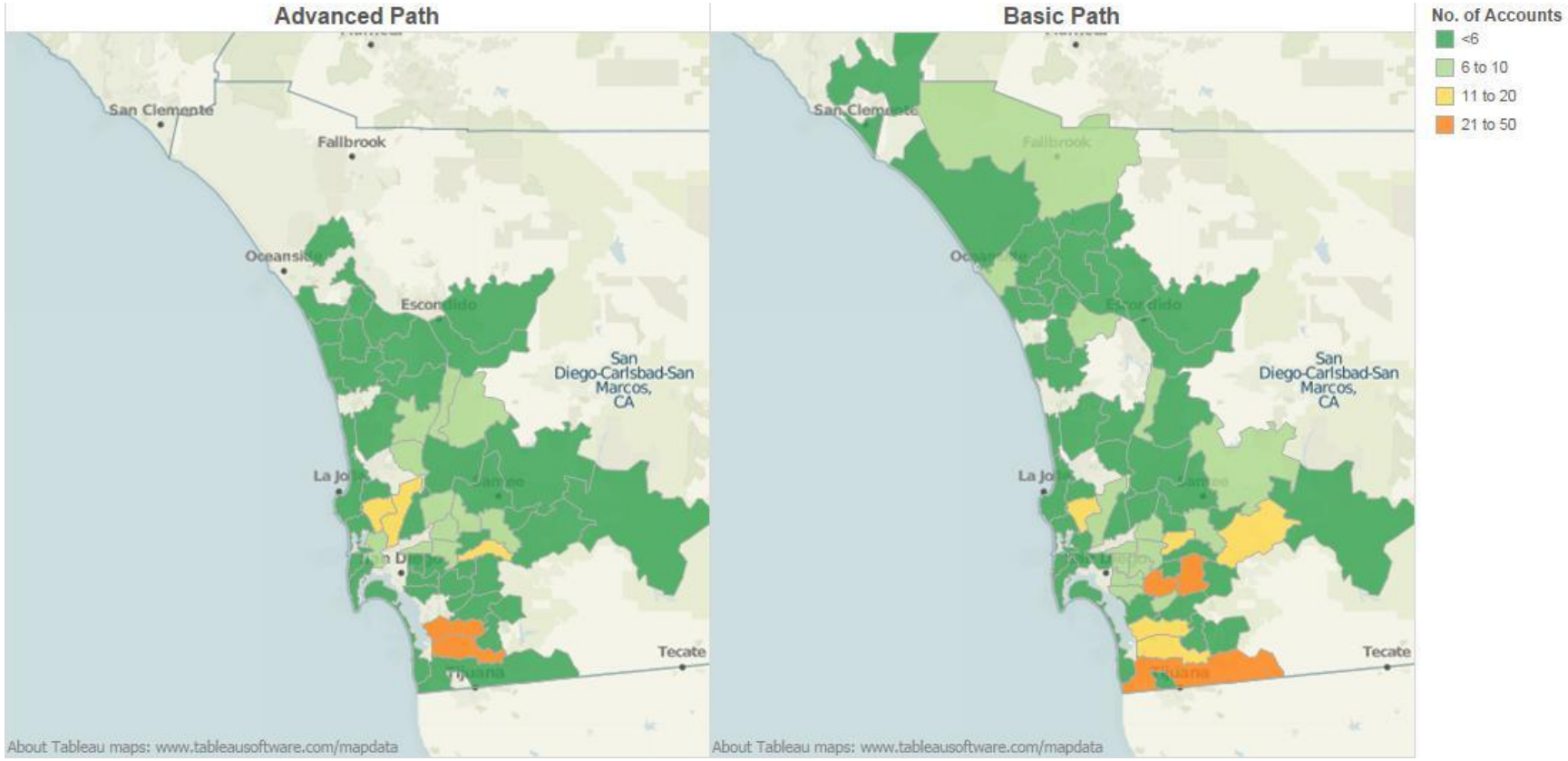
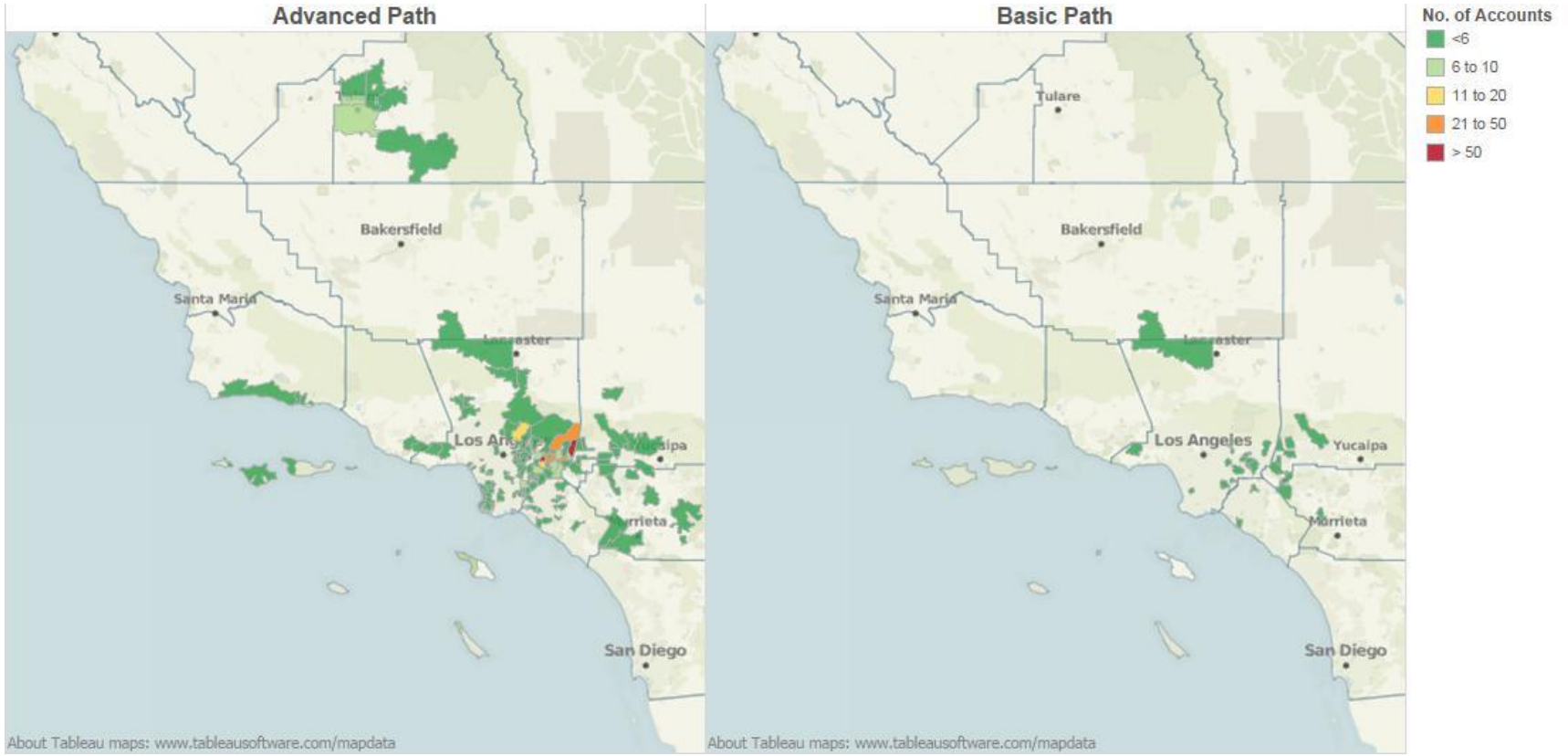


Figure 4: Distribution of 2010-2012 Program Participants in the SCG Service Territory



Program participation tends to be more concentrated in some specific climate zones. California Climate Zones are presented in Appendix A. The climate zones with the most program participants as a percent of each utility's participants are:

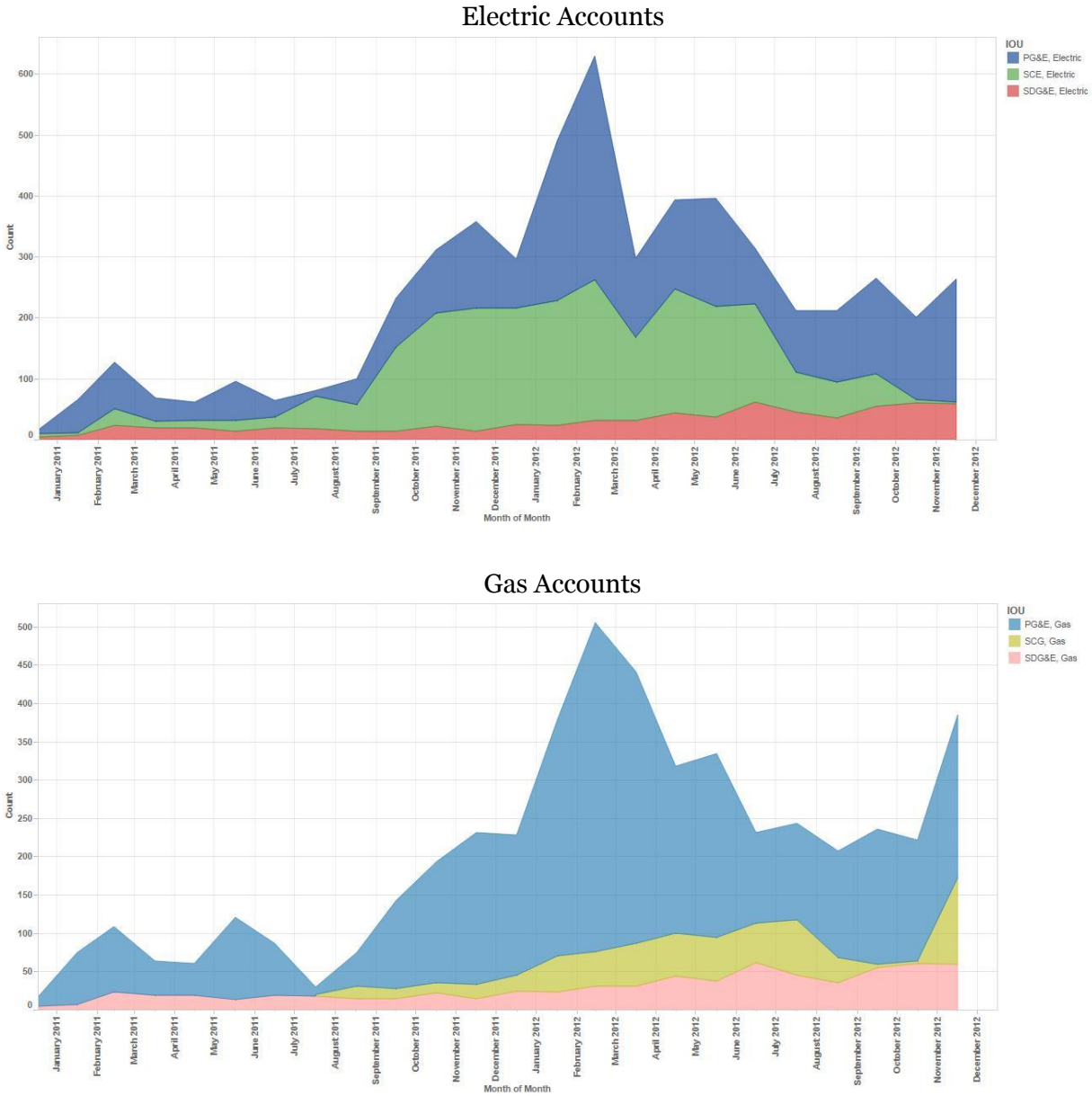
- 27% of PG&E's program participants (1,049 customers) are in Climate Zone 3
- 46% of PG&E's program participants (1,762) are in Climate Zone 12
- 16% of SCE's program participants (368) are in Climate Zone 8
- 48% of SCE's program participants (1,070) are in Climate Zone 9
- 7% of SCG program participants (58) are in Climate Zone 8
- 70% of SCG program participants (565) are in Climate Zone 9
- 36% of SDG&E's program participants (256) are in Climate Zone 10
- 63% of SDG&E's program participants (446) are in Climate Zone 7

The distribution by climate zone shows that the program concentrated on areas that have high concentration of population and are in mild weather.

1.5 Timing of Participation

This section describes the number of participants per month and year across all IOUs. The influence of ARRA-funded program on the IOU programs is clear. The ARRA program ended in March 2012. It is visible that several joint ARRA-IOU projects were completed just before and at the deadline.

Figure 5: Number of Program Participants per Calendar Month



1.6 Pre-Retrofit Equipment Conditions for Advanced Path

This report does not deal with classifying measures as "early retirement" versus "add-on retrofit" or "normal replacement"/"replace-on-burnout" as required by D.11-07-030/D.12-05-015. For the Advanced Path measures (those for which the savings were calculated with EnergyPro) the IOUs claimed the savings from the pre-existing to the post-install for the full life of the measure and using a measure life that is not well documented. For water heating replacements and AC and furnace replacements evidence of "early retirement" is required to claim the pre-existing baseline, and only for the remaining life of the pre-existing equipment (defined as 1/3 the life of the equipment by policy). This report provides information on the pre-existing efficiencies of the equipment replaced, but does not make adjustments to the savings estimates. Appendix F provides a comparison of the pre-retrofit equipment efficiency for Advanced Path simulation models compared to the replace on burnout code baseline for piece of equipment.

To some extent the free-ridership adjusts for measures that would have been replaced in the absence of the program. Meaning there are zero net savings for replace on burnout measures if they were indicated as freerider measures. This still means that the dual baseline is not fully addressed by the estimated gross savings.

2. Gross Savings

This evaluation included three primary activities that estimate savings while also informing future program design: gross savings analysis, free-ridership analysis, and net savings estimation. The gross savings analysis followed a billing analysis approach tailored to the state of the program at the time of the evaluation: no prior cycle program activity, participation started during the middle of the 2010-2012 program cycle, and the program worked simultaneously with similar ARRA funded programs until March of 2012.

2.1 Method Overview

Whole-building retrofits involve the installation of multiple measures. Because of this, the estimation of total savings requires a comprehensive method for capturing the combined effect of the installed measures. The general method recommended for this type of program is a billing analysis – the comparison of post-participation energy use to energy use that is unaffected by the program and a valid comparison.

The billing analysis method used in this evaluation (Pooled Fixed Effects regression model) is compliant with the International Performance Measurement and Verification Protocol (IPMVP) option Method C, Whole Facility, the California Evaluation Protocols[8], and the California Evaluation Framework[9], and was recently published in the Department of Energy's Uniform Methods Project (UMP) Whole-Building Retrofit Evaluation Protocol[10].
The Pooled method is appropriate to the Whole House Retrofit program due to the lack of a comparison group during the first stage of the program between 2010 and 2011. There are evaluation challenges inherent in a program where all participants are self-selected, and the characteristics that drive this self-selection are extremely difficult to measure and assess in both participants and non-participants. Some of these challenges can be addressed by utilizing the program's pipeline (its future participants) as a comparison group. This evaluation also included a comparison group approach where subsequent program participants were used as a comparison group for prior program participants. To emphasize:

[8] http://www.cpuc.ca.gov/nr/rdonlyres/27629e7a-f01a-48ca-8b2c-b07ecee7dd5a/0/caenergyefficiencyevaluationprotocols.doc

[9] http://www.calmac.org/events/California_Evaluation_Framework_June_2004.pdf

[10] The Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol. http://energy.gov/sites/prod/files/2013/11/f5/53827-8.pdf
The entire set of the Uniform Methods Project's protocols is available at:
http://energy.gov/eere/downloads/uniform-methods-project-methods-determining-energy-efficiency-savings-specific

Gross savings for this study were estimated in two phases:

- Phase 1 (preliminary results) included IOU residential customers that participated in the program in 2010 and 2011. Given that these two years were the first in the Program and that participation in 2010 was minimal, this Phase does not include a comparison group analysis. Phase 1 estimates were used to provide a savings preview to the Energy Division and the IOUs. These estimates are presented in Appendix F.

- Phase 2 (final results) included participants from 2010 through 2012. A Pooled Fixed Effects model without a comparison group was tested. The results of this test are included in Appendix B. The methodology utilized for the gross savings estimates included in this section is a Pooled Fixed Effects with a comparison group.

Two billing analysis approaches were used to estimate program savings:

- The first approach analyzed participants' pre- and post-consumption in a pooled fixed effects framework without a comparison group. This was the only method applied in Phase 1, since there was no comparison group data available when the Phase 1 analysis was conducted. This method was also tested in Phase 2.

- The second approach also employed a pooled fixed effects model, but evaluated program savings with the use of subsequent participants as comparison group. As described above, this approach was used only in Phase 2

Both approaches utilized a site-level model that was used to estimate cooling and heating set points for program participants that were used as inputs to the fixed effects models. This section discusses the site-level model and the Pooled Fixed Effects model with comparison group. The discussion on the Pooled Fixed Effects model without comparison group is presented in Appendix B.

2.1.1 Site-Level Modeling

DNV GL conducted site-level modeling[11] to estimate: (a) individual outdoor temperatures that trigger cooling and heating for each program participant, and (b) a weather-adjusted consumption that reflects a typical weather year for each site.

The model specification used is the following:

[11] The site-level modeling approach was originally developed for the Princeton Scorekeeping Method (PRISM™) software.

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

Where:

E_{im}	Average electric (or gas) consumption per day for participant i during billing month 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 H,
$C_{im}(\tau_C)$	Cooling degree-days (CDD) at the cooling base temperature τ_C (not included in gas model),
β_H	Heating coefficient, determined by the regression,
β_C	Cooling coefficient, determined by the regression (not included in gas model),
τ_H	Heating base temperatures, determined by choice of the optimal regression,
τ_C	Cooling base temperatures, determined by choice of the optimal regression, and
ε_{im}	Regression residual.

Rather than forcing the same degree-day base temperature on all of sites used in this study, we estimated consumption across a range of heating and cooling degree day bases. CDD bases covered 64°F to 84°F while HDD bases covered 50°F to 70°F. Electric consumption was estimated using the following models: 'heating and cooling model', 'cooling only model', 'heating only model' and 'base load only model'. Gas consumption was estimated using the following models: 'heating-only' and 'base load only'. For each model estimated, we used an F-test to determine which model specification is superior, and we chose the best heating degree base for each site based on the individual R-squared.

The distributions of cooling and heating base temperatures from the 'best' model were examined. The median of the degree-day bases (70°F for cooling and 60°F for heating) was selected, and the models were re-estimated.

Normalized Annual Consumption:

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

Where:

NAC_i	Normalized annual consumption for customer i,
H_0	Annual TMY[12] HDD calculated at the optimal heating base temperature $\hat{\tau}_H$ for participant i,
C_0	Annual TMY CDD calculated at the optimal cooling base temperature $\hat{\tau}_C$ for participant i (not included in gas model), and
$\hat{\mu}_i, \hat{\beta}_H, \hat{\beta}_C$	Base load and heating parameter estimates from the site-level models.

[12] Typical Meteorological Year (TMY3)
http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/

The median of the optimal base temperatures for heating and cooling were used as the set points for calculating degree-days in the fixed effects model.

2.1.2 Pooled Fixed Effects Model with Comparison Group

The goal of billing analysis in energy efficiency program evaluation is to measure the change in consumption due to the program, while accounting for the effect of natural changes in consumption, such as due to milder or extreme weather, general economic conditions, disruptions in service and other effects that are external to the program. These externalities can be accounted for with the use of a comparison group.

This evaluation's research plan called to construct comparison groups that are composed of customers who have opted into the same program as the participants. For Phase 2, we examined the use of participants in 2012 as comparison group for 2011 participants and participants in 2013 as comparison for 2012 participants. If the comparison group was found to be adequate, we would estimate a fixed effects model with the use of the comparison group. If not, we would default back to the fixed effects model without comparison group.

Construction of the Comparison Group

It is not possible to build a perfect comparison group (a true *control* group) for a program such as the Energy Upgrade California. For example, a control group would require that the program be offered to some but not all similar residences in the same climate zone, and that the selection of what homes do not have access to the program be determined in advance of program roll out.

Because future participants will soon participate in the program, they are unlikely to install program measures on their own during their pre-participation period. The self-selection into the program makes participants unique and different from the rest of the population. Because of this, the use of future participants as a comparison group can address the issue of self-selection bias in ways that a comparison group constructed from the general population cannot do.

DNV GL constructed a two-year pre-installation period that mirrors the pre-and post-installation periods of the evaluated participants. These consecutive non-program periods were matched with the pre- and post-installation periods of the participants to control for non-program change in the estimates of savings. The first pre-installation year of the comparison group corresponded to participants' pre-installation period while the second pre-installation year of the comparison group corresponded to the post-installation period of the participants.

Based on the installation dates reported in the tracking data, participants were assigned 12-month pre- and 12-month post-installation periods, plus a blackout period of approximately 60 days. Blackout periods were assigned as the billing month prior to the installation and the billing month that includes the installation date. For households in the comparison groups, we defined a two-year pre-installation period that corresponds to the pre- and post- period of the participants.

Table 6 shows an example of how we designated pre- and post-retrofit period for participants and comparison group. The blackout column refers to the period in which the installation of program measures is taking place. The data from the blackout period is excluded from the models.

Table 6: Example of Pre- and Post-Retrofit Designation

Program	Group	Install date	First Billing Period	Blackout Period	Second Billing Period
2011 Evaluation	2011 Participants	Jan2011	Pre-Retrofit: Dec2009 – Nov2010	Dec2010 – Jan2011	Post-Retrofit: Feb2011 - Jan2012
	Future installers (2012 Participants)	Mar2012	Pre-Retrofit: Feb2011 - Jan2012	Feb2012 – Mar2012	Post-Retrofit: Apr2012 - Mar2013
	Future installers (2012 participants) used as comparison group		Pre-Retrofit: Dec2009 – Nov2010	Dec2010 – Jan2011	Pre-Retrofit: Feb2011 - Jan2012
2012 Evaluation	2012 Participants	Jan2012	Dec2010 – Nov2011	Dec2011 – Jan2012	Feb2012 - Jan2013
	Future installers (2013 Participants)	Mar2013	Feb2012 - Jan2013	Feb2013 – Mar2013	Apr2013 - Mar2014
	Future installers (2013 participants) used as comparison group		Dec2010 – Nov2011	Dec2011 – Jan2012	Feb2012 - Jan2013

Table 7 summarizes the effects captured by participant and comparison groups for each period. For households that participated in 2011, the pre- and post-difference provided a savings estimate that combined program-related effect and exogenous (non-program-related, natural trend) change. The comparison group, made up of households that became program participants a year later, captured only exogenous changes during the two-year pre-installation periods. Removing the comparison groups' difference (exogenous, natural trend only) from the 2011 participant group's difference (program + exogenous, natural trend) removed the changes due to natural trends and provided an estimate of savings that is due to the program.

Table 7 :Pre- and Post-Installation Differences of Participants and Comparison Groups

Group	Pre-Installation	Post-Installation	Pre-/Post-Installation Difference Within Group	Pre-/Post-Installation Difference Between Groups
Participants	Natural trend	Natural trend + program effect	Program effect + effects from natural trend	Program savings
Future Participants* (Comparison Group)	Natural trend	Natural trend	Effects from natural trend	

*Installed more than a year after the households with which they are matched for comparison purposes

In the fixed effects model with comparison group, all monthly consumption data (both pre- and post-installation) of eligible participants and the two year-long pre-installation consumption data of the comparison group were included in a single model for each IOU, with the following specification:

$$E_{im} = \mu_i + \beta_1 Post_{im} + \beta_2 CDD_{im} + \beta_3 HDD_{im} + \beta_4 PostCDD_{im} + \beta_5 PostHDD_{im} + \beta_6 TreatHDD_{im} + \beta_7 TreatCDD_{im} + \beta_8 TreatPost_{im} + \beta_9 TreatPostCDD_{im} + \beta_{10} TreatPostHDD_{im} + \theta_m + \varepsilon_{im}$$

Where:

E_{im}	Average electric (or gas) consumption per day for participant *i* during billing period *m*
μ_i	Fixed effect (or specific intercept) for participant *i*
$Post_{im}$	Post-retrofit period indicator (1 for post-installation and 0 for pre-installation period)
CDD_{im}	Average daily cooling degree days (CDD) at 70^0F for participant *i* during billing period *m (not included in gas model)*
HDD_{im}	Average daily healing degree days (HDD) at 60^0F for participant *i* during billing period *m*
$PostCDD_{im}$	Interaction term between post indicator and CDD *(not included in gas model)*
$PostHDD_{im}$	Interaction term between post indicator and HDD
$TreatCDD_{im}$	Interaction term between treatment indicator and CDD*(not included in gas model)*
$TreatHDD_{im}$	Interaction term between treatment indicator and HDD
$TreatPost_{im}$	Interaction term between treatment indicator and post indicator
$TreatPostCDD_{im}$	Interaction term between treatment indicator and post indicator and CDD
$TreatPostHDD_{im}$	Interaction term between treatment indicator and post indicator and HDD
θ_m	Monthly binary variables for each billing month
β_1	Change in energy consumption during post-installation period
β_2	Effect of cooling on energy consumption during pre-installation period
β_3	Effect of heating on energy consumption during pre-installation period

β_4	Change in the effect of cooling on energy consumption during post-installation period
β_5	Change in the effect of heating on energy consumption during post-installation period
β_6	Difference in HDD across the whole period between participant and comparison group
β_7	Difference in CDD across the whole period between participant and comparison group
β_8	The difference in the change in consumption during post-installation period between treatment and comparison group
β_9	The difference in the change in the effect of cooling on energy consumption during post-installation period between treatment and comparison group
β_{10}	The difference in the change in the effect of heating on energy consumption during post-installation period between treatment and comparison group
ε_{im}	Error term for participant i in month m

Weather-normalized savings were calculated as:

$$Average\ Normalized\ Daily\ Savings = \hat{\beta}_8 + \left(\hat{\beta}_9 \times \overline{CDD70}_{norm}\right) + \left(\hat{\beta}_{10} \times \overline{HDD60}_{norm}\right)$$

Where:

$\widehat{\beta_8}, \widehat{\beta_9}, \widehat{\beta_{10}}$	Coefficients determined by the fixed effects model
$\overline{CDD70}_{norm}$	Average daily CDD calculated using temperature data from TMY3 or CTZ2 of the participants *(not included when estimating gas savings)*
$\overline{HDD60}_{norm}$	Average daily HDD calculated using temperature data from TMY3 or CTZ2 of the participants

2.2 Data Summary

This section describes the data used in the impact evaluation of the Whole House Upgrade program. DNV GL collected information from the CPUC's program tracking database, IOU billing data, and weather data from NOAA[13] and NREL[14] and CTZ2.[15] Prior to analysis, we examined all data for completeness and potential data issues such as duplicates, extreme values, missing observations and other inconsistencies.

Table 8 describes the tracking, billing, customer, and weather datasets used in this evaluation.

[13] National Oceanic and Atmospheric Administration Hourly Weather Data

[14] National Renewable Energy Laboratory (NREL), U.S.., U.S. Department of Energy Typical Meteorological Year weather data.

[15] California Energy Commission's California Thermal Zones Typical Weather Data. This data was not used in this evaluation.

Table 8: Datasets Used in this Whole House Retrofit Impact Evaluation

Data		PG&E	SCE	SCG	SDG&E
Tracking Data (Source: CPUC Tracking Data 2010-2012)	Program name	Whole House Performance Program	Whole House Prescriptive Program/ Comprehensive Home Performance	Prescriptive Whole House Retrofit/ Local Whole Home Performance	Prescriptive Whole House Retrofit/ Local Whole Home Performance
	Number of Program Participants [1]	3,823	2,231	828	720
	Installation period	July 2010-December 2012	December 2010- Dec-12	March 2011-December 2012	November 2010-December 2012
	Total electric (kWh) savings - Basic and Advanced (unadjusted)	7,044,372	2,331,032	8,658	1,170,699
	Advanced Path Total electric (kWh) savings - EnergyPro	7,031,903	1,693,172	0	824,170
	Total electric (kWh) savings – claimed with adjustment	4,231,610	1,315,129	8,658	676,197
	Total gas (therms) savings - Basic and Advanced (unadjusted)	1,251,441	-1,334	176,340	90,605
	Advanced Path Total gas (therms) savings - EnergyPro	1,249,183	0	174,091	67,140
	Total gas (therms) savings - claimed with adjustment	751,768	-1,334	141,522	62,656

Data		PG&E	SCE	SCG	SDG&E
Billing Data (Source: IOU)	Billing periods available	Monthly billing data from Jan. 2009-Dec. 2012	Monthly billing data from Jan. 2009-Feb. 2013	Monthly billing data from Jan. 2009-Dec. 2012	Monthly billing data from Jan. 2009-Feb. 2013
Customer Data (Source: IOU)	Available	Yes	Yes	Included in billing data	Yes
Weather Data (Source: NOAA, NREL, and CTZ2)	Available: Actual, TMY3, and California Climate Zone weather data	Yes	Yes	Yes	Yes

[1] For the purposes of this table, a Program Participant is equivalent to a residential premise in the utilities' customer information data. The number of participating accounts is slightly higher (3,837 for PG&E, 2,248 for SCE, 828 for SCG, and the same -720- for SDG&E).

Table 9 summarizes the program population by installation year and the final sample used in billing analysis for each IOU.

Table 9: Number of Program Participants and Number of Program Participants Used in Billing Analysis

Data Disposition	PG&E	SCE	SCG	SDG&E
Number of program participants	**3,823**	**2,231**	**828 (a)**	**720**
By Fuel				
Both electric and gas	2,445			686
Electric only	205			21
Gas only	1,173			13
By program year				
2010 Participants	6	8		2
2011 Participants	992	723	98	188
2012 Participants	2,825	1,500	711	515
Total number of sites in Advanced Path	3,731	692	639	318
Total number of accounts linked to electric bills	2,650	2,218		693
Total number of accounts linked to gas bills	3,618		613	684
Total number of net metered sites	442	138		63
Sites with 6 to 12 months in the pre and post period	2,292 (elec)	1,959	561	631 (elec)
	3,137 (gas)			584 (gas)
Sites with 9 to 12 months in the pre and post period	2,177 (elec)	1,888	543	610 (elec)
	2,984 (gas)			561 (gas)
Sites with 12 months in the pre and post period	2,091 (elec)	1,828	536	595 (elec)
	2,864 (gas)			548 (gas)
Sites excluded from Billing Analysis				
Sites that installed lighting measures only	0	0	0	7
Sites with zero ex ante kWh and therms savings	91	1	2	7
Sites with estimated/adjusted meter readings during the analysis period	76 (elec)	159	3	25 (elec)
	47 (gas)			22 (gas)
Sites with very low average annual	150 (elec)	93	17	37 (elec)

Data Disposition	PG&E	SCE	SCG	SDG&E
consumption (less than 1,000 kWh/year and/or less than 40 therms/year)	130 (gas)			51 (gas)
Final sample used in Billing Analysis				
Total number of sites with electric	**1,625**	**1,486**		**558**
2011 Participants	422	462		137
2012 Participants	1,203	1,024		421
Total number of sites with gas	**2,737**		**536**	**532**
2011 Participants	707		57	130
2012 Participants	2,030		479	402

(a) SCE column totals exclude 19 accounts with missing IDs

2.3 Gross Savings Estimates

This section presents the gross savings for program years 2010-2012 estimated during Phase 2 (final results) of this evaluation.

Phase 1 (preliminary results) are based on IOU residential customers that participated in the program in 2010 and 2011, without a comparison group. Phase 1 estimates are presented in Appendix F.

2.3.1 Site-Level Model Results

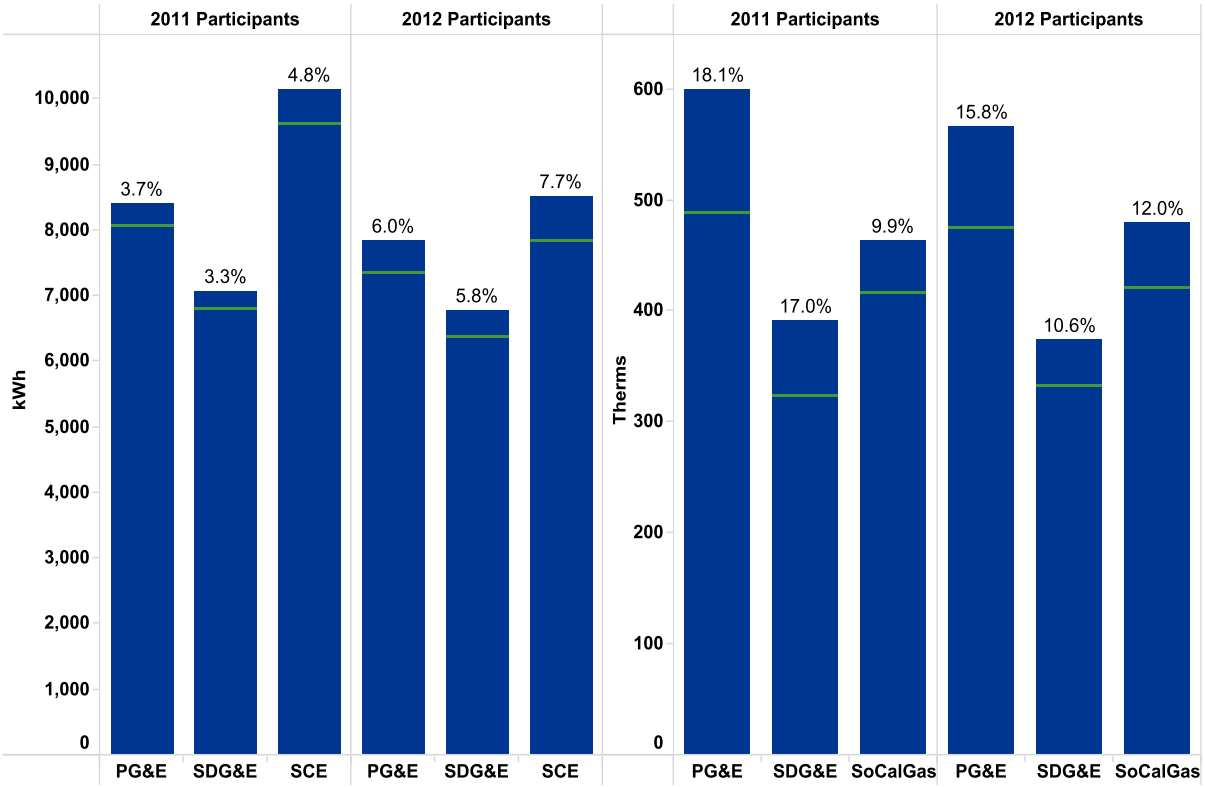
DNV GL estimated weather-adjusted electric and gas consumption for each site using site-level models. The normalized annual consumption (NAC) from these models allowed for a pre- and post-installation comparison of energy consumption under a normal weather year. NAC was estimated for the pre- and post-installation period of the participants using the optimal degree-day base for each site. This individual degree day base is a representation of the outdoor temperature at which each house needs heating or cooling. Each house has a unique degree day base due to its level of envelope insulation, infiltration, internal/solar gains, and thermostat set point schedule (i.e., at home during the day, not at home during the day, preferred set points). This modeling approach allowed the underlying structure of the degree-day data to conform to the unique characteristics of each site instead of imposing a fixed degree-day basis on all sites.

The percentage change in NAC removes the effect of weather differences in the pre- and post-periods, but it is confounded by other factors. The next step in the analysis, the pooled fixed effects

model, captures changes from effects such as program participation, and externalities such as consumption trends and other unobserved site-specific characteristics.

Figure 6 compares the average NAC level between the pre- and post-period of participants for electric and gas by IOU. The blue bars represent NAC during the pre-installation period while the horizontal line in each bar represents NAC for the post-installation period. The values in percent represent the overall change in NAC.

Figure 6: Change in Normalized Average Consumption



Results showed that, on average, 2011 participants reduced their electric normalized annual consumption between 3% and 5% while 2012 participants reduced their gas NAC by 6% to 8 %. In general, the average electric NAC in the pre- and post-installation period were relatively lower for 2012 participants. For gas, the percent reduction in NAC was relatively higher than electric. On average, 2011 participants reduced their gas normalized annual consumption between 10 and 18% while 2012 participants reduced their gas NAC by around 11% to 16%.

1. For both gas and electric NAC, most of the participants are grouped in the second bin (5 to 30% change in NAC) and in the lower bin (negative change – an increase in post-retrofit consumption)

2. in both years, more than 40% of the participants had reductions in electric NAC from 5% to 30%, while less than 10% of the participants had electric NAC reductions of more than 30%. We also found that more than 30% of the participants showed an increase in electric NAC after participating in the program across all IOUs.

3. As with electric, changes in gas NAC are similar in 2011 and 2012. The percent of customers in the highest bin exceed 20%. Most program participants saved from 5 to 30%. Over 20% of customers exhibit higher NAC in the post-retrofit period.

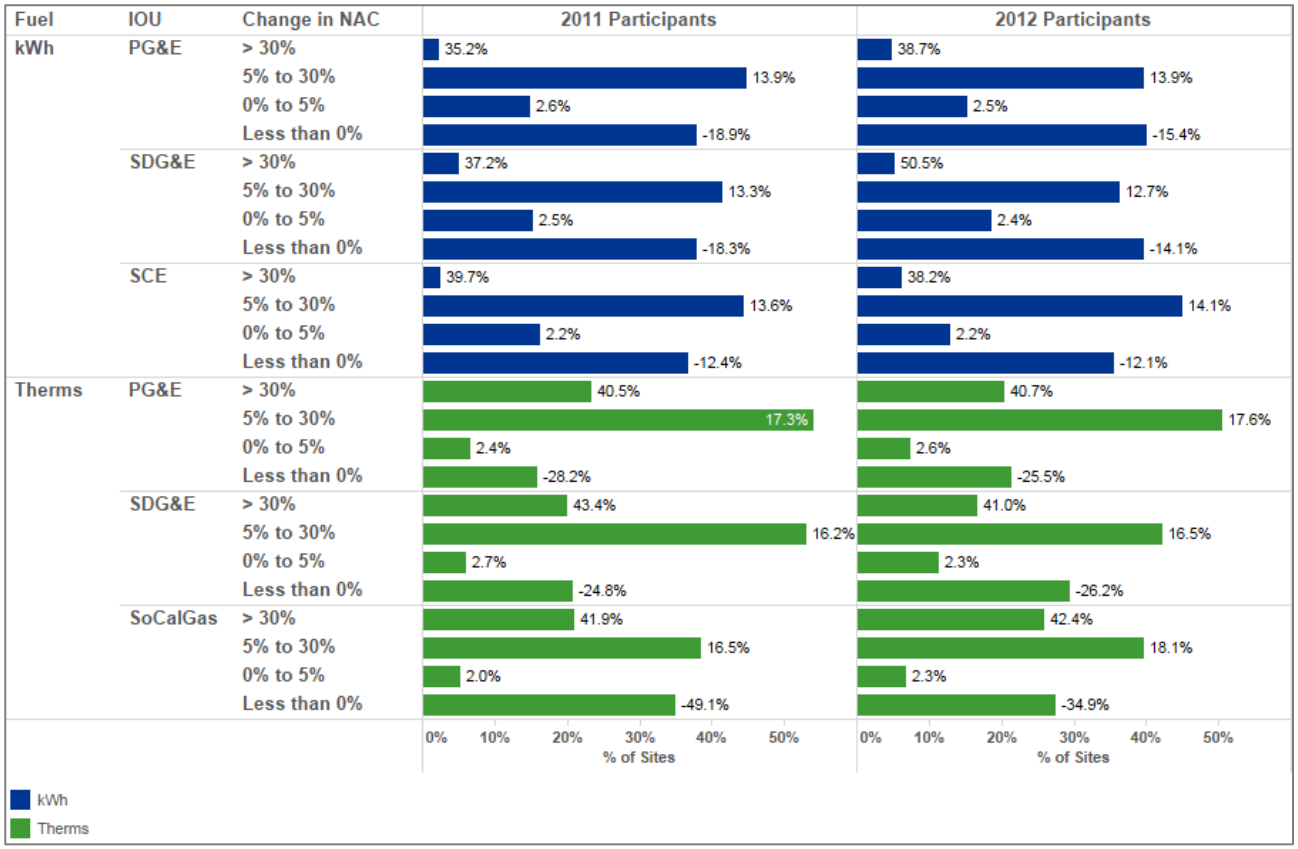
Figure 7 summarizes the distribution of participants by the level of change in NAC from the pre- to the post-retrofit period by IOU and program year. The values next to the bars represent the average savings for each bin. The horizontal axis represents the percent of customers in each bin. Results showed that the level of change in NAC varies among participants, but the overall savings distribution pattern was similar between 2011 and 2012 participants, and for both fuels:

4. For both gas and electric NAC, most of the participants are grouped in the second bin (5 to 30% change in NAC) and in the lower bin (negative change – an increase in post-retrofit consumption)

5. in both years, more than 40% of the participants had reductions in electric NAC from 5% to 30%, while less than 10% of the participants had electric NAC reductions of more than 30%. We also found that more than 30% of the participants showed an increase in electric NAC after participating in the program across all IOUs.

6. As with electric, changes in gas NAC are similar in 2011 and 2012. The percent of customers in the highest bin exceed 20%. Most program participants saved from 5 to 30%. Over 20% of customers exhibit higher NAC in the post-retrofit period.

Figure 7: Distribution of Participants by the Change in Normalized Annual Consumption (NAC)

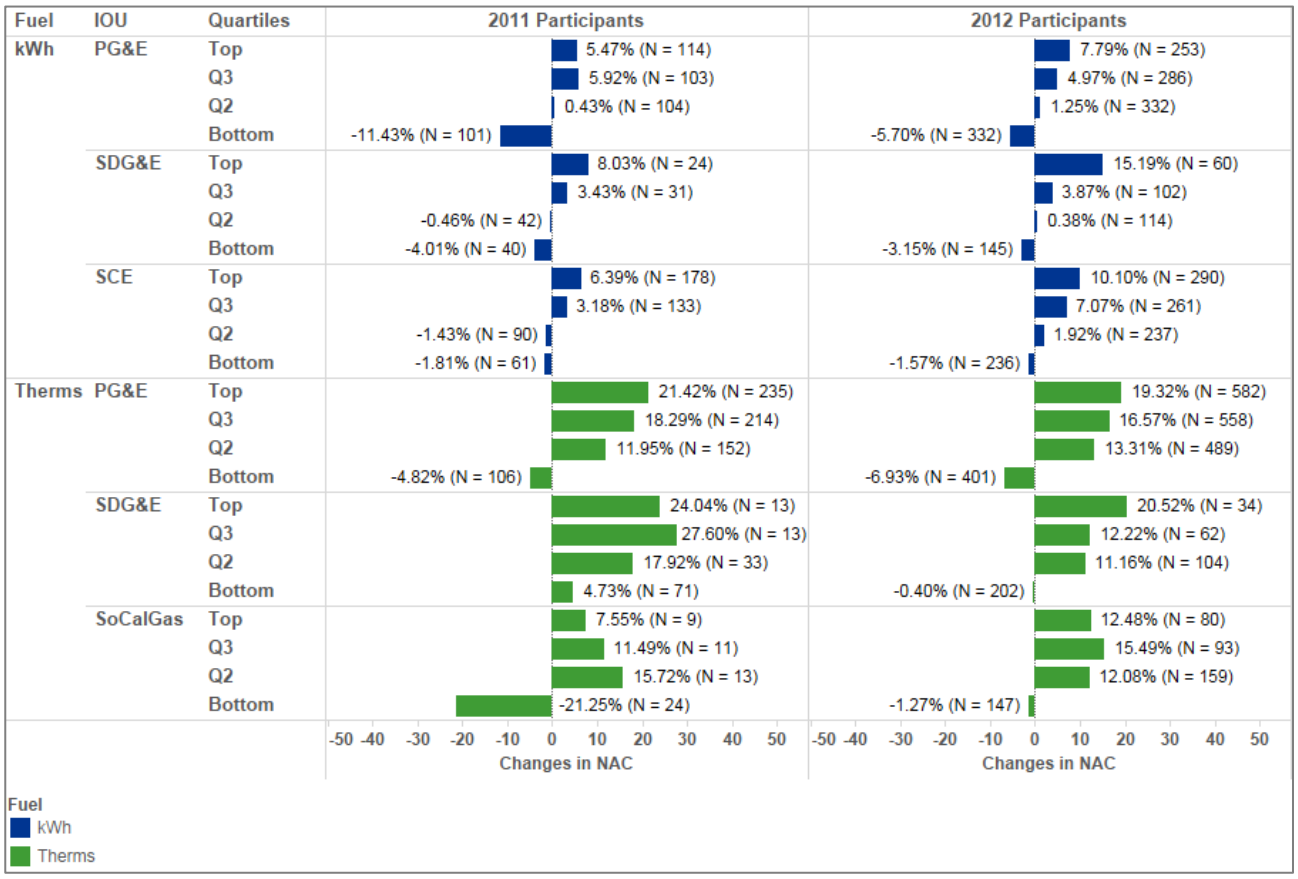


DNV GL also examined the differences in the change of NAC across different quartiles (defined by pre-retrofit energy use) to show differences in NAC between high energy users and low energy users. The different quartiles are described below:

- The 'Top' quartile includes participants whose pre-installation consumption belong in the 75th percentile and above of the overall consumption distribution,
- 'Q3' represents participants whose pre-installation consumption belong in the 50-75th percentile of the overall consumption distribution
- 'Q2' represents participants whose pre-installation consumption belong to the 25-50th percentile of the overall consumption distribution
- The 'Bottom' quartile comprises of participants whose pre-installation consumption fall in the lowest 25th percentile of the overall consumption distribution

Figure 8 presents average change in NAC across different quartiles by IOU and program year. The values in percent next to the bars correspond to the average change in each quartile while the values in parenthesis show the number of sites that belong to each quartile.

Figure 8: Change in Normalized Annual Consumption(*) by Quartile(**)



(*) In this graph, a reduction in normalized energy use is presented as a positive number. A negative change in NAC represents increased energy use in the post-retrofit period.
(**) Includes sites that were used in the Billing Analysis. These have 12 months of pre- and post-retrofit consumption.

Overall, we found that there is a correlation between greater household consumption before participating in the program and greater reduction in NAC. Specifically we found that:

a) Households in the top quartile reduced electric consumption at an average rate of over 5% for all IOUs with SDG&E showing the highest NAC reduction in the top quartile; and

b) Households in the top quartile reduced gas consumption at an average rate of around 20% or more for PG&E and SDG&E.

c) All IOUs show increases in energy use in the post-retrofit period. On average, households in the bottom quartile increased gas and electric consumption from the pre- to the post-installation periods (except for gas consumption of 2011 SDG&E – a relatively small

number of participants.) No systematic changes that would increase energy use in these households were revealed in surveys. This finding shows that the savings uncertainty of low energy users is high.

d) On average, gas changes in NAC are of a bigger magnitude than for electric.

7. Figure 6 and For both gas and electric NAC, most of the participants are grouped in the second bin (5 to 30% change in NAC) and in the lower bin (negative change – an increase in post-retrofit consumption)

8. in both years, more than 40% of the participants had reductions in electric NAC from 5% to 30%, while less than 10% of the participants had electric NAC reductions of more than 30%. We also found that more than 30% of the participants showed an increase in electric NAC after participating in the program across all IOUs.

9. As with electric, changes in gas NAC are similar in 2011 and 2012. The percent of customers in the highest bin exceed 20%. Most program participants saved from 5 to 30%. Over 20% of customers exhibit higher NAC in the post-retrofit period.

Figure 7 show the change in NAC between pre- and post-installation period across different groups. The percentage change in NAC only removes the effect of weather differences in the pre- and post-periods, but it is confounded by changes that are not weather related. To account for such factors, we estimated a pooled fixed effects model that accounts for consumption trends and other unobserved site-specific characteristics.

2.3.2 Pooled Fixed Effects Model Results

DNV GL estimated gross program savings using a fixed effects model for each IOU and program year. This analysis was performed twice: with and without the use of a comparison group. Results with a comparison group are included in this section. Results with no comparison group are included in Appendix B.

The second analysis was done to include a comparison group in a pooled fixed effects framework. This was done in an attempt to capture changes in household characteristics that might have affected consumption during the analysis period and may not have been captured in the first analysis. DNV GL utilized future program participants as a comparison group. Specifically, we used 2012 program participants as the comparison group for 2011 program participants and used 2013 program participants as a comparison group for 2012 program participants. Details about comparison group specification are described in the methodology section.

Table 10 summarizes the number of sites in the participant and comparison groups for program years 2011 and 2012. We only conducted this second analysis for IOUs with reasonable number of sites in the participant and comparison group.

Table 10: Number of Sites Used in Analysis in the Participant and Comparison[a] Groups for Program Years 2011 and 2012

IOU	Fuel	Group	Basic		Advanced	
			2011	2012	2011	2012
PG&E	Electric	Comparison	--	--	854	704
		Participants	--	--	422	1,203
	Gas	Comparison	--	--	1,489	1,063
		Participants	--	--	854	2,030
SCE	Electric	Comparison	712	340	712	340
		Participants	313	721	149	303
SCG	Gas	Comparison	--	--	346	66
		Participants	--	--	57	479
SDG&E	Electric	Comparison	302	32	302	32
		Participants	19	303	113	109
	Gas	Comparison	296	38	296	38
		Participants	20	295	110	107

(a) When applicable, the comparison groups are the same for Basic and Advanced and for both years

Table 11: Average Energy Use of Sites Used in Analysis in the Participant and Comparison[a] Groups for Program Years 2011 and 2012

IOU	Fuel	Group	2011 Program Year		2012 Program Year	
			Pre-	Post-	Pre-	Post-
PG&E	Electric (kWh)	Comparison	7,996	8,000	7,996	8,000
		Participants	8,327	8,090	8,327	8,090
	Gas (Therms)	Comparison	604	589	604	589
		Participants	620	503	620	503
SCE	Electric (kWh)	Comparison	6,474	6,688	6,474	6,688
		Participants	7,123	6,926	7,123	6,926
SCG	Gas (Therms)	Comparison	396	402	396	402
		Participants	413	345	413	345
SDG&E	Electric (kWh)	Comparison	7,821	8,108	7,821	8,108
		Participants	9,948	9,906	9,948	9,906
	Gas (Therms)	Comparison	531	508	531	508
		Participants	477	388	477	388

(a) When applicable, the comparison groups are the same for Basic and Advanced and for both years

For the remaining IOUs with enough number of sites in the comparison group, DNV GL examined the groups' validity. A key requirement when using future participants as comparison group is that program and target population must be stable throughout multiple years. To verify uniformity in target population across program years, we examined the distribution of participants and future participants across different climate zones. In addition, we compared average monthly electric and gas consumption in the pre-period to ensure that consumption trends are similar between participants and comparison group.

Based on our analysis, PG&E and SDG&E 2011 and 2012 participants had a more or less similar distribution by climate zone and trends in consumption during the pre-retrofit period. On the other hand, we found that participation for SCE was not very stable between 2011 and 2012 program years where very big households from CZ 15 joined the program in the latter part of the 2011. This caused the average electric consumption during the last quarter of pre-period to shift above the consumption curve of the comparison group.

The secondary analysis for 2012 participants involved the use of 2013 participants as comparison group. Only PG&E and SCE had enough number of 2013 participants for use as comparison group. Because it is likely that 2013 Program participants are different from the 2010-2012 Program participants, creating a valid comparison group from 2013 participants to mirror 2012 participant characteristics is difficult. We identified the following differences: for PG&E, we found that the percentage of 2013 participants was higher in CZ 12 and 13 compared to 2012. Also, PG&E consumption trends between the two groups diverge. SCE had a higher percentage of 2013 participants from CZ8 compared to 2012. We also found that consumption trends of 2012 and 2013 participants during the pre-program period were not similar for SCE.

Table 12 summarizes the results from the pooled fixed effects approach with a comparison group. We found that the percent savings estimates were very similar from one year to the next for electric and gas savings estimates only increased by around 1%. Similar to the results from the primary analysis, the program generated higher gas savings than electric savings.

Table 12: Program Savings from Pooled Fixed Effects Model With Comparison Group

IOU	Fuel	Fixed Effects Model 2011 with Comparison Group				Fixed Effects Model 2012 with Comparison Group			
		N	Estimated Savings per Partcipant	Std Error	% Savings	N	Estimated Savings per Partcipant	Std Error	% Savings
Advanced Path									
PG&E	Elec	1,276	177.5	88.9	2.1%	1,907	212.3	73.6	2.7%
	Gas	2,196	77.6	6.9	12.9%	3,093	72.3	6.3	12.8%
SCG	Gas	403	45.6	19.03	10.2%	545	154.8	21.7	33.3%
SDG&E	Elec	415	300.5	168.7	4.4%	141	-15.8	313.1	-0.2%
	Gas	406	67.0	10.9	16.9%	145	58.9	15.9	14.6%
SCE	Elec	861	691.4	138.6	8.2%	643	393.8	134.8	4.7%
Basic Path									
SDG&E	Elec	321	791.6	373.3	9.6%	335	232.9	205.0	3.5%
	Gas	316	67.9	15.0	18.5%	333	12.6	10.5	3.5%
SCE	Elec	1,025	742.9	205.8	6.8%	1,061	200.4	127.6	2.3%

We limit our analysis to the use of future participants as comparison group because the number of prior participants (in 2010) is very low. The Whole House Retrofit program started in 2010 and only few customers participated during the first year of the program. The analysis team did not consider creating a comparison group by matching participants to the general population because it is not possible to compensate for self-selection. Participants that self-select into the program are different from the rest of the population in ways that are not visible to evaluators. The program is likely to attract customers that belong to higher income groups, who possess relatively larger houses and have relatively older heating and cooling equipment in the house. Also, it is worth noting that program participants are likely to have some level of awareness on energy efficiency and desire to upgrade their home and/or save energy. To incorporate these factors in the creation of a non-participant comparison group would be difficult and very expensive.

The gross savings estimates produced with this approach do not address dual baselines. If these were individual measures, the billing analysis methodology could compensate and adjust for savings above the energy code for replace-on-burnout measures. Since whole house programs include a combination of insulation and air sealing measures with no code baseline and equipment measures with code baselines, this distinction could not be made explicitly.

2.3.3 Gross Realization Rate

Estimation of Gross Realization Rates with the Comparison Group

As mentioned earlier, it is not possible to build a perfect comparison group (a true *control* group) for a program such as the Energy Upgrade California. For example, a control group would require that the program be offered to some but not all similar residences in the same climate zone, and that the selection of what homes do not have access to the program be determined in advance of roll out. Considering that the comparison group used in this evaluation is composed of future program participants, it is also not possible to draw a perfectly clean line between gross and net estimated savings. Given the nature of the comparison group (future participants), the estimates derived with this method are closer to gross than to net savings.

The savings derived with a combination of pre-/post-program energy use analysis and a comparison group are relative to the comparison group's (future participants) consumption in their pre-program period. We consider it unlikely that someone who embarks on whole house retrofit this year did much in the way of retrofit activity in the last year (the years that we are using for the comparison.)

The result will only be partially net if there is reason to believe that the comparison group was doing some retrofit activity outside of the program during their pre-participation year. That we do not expect this to happen is one of the two primary reasons we focus on subsequent participants as a valid comparison group. The other reason is that, by ultimately opting-into the program, they are indicating that they are relatively similar households to those that already participated, but acting in a different timeframe.

Fully net savings could be estimated only if the comparison households had, on their participation date, done retrofit work at exactly the rate that the participants would have done that work *in the absence of the program*.

Many of the comments received during the public comment period for this report center on whether the savings estimates obtained with the comparison group are gross, net, or somewhere between the two. The Energy Division enlisted four subject matter experts ("advisors") to assist in the report review. The advisors did not have methodological objections to the evaluation results.

The ED, its advisors, and DNV GL concur that:

- Net savings are somewhere between the participant billing analysis with comparison group estimate by itself ("unadjusted savings estimate", presented as "gross savings" in this report), and the same estimate adjusted by the NTGR calculated with the self-report analysis.

- The billing analysis with comparison group produces a savings estimate that is closer to gross savings than to net savings
- A variety of arguments can be made as to whether net savings are closer to the unadjusted or the adjusted savings estimates. The nature of the program and the survey results indicate that the unadjusted estimates are closer to gross than to net savings.
- The method of adjustment stipulated in the research plan is a self-report survey, which was designed according to best practices and is tailored to the program. The final free-ridership estimate is based on a self-report analysis of individual measures that are weighted based on ex ante estimated measure savings and the participants' premise-based probability of selection.
- To summarize, the advisors and DNV GL agree that:
    - Actual net savings are higher than reported
    - The difference between actual and reported net savings cannot be calculated with the data available for this evaluation
    - The net savings estimated in this evaluation have a bias of known direction that cannot be quantified at this time, but that it is reasonably believed to be small

Additional discussion regarding the reasoning behind the use of future participants as a comparison group that enables the estimation of gross savings is presented in Appendix D.

Gross Realization Rate

The evaluation team took the final billing analysis results and the original ex ante savings claims and developed a gross realization rate for the two phases of the analysis. The number of participants in Phase 2 is greater so the final gross realization rate is weighted more towards later participants. Gross realization rates are presented in the following page.

Table 13: Gross Realization Rates

IOU	Fuel (unit)	Fixed Effects Model (2011 With Comparison Group)				Fixed Effects Model (2012 With Comparison Group)			
		Program Participants	Average Ex Ante	Savings Estimate	Gross Realization Rate	Program Participants	Average Ex Ante	Savings Estimate	Gross Realization Rate
Advanced Path									
PG&E	Electricity (kWh)	692	2,337.9	177.5	7.6%	1,958	2,765.1	212.3	7.7%
	Gas (Therms)	944	373.5	77.6	20.8%	2,674	335.3	72.3	21.6%
SDG&E	Electricity (kWh)	162	1,355.2	300.5	22.2%	156	3,873.7	-15.8	-0.4%
	Gas (Therms)	158	141.3	67.0	47.4%	153	292.8	58.9	20.1%
SCE	Electricity (kWh)	228	870	691.4	79.5%	464	3,222.3	393.8	12.2%
SCG	Gas (Therms)	98	25.0	45.6	182.7%	541	317.3	154.8	48.8%
Basic Path									
PG&E	Electricity (kWh)	72	135.5	PassThru	100%	20	135.5	PassThru	100%
	Gas (Therms)	72	24.5	PassThru	100%	20	24.5	PassThru	100%
SDG&E	Electricity (kWh)	24	1806.5	791.6	43.8%	378	802.8	232.9	29.0%
	Gas (Therms)	25	33.88	67.9	200.4%	368	41.7	12.6	30.2%
SCE	Electricity (kWh)	466	267	742.9	278.2%	1,073	478.5	200.4	41.9%
SCG	Gas (Therms)	0	0	0	0%	170	13.2	PassThru	100%

3. Free-Ridership and Net Savings

3.1 Method overview

The central objective of the WO46 Whole House Impact Evaluation survey was to capture program participants' self-reported responses that provide information on free-ridership and allow estimation of net-to-gross ratios which are then used to adjust gross savings estimates. This self-reported approach involved asking Advanced Path 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.

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

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

- Information received by the respondent from their project contractor
- Project financing
- Prior implementation of energy efficiency measures (as excerpted from the standard segmentation questions provided by the IOUs)
- Attitude towards the environment, price sensitivity (as excerpted from the standard segmentation questions provided by the IOUs)
- Standard respondent demographics and household characteristics

3.1.1 CPUC Guidelines

The WO46 Whole House Impact Evaluation survey follows the CPUC guidelines[16] provided for residential net-to-gross (NTG) instruments. The survey development process followed by the evaluation team solicited IOU input, incorporated changes to the survey based on feedback, and finalized the survey subsequent to multiple rounds of this process. Considerations were made for respondent fatigue, complexity of instrument, timing and budget constraints.

[16] http://www.energydataweb.com/cpucFiles/26/DraftGenericResidentialNTGInstrument_2.pdf

The survey was conducted in January 2014 with residential decision-makers and Advanced Path participants in the 2010-2012 cycle of the Energy Upgrade California programs. The survey included a series of warm-up or setup questions that served to remind the respondents of the details of their participation in the program and that helped validate the internal consistency of responses. Table 14 below summarizes the specific details of the WO46 Whole House Impact Evaluation Survey that map to the guidelines set by the CPUC for residential NTG surveys.

Table 14: Demonstration of Interpretation of CPUC Guidelines for NTG Estimation

CPUC/MECT Guidelines	WO46 Whole House Impact Evaluation Survey
Timing of the Interview	The survey was conducted in January 2014 and within a year of conclusion of the 2010-2012 program cycle.
Identifying the Correct Respondent	Respondents were screened and the survey was conducted with decision makers for the project.
Set-up Questions, Use of Multiple Questions, Validity and Reliability, Consistency Checks, and Ruling Out Rival Hypotheses	▪ Multiple questions were used at the start of the survey as a "warm-up," such as audits conducted prior to project implementation, fees paid, and contractors used. ▪ These questions helped the respondent "think back" to the time under consideration and prepare the context for subsequent program participation and measure-specific questions, thus contributing to more accurate recollections and hence responses. ▪ The right flow of warm-up questions and follow-up questions improved recall, ensured that responses pertained to the program under consideration and helped rule out or minimize any rival effects. ▪ Follow-up questions were asked based on responses to select questions and served as consistency checks.
Making the Questions Measure Specific	The survey was modular. The set of free-ridership questions were asked for each measure the respondent reported that they installed.
Partial Free-ridership	The survey had Quantity, Efficiency, and Timing (QET) questions (both overall and by measure) that included response options to capture both partial and pure free-ridership. Measure by measure was used when the respondent answered that they made individual decisions or they answered that they would have done some measures in the Overall battery.
Deferred Free-ridership	Timing questions included response options that captured deferred free-ridership, which is participants installing measures promoted by the program earlier than originally planned.
Pre-testing the Questionnaire	The survey was tested both internally by DNV GL/the evaluation team and with respondents using a soft-launch to refine and finalize instrument prior to a full rollout.
Qualified Interviewers	The CATI survey was conducted by Discovery Research Group, which is an experienced and approved subcontractor on projects for the CPUC. DNV GL monitored interviewing and cycled through all the interviewers active on the phone to provide feedback, if any, to the CATI subcontractor.
Handling Non-responses and "Don't Know"	Non-response and "Don't Know" responses were taken at face value when the survey was administered and the respondent was skipped to the next survey module, as applicable. Post-field data processing included examination of both variable level and respondent level non-response, and any variables or records with non-response over a certain threshold will be imputed or expunged. The survey data exhibits this to a minimal degree and thus does not necessitate the above processing step.
Weighting NTGR	Case weights have been applied to the sample estimates in order to develop a NTGR estimate that is representative of the population.
Precision of the NTGR	The total sample size for this study (n=527) was well over the minimum required to allow estimation of the NTGR at the level of precision specified by the guidelines, which is 90% level of confidence +/- 10%.
Scoring Algorithms	The questions used as input and the exact details of the scoring algorithm are outlined with examples later in this chapter. Partial free-riders elements were limited based on the measure, and categories limited to avoid respondent fatigue..

3.1.2 Survey Version: Short-form vs. Long-form

The evaluation team recognized that the customer decision-making process for participation in the program and the selection of measures implemented differs by respondent. Early discussions with the project team and the IOUs also surfaced concerns regarding survey length. Both these factors combined led to development of a survey tailored to the respondents' reported decision making process for program participation. This allowed for administering a tighter and shorter survey in select cases, as summarized in Table 15 below, thus reducing respondent fatigue where possible and resulting in economies of time and costs for the evaluation itself.

Respondents were asked about the specific measures installed and whether they considered the measures installed as a single package for which they made one purchasing decision versus considering each measure individually. Respondents that stated that they considered the installations as one single package were asked about the overall likelihood of installing the measures in the absence of the program, and if they would have installed these measures at the same levels of efficiency, in the same quantity, and at the same time, in the absence of the program.

Respondents who were unable to definitively answer the overall free-ridership questions related to quantity, efficiency, and timing and/or those who indicated that their response to these questions differed based on the measure being considered, were taken through a modular survey with free-ridership questions corresponding to each measure installed, hereafter referred to as the long-form of the survey. The remaining respondents were taken through the short-form of the survey, which skips them directly to the latter part of the survey with questions regarding information they received from their contractor, project finances, attitudes, adoption of energy efficient behaviors, project finances, household characteristics, and demographics.

Table 15: Survey Version: Short-Form vs. Long-Form Sample Composition

Description	Number of Completes
Short-form survey (single package, overall project free-ridership)	132
Long-form survey (measures considered individually, free-ridership for each installed measure)	395
Total	527

The average amount of time taken to complete the short form and the long form of the survey were 14.7 minutes and 17.1 minutes, respectively. The overall average survey length was 16.45 minutes.

3.2 Survey Disposition

The WO46 Whole House Impact Evaluation CATI survey was fielded by Discovery Research Group on behalf of DNV GL from January 21 to March 2 of 2014. The net effective incidence was 61%.

In computing response rates and aligning results with the industry accepted standards, DNV GL refers to the response rate calculator developed by the American Association for Public Option Research (AAPOR). AAPOR encourages research industry professionals to utilize the calculator when reporting survey response rates. "AAPOR's calculator was developed as a service to the research industry and survey research professional"[17]. DNV GLs response rate calculation approach (formula and final disposition categories) mirrors AAPOR's, while temporary disposition codes and assignment of those codes are unique to the current study. The response rate (AAPOR RR3) was 14.5%. Details are as shown below in Table 16.

Table 16: Survey Disposition Summary

Sample Description	Number	Percent of Sample - Valid
Starting Sample	**4,270**	N/A
Never Called	177	
Sample Used	**4,093**	
Known Not Eligible	277	
Estimated additional not eligible	182	
Sample-Valid	**3,634**	
Complete	527	14.5%
Refused	1,664	45.8%
Not Completed - Eligible	-	0.0%
Not Completed - Est. Eligible	1,443	39.7%

Note that, since it is not known a priori whether respondents will take the "long form" or the "short form" version of the survey, it is not possible to calculate dispositions for these two groups separately. In other words, we know how many respondents qualified for each form of the survey, but we do not know how many total program participants would have qualified for each.

3.3 Survey Sample Design

In consultation with the IOUs and staff consultants, the CPUC approved surveying of Advanced Path participants only. There were two main reasons for this decision: (a) at the time it appeared that the Basic Path would be discontinued, and thus it was more important to learn from Advanced Path participants, and (b) Advanced Path participants account for most of the EUC savings.

DNV GL analyzed the 4,807 Advanced Path participants and stratified them as follows:

[17] The American Association for Public Opinion Research. 2009. *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys. 6th edition*. AAPOR

- Utility
  - Pacific Gas & Electric
  - Southern California Edison/Southern California Gas
  - San Diego Gas & Electric

- Climate zone groups
  - Climate Zone Group "Mild" (M) – T24 Climate Zones: 1 through 7, and 16
  - Climate Zone Group "Inland" (I) – T24 Climate Zones: 8 through 14
  - Climate Zone Group "Desert" (D) – T24 Climate Zone: 15

  This climate zone grouping is consistent with what was utilized in other Energy Division studies such as California Lighting and Appliance Saturation Study ("CLASS" – WO 21) and the Residential/Advanced/Upstream Lighting Impact Evaluation (WO 28).

- Level of Ex Ante Savings
  - Top third, middle third, and bottom third for each commodity, plus zero savings.
  - Zero savings are those where the utility does not serve that commodity and a corresponding account at other utility could not be identified.

- Minimum number of participants
  The stratification by climate zone group and level of savings resulted in 30 strata, some with very few sample points. These strata were "collapsed" (combined with adjoining strata) until each of the final strata had at least 5% of the total number of Advanced Path Participants.

A sample size of 600 surveys was defined in the scope of work, based on budget and a priori assumptions. Response rates were very low. This prompted the following two actions: Further collapsing, so that no stratum weight is over 12, with the exception of Stratum 11; and open surveying, so that all eligible program participants were called several times. The original design included a primary group of randomly selected participants within each strata, that would be supplemented with other participants if there were not enough survey respondents within the primary group

The following table describes the original sample design and the final sample design for the purposes of case weight estimation and survey analysis.

Table 17: Survey Sample Stratification and Case Weight Calculation

Stratum Number	Utility	Climate Zone Group	Level of Electric Savings (1)	Level of Gas Savings (1)	Advanced Program Participants	Advanced Program Participants w/ Phone Numbers	Target Number of Surveys	Target Weight	Final Number of Surveys	Preliminary Weight	Final Level of Electric Savings (1)	Final Level of Gas Savings (1)	FINAL Weight
1	PG&E	I	0	1	414	402	46	9	28	14.79	0	1,2,3	11.21(2)
2	PG&E	I	0	2,3	348	338	38	9	40	8.70			
3	PG&E	I	1	1	556	532	61	9	63	8.83	1	1	8.83
4	PG&E	I	1	2,3	185	181	21	9	27	6.85	1	2,3	6.85
5	PG&E	I	2	1,2,3	306	298	34	9	39	7.85	2,3	1,2,3	8.90(2)
6	PG&E	I	3	1,2,3	121	121	14	9	9	13.44			
7	PG&E	M	1	1	739	708	81	9	92	8.03	1	1	8.03
8	PG&E	M	1	2,3	523	508	57	9	74	7.07	1	2,3	7.07
9	PG&E	M	2,3	1,2,3	273	261	30	9	28	9.75	2,3	1,2,3	9.75
10	PG&E	I, M	1,2,3	0	211	207	26	8	23	9.17	1,2,3	0	9.17
11	SCE/SCG	I	0	1,2,3	126	47	23	5	5	25.20	0	1,2,3	25.20
12	SCE/SCG	I	1	1,2,3	289	289	58	5	20	14.45	1,2,3	1,2,3	12.00(2)
13	SCE/SCG	I	1,2,3	0	100	97	19	5	12	8.33	1,2,3	0	8.33
14	SCE/SCG	I	2,3	1,2,3	215	215	44	5	22	9.77	1,2,3	1,2,3	12.00(2)
15	SCE/SCG	M	1,2,3	1,2,3	87	79	17	5	14	6.21	1,2,3	1,2,3	6.21
16	SDG&E	I, M	1,2,3	1,2,3	314	249	31	10	31	10.13	1,2,3	1,2,3	10.13
	TOTAL				4,807	4,532	600		527.0				

(1) 1 = Bottom third, 2 = Middle third, 3 = Highest third, 0 = Commodity not present

(2) Strata 1 and 2, 5 and 6, and 12 and 14 were collapsed due to an insufficient number of responses

3.4 Scoring Examples

3.4.1 Overall Free-Ridership: 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 answer questions related to free-ridership as shown in Table 18. The overall free-ridership score for a respondent who completes the short form of the survey is aggregated up from the free-ridership scores computed based on the quantity, efficiency, and timing (QET) questions. Table 18 below displays the questions used to address overall free-ridership, response options and associated scoring. A score of 1 indicates a total/pure free-rider, a score between 0 and 1 indicates partial free-ridership, and a score of zero indicates zero free-ridership.

The shaded rows in the below are used as an example of a response sequence which would result in the respondent being assigned an overall free-ridership score of (1.0 + 1.0 + 0.5)/3 = 0.83.

Table 18: Free-ridership Scoring for Short-Form Survey Respondents

OVERALL QUANTITY			
QT1. In the absence of the program, would you have installed ... [READ LIST, SINGLE RESPONSE] …of the measures?			
Response Code	**Description**	**Free-ridership score**	
1	ALL [go to overall efficiency EF1]	1.0	
2	SOME [go to first applicable measure section]	0.5	
3	NONE [go to overall efficiency EF1]	0.0	
-97	Don't know [go to first applicable measure section]		
-98	Refused [go to first applicable measure section]		
OVERALL EFFICIENCY			
EF1. In the absence of the program, would you have opted to install insulation and equipment with the same levels of efficiency?			
Response Code	**Description**	**Free-ridership score**	
1	Yes	1.0	
2	No	0.0	
-97	Don't know [go to first applicable measure section]		
-98	Refused [go to first applicable measure section]		
OVERALL PROJECT TIMING			
T1. In the absence of the program, would you have undertaken this project… [READ LIST, SINGLE RESPONSE]?			
Response Code	**Description**	**Free-ridership score**	
1	At the same time [SKIP TO T3]	1.0	
2	Earlier	1.0	
3	Later	0.5	
4	Never [SKIP to T2_v]	0.0	
-97	Don't know [go to first applicable measure section]		
-98	Refused [go to first applicable measure section]		

3.4.2 Measure Level Free-Ridership: Long-Form Survey Respondents

Respondents who took the long-form of the survey answer questions related to free-ridership for each measure that they report installing. In some cases, the quantity, efficiency, and timing 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. Table 19 below displays the free-ridership questions asked of respondents who indicate installing any one of attic/ceiling, wall, or floor insulation. Like in the overall free-ridership scoring example above, scores were aggregated up from responses to the QET questions to arrive at measure-level free-ridership scores. Responses as shown in the shaded rows below were scored as $(0.5 + 1.0 + 0.5)/3 = 0.67$.

Table 19: Free-ridership Scoring for Long-Form Survey Respondents

INSULATION - QUANTITY			
INS3_#. In the absence of the program, would you have installed **more or less <MEASURE>**? Would you have … ***[READ LIST, SINGLE RESPONSE]***			
Response Code	**Description**	**Free-ridership score**	
1.	Covered LESS area/square feet	0.5	
2.	Covered the SAME area	1.0	
3.	Covered MORE or	1.0	
4.	Would NOT have installed <MEASURE> [SKIP TO NEXT APPLICABLE MEASURE]	0.0	
-97	[Don't know]		
-98	[Refused]		
INSULATION -EFFICIENCY			
Insulation is rated as an "R-Value", where the higher the R-value, the better the insulation's effectiveness ***[READ ONLY ONCE - FOR FIRST APPLICABLE MEASURE WITHIN INSULATION]***			
INS4_#. In the absence of the program, how different would your installed R-Value have been? For **<MEASURE>,** would you have installed…***[READ LIST, SINGLE RESPONSE]***			
Response Code	**Description**	**Free-ridership score**	
1.	A lower R value	0.5	
2.	The same R value	1.0	
3.	A higher R value	1.0	
4.	Would not have installed any insulation [SKIP TO NEXT APPLICABLE MEASURE]	0.0	
-97	[Don't know]		
-98	[Refused]		

INSULATION -TIMING			
INS5_#. In the absence of the program, would you have installed <MEASURE>… ***[READ LIST,*** *SINGLE RESPONSE****]?***			
Response Code	**Description**	**Free-ridership score**	
1.	At the same time	1.0	
2.	Earlier	1.0	
3.	Later	0.5	
4.	Never	0.0	
-97	[Don't know]		
-98	[Refused]		

3.4.3 Aggregated Overall Free-Ridership: Long-Form Survey Respondents

For respondents who took the long form of the survey, measure level free-ridership scores, as computed above, are aggregated to obtain one overall respondent level free-ridership score. In the example shown in Table 20 below, the 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 and is computed as (0 + 0 + 0.5+ 0.5 + 0.5)/5 = 0.3.

Table 20: Individual Respondent Free-ridership Scores – Illustrative Example

Measure	Free-ridership Scores
Attic Insulation	0.0
Wall Insulation	0.0
Floor Insulation	No Measure
Air Sealing	0.5
HVAC Systems Upgrade - Heat Pump	No Measure
HVAC Systems Upgrade - Furnace	No Measure
HVAC Systems Upgrade - Air Conditioning	No Measure
HVAC Duct Leakage Reduction	0.5
HVAC Duct Insulation	0.5
EE Water Heater	No Measure
Hot Water Distribution	No Measure
Window replacement	No Measure
Respondent level free-ridership score (across all installed measures)	**0.3**

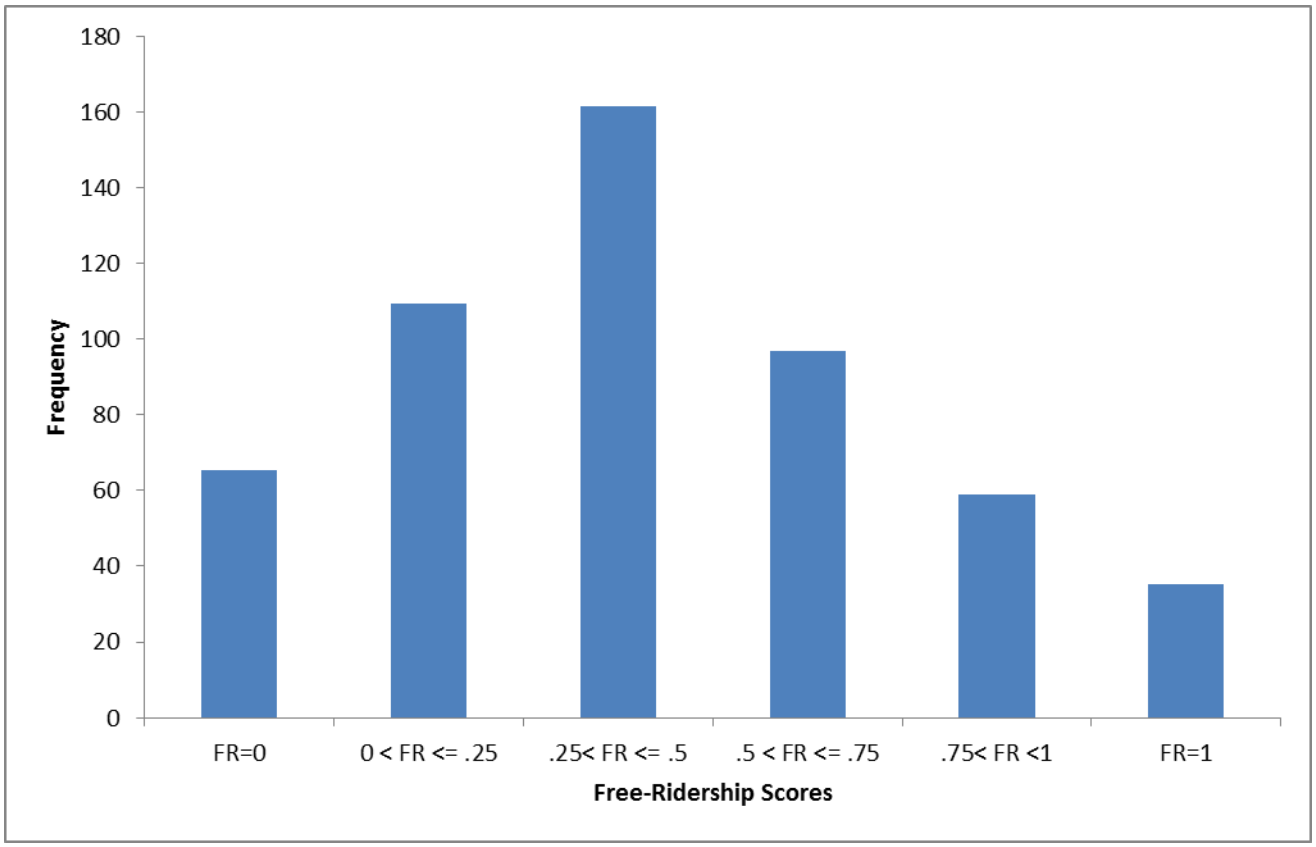
3.5 Net-to-Gross Results

The free-ridership analysis began with a review of the distribution of scores based on the number of measures installed and the results for each individual measure. Case-weights are applied to ensure that the sample is balanced to reflect true population proportions. The final case-weighted results by utility, geography, and other subgroups of interest such as short-form versus long-form survey respondents are then provided and will be applied to the gross savings results.

3.5.1 Distribution of free-ridership scores

Overall free-ridership scores were computed for short-form and long-form survey respondents, as detailed in the scoring examples above (Table 18 and Table 19). The distribution of free-ridership scores across the total sample, both long-form and short-form survey respondents, are as displayed in **Error! Reference source not found.** below. Results specific to short-form and long-form urvey respondents are summarized in Table 21. The majority of the respondents may be described as partial free-riders with more than 80% with free-ridership scores that are greater than zero and less than one , and significantly smaller segments of the sample were non free-riders and pure free-riders at 7% and 12% respectively.

Figure 9: Distribution of Case-Weighted Free-Ridership Scores



A further examination of average free-ridership scores by subgroups of interest, such as IOU service territory, number of measures implemented by respondents, short-form versus long-form,

and geography, reveals that the level of free-ridership does not differ significantly by the subgroups as shown in Table 21 below.

Table 21: Distribution of Case-Weighted Free-Ridership Scores by Subgroups of Interest

Group	N	Average Free-Ridership Score	Standard Error of Mean	95% Confidence Interval for Mean	
Total	527	44%	1%	42%	47%
PG&E	423	46%	2%	43%	49%
SCE/SCG	73	40%	3%	33%	47%
SDG&E	31	43%	5%	32%	53%
PG&E, Short Form	106	42%	4%	35%	49%
PG&E, Long Form	317	47%	2%	44%	50%
SCE/SCG, Short Form	15	42%	11%	18%	66%
SCE/SCG, Long Form	58	39%	3%	32%	46%
SDG&E, Short Form	11	43%	12%	15%	70%
SDG&E, Long Form	20	43%	5%	33%	53%
Short Form	132	42%	3%	35%	49%
Long Form	395	45%	1%	42%	48%
Inland	288	44%	2%	41%	48%
Coastal	239	44%	2%	41%	48%
One to Two Measures	35	54%	6%	42%	66%
Three to Four Measures	150	41%	2%	37%	46%
Five to Seven Measures	288	44%	2%	40%	47%
Eight to Eleven Measures	54	49%	4%	40%	58%

3.5.2 Sensitivity Analysis of Free-Ridership Scores

DNV GL conducted a sensitivity analysis in order to help calibrate the free-ridership estimates computed as described in 3.4. In the scoring example described above in Section 3.4, responses to the QET questions, overall and for each measure, are coded with values 1, .5, and 0 which correspond to total/pure, partial, and non-free-riders respectively. These are averaged to arrive at measure level scores which are then further averaged to develop respondent level free-ridership estimate across all measures implemented. If the respondent indicates that they made a single purchase decision, responses to the overall QET questions inform respondent level FR scores.

Free-ridership is particularly sensitive to partial-free-riders. The current survey contains a single catch-all response to capture partial free-ridership with lesser amount installed, lower efficiency installed, and installed at a later time serving as the partial free-ridership option for the QET questions respectively. All partial free-riders are coded as a .5 and there is no further questioning to tease out where on the spectrum of partial free-ridership the respondents lie. The current

instrument and corresponding scoring potentially introduces a bias so the resultant FR score converges towards the center, especially for partial free-riders.

The sensitivity analysis involves examining free-ridership under the extreme boundary conditions where we set partial free-ridership to total/pure free-riders or non-free-riders. The results of this analysis, presented in Table 22, indicate a potential low free-rider score of 29% and a high of 61%.

Table 22: Free-Ridership Sensitivity Analysis

Overall free-ridership with all partial free-riders set to non free-riders	Overall free-ridership	Overall free-ridership with all partial free-riders set to pure free-riders
29%	44%	61%

As indicated in section 3.2, this survey was lengthy at almost 17 minutes on average. A shorter survey (with questions about less measures, for example) could have included multiple response options that describe differing levels of partial free-ridership that allow the respondent to indicate the degree of partial free-ridership that best describes the choice they made. In other words, the survey used in this study asks if the participants would have installed the measure "later". An expanded survey could include multiple choices such as "3 months later", "3 to 6 months later", etc. allowing developing more detailed estimates for partial free-ridership. However, this survey had 25 quantity/efficiency/timing ("QET") questions for 11 measures. To add another question, and/or 2 or 3 additional response options to each question, would have increased respondent burden substantially.

3.5.3 Free-Ridership Scores by Number and Type of Measures Installed

The cross tabulation in Table 23 below displays the distribution of free-ridership scores by the number of measures installed. The proportion of respondents that indicated zero free-ridership decreased as the number of measures installed increased. Partial free-ridership was lower amongst respondents who installed one to two measures at 62% versus more than 80% for those who installed three or more measures.

Table 23: Free-Ridership Case-Weighted Scores by Number of Measures Installed

Free-ridership Score Categories→	Zero Free-ridership	Partial Free-ridership				Pure free-ridershipPure free	Number of respondents
Number of measures installed↓	0	> 0, <= .25	> .25, <= .5	> .5, <= .75	>.75, <1	1	
1 to 2	17%	11%	26%	14%	11%	20%	35
3 to 4	13%	27%	26%	21%	9%	5%	150
5 to 7	12%	20%	32%	19%	11%	6%	288
8 to 11	7%	15%	31%	19%	20%	7%	54
Number of respondents	63	110	158	100	61	35	527

Table 24 : Free-Ridership Case-Weighted Scores by Number of Measures Installed

Free-ridership Score Categories→	Zero Free-ridership	Partial Free-ridership				Pure free-ridership	Number of respondents
Number of measures installed↓	0	> 0, <= .25	> .25, <= .5	> .5, <= .75	>.75, <1	1	
1 to 2	6	4	9	5	4	7	35
3 to 4	19	40	39	31	13	8	150
5 to 7	34	58	93	54	33	16	288
8 to 11	4	8	17	10	11	4	54
Number of respondents	63	110	158	100	61	35	527
Percent of respondents	12%	21%	30%	19%	12%	7%	100%

Free-ridership scores by type of measures installed, as displayed in Table 25 below, indicate that there are significant differences in both the installation rate and the level of free-ridership for the installed measures. While energy efficient windows were reportedly installed by less than 20% of the sample, the level of pure free-ridership was highest for this measure at 7% compared with other measures for which pure free-ridership ranged from 1% to 3%. Wall insulation and domestic hot water distribution measures had the highest proportion of respondents, with zero free-ridership at 13% and 10% respectively compared with other measures for which this proportion ranges from 1% to 8%. Shell measures such as air sealing and insulation and HVAC measures such as duct leakage, duct insulation, and HVAC systems upgrades were reportedly the highest installed measures. Approximately 90% of respondents installing each of these measures could have been described as partial free-riders.

Table 25: Free-Ridership Case-Weighted Scores by Type of Measure Installed

Free-ridership Score Categories→	Zero Free-ridership	Partial Free-ridership				Pure Free-ridership	Number installing measure ↓	Average Free-ridership scores
Measures installed↓	0	> 0, <= .25	> .25, <= .5	> .5, <= .75	>.75, <1	1		
Short Form	25%	27%	15%	3%	13%	17%	132	**42%**
Attic/Ceiling Insulation	8%	21%	35%	23%	11%	3%	321	**49%**
Wall Insulation	13%	21%	39%	16%	10%	1%	129	**34%**
Floor Insulation	6%	24%	38%	18%	13%	2%	124	**31%**
Air Sealing	8%	21%	36%	23%	9%	3%	259	**37%**
HVAC Systems Upgrade – Heat Pump	5%	14%	37%	28%	16%	1%	192	**54%**
HVAC Systems Upgrade – Furnace	1%	19%	37%	28%	14%	1%	118	**46%**
HVAC Systems Upgrade – Air-conditioner	8%	18%	31%	24%	19%	0%	39	**56%**
HVAC Duct Leakage Reduction	8%	18%	37%	24%	10%	3%	325	**41%**
HVAC Duct Insulation	7%	18%	37%	26%	11%	2%	250	**47%**
Energy-Efficient Water Heater	5%	17%	41%	25%	10%	2%	135	**55%**
Domestic Hot Water Distribution	10%	16%	40%	23%	8%	2%	126	**40%**
Windows	4%	19%	27%	26%	17%	7%	100	**66%**

Table 26 : Free-Ridership Case-Weighted Scores by Type of Measure Installed

Free-ridership Score Categories→	Zero Free-ridership	Partial Free-ridership				Pure Free-ridership	
Measures installed↓	0	> 0, <= .25	> .25, <= .5	> .5, <= .75	>.75, <1	1	Number installing measure↓
Short Form	32	35	21	4	17	23	132
Attic/Ceiling Insulation	25	68	108	75	37	8	321
Wall Insulation	15	28	47	23	14	2	129
Floor Insulation	7	31	45	21	18	2	124
Air Sealing	20	53	92	61	25	8	259
HVAC Systems Upgrade – Heat Pump	9	26	70	55	31	1	192
HVAC Systems Upgrade – Furnace	2	24	42	32	17	1	118
HVAC Systems Upgrade – Air-conditioner	3	8	12	8	8	0	39
HVAC Duct Leakage Reduction	25	59	116	80	36	9	325
HVAC Duct Insulation	17	44	90	67	28	4	250
Energy-Efficient Water Heater	7	24	54	34	14	2	135
Domestic Hot Water Distribution	11	21	51	29	11	3	126
Windows	4	18	27	27	18	6	100

3.6 Measure Costs and Savings Weighted Free-Ridership Scores

The free-ridership scores presented thus far assigned equal weights for each of the measures implemented. Since the cost to implement and the potential savings varies by measure, the next step in the analysis involved an examination of free-ridership scores with measure level weights that reflected variable costs and savings. Table 27 summarizes the measure cost and the measure savings weights, developed by the evaluation team based on the total energy perspective that were used in this analysis.

Table 27: Measure Cost and Measure Savings Weights

Measures Implemented	Measure Costs Weight	Measure Savings Weight
Attic Insulation	5	20
Wall Insulation	10	15
Floor Insulation	5	10
Air Sealing	5	10
HVAC Systems Upgrade	25	10
HVAC Duct Leakage Reduction	5	15
HVAC Duct Insulation	5	3
Energy Efficient Water Heater	10	5
Hot Water Distribution	5	2
Window Replacement	25	10

The above weights were applied to measure level free-ridership scores and then aggregated to obtain overall respondent level measure costs and measure savings weighted free-ridership scores. Evaluators assigned weights based on the total energy perspective and these may be broken into electric and gas weights based on estimates other than the EnergyPro estimates which are acceptable to the CPUC. Case weights were then applied to measure weighted respondent level scores to obtain free-ridership scores at the total sample level and for subgroups of interest. Results from this analysis are summarized in Table 28 below. While the application of measure cost weights resulted in free-ridership scores in the same range as before, measure-savings weighted free-ridership scores were marginally lower. We would interpret this finding to mean that measures with higher savings weight had lower levels of free-ridership.

Table 28: Measure Cost and Savings Weighted Free-Ridership Scores

Group	n	Case Weighted	Case Weighted and Measure Cost Weighted	Case Weighted and Measure Savings Weighted
Total	527	44%	45%	40%
PG&E	423	46%	46%	42%
SCE/SCG	73	40%	41%	32%
SDG&E	31	43%	44%	36%
Short form	132	42%	42%	42%
Long Form	395	45%	46%	40%
Inland	288	44%	45%	40%
Coastal	239	44%	45%	41%
One to Two measures	35	54%	54%	52%
Three to Four measures	150	41%	42%	35%
Five to Seven measures	288	44%	45%	40%
Eight to Eleven measures	54	49%	50%	47%

3.7 Free-Ridership by Potential Covariates and Participant Demographics

The evaluation team investigated several possible calculations for the free ridership estimate and ultimately the case-weighted and measure savings weighted results were the most defensible. With a free ridership estimate of 0.40 the NTGR is simply the compliment or 0.60. As discussed previously in this chapter, the distribution of free ridership estimates revealed that there were many partial free riders and those partial free riders ended up driving the overall estimate as they primarily fell within the range of 0.25 to 0.5 as shown in Table 28with a normal distribution around that bin. The evaluation team applied the IOU-specific final NTGRs to the gross realized savings to develop final net savings estimates.

The covariates examined in this analysis included several demographic variables and the demographic distribution of participants is of particular interest to understand program participation/adoption. We note that certain customer segments have disproportionately higher representation amongst program participants:

- Almost 60% of participants did not avail of project financing
- More than 70% of the participants are aged 45 years or older
- Almost 75% of the participants have a four-year college degree education or higher
- More than 50% of the participants who provided income information stated that they had annual household incomes of over $100,000

This indicates that the majority of the participants in the program were highly-educated, middle-aged, and established customers with a level of affluence that does not necessitate availing of project financing. Table 29 illustrates the percent of program participants that utilized project financing for the program as a total and by geographical area.

This is an important finding for the program because in order to achieve its adoption goals, it will require targeted marketing and messaging to reach other key customer segments. Additionally, more than 67% of participants state that their home was built before 1970, which seems logical given that these buildings would be more in need of retrofits compared to those of a later vintage.

Table 29: Use of Financing by Geographical Area

Utilized Financing	Geographical Area	Percent of Program Participants	Std Err of Percent
No	Inland	28%	2%
	Coastal	31%	2%
	Total	58%	2%
Yes	Inland	32%	2%
	Coastal	9%	1%
	Total	42%	2%
Total	Inland	60%	2%
	Coastal	40%	2%
	Total	100%	

3.8 Rebound Indicators

Rebound (also known as take-back –the increased use of a resource following an increase in its efficiency) is a common outcome in energy efficiency projects. In some cases, rebound can offset the energy efficiency gains of certain projects.

This study does not include a full rebound analysis. This section presents indicators of rebound from survey responses.

- Based on the survey, it is estimated that 1,105 Advanced Path (AP) program participants (or 23.6% of all AP program participants) installed Central Air Conditioning as part of the project. Of these, about 294 Advanced Path participants (6% of all Advanced Path participants) added a first or second unit that did not exist before

  Not all additions of new equipment that did not exist before result in energy use increases. Some program participants added second units that did not exist before. For example, a house with a CAC that added a second CAC. It is possible that the second unit results in lower energy use because the house was zoned and/or the second unit reduces distribution losses.

- About 1,666 AP program participants (35.6%) have a furnace. Of these, 91 participants (2%) added a first or second furnace that did not exist before

- About 185 AP participants (4%) responded that they increased their home's square footage during the project

- About 98 program participants (2%) added a pool or spa during the project
- There is indication that a small percentage of participants (1% or less) added room air conditioners that did not exist before. Given the low number of respondents, count estimates are not reported for this category
- About 15% of all Advanced Path program participants exhibit one or more of the rebound indicators described in this section

3.9 Changes in Occupancy

Survey results indicate that 11% of program participants increased the number of inhabitants after the retrofit, and the same percentage (11%) decreased after the retrofit.

Since the net number of households that increased in number of occupants is zero, this indicates that changes in the number of household occupants did not play a role in biasing program savings downward or upward.

Changes in occupancy due to occupants spending more or less time at home than before the retrofit were not investigated in this survey.

3.10 Net-to-Gross Ratio

The evaluation team investigated cost and savings weights for the free ridership estimate and ultimately the measure savings and case-weighted results were the most defensible. With a free ridership estimate of 0.44, the NTGR is simply the complement, or 0.56. As discussed in this chapter, the distribution of free-ridership estimates revealed that there were many partial free-riders, which ended up driving the overall estimate as they primary fell within the range of 0.25 to 0.5 with a normal distribution around that bin.

4. Conclusions and Recommendations

The evaluation team estimated total net program savings by applying the gross realization rate and the NTGR to the program ex ante savings claims. After developing the final savings estimates, the team developed a set of conclusions based on the data and analysis. Finally, the team looked at the recommendations from the IOU process evaluation and determined whether the impact analysis further supports the recommendations of the process evaluation or allows the CPUC and the IOUs to prioritize the recommendations.

4.1 Final Net Savings

The evaluation team estimated total net program savings by applying the gross realization rate and the NTGR to the program ex ante savings claims. The gross realization rates were different for 2010-11 and 2012 and thus are presented in separate tables. The total net savings by IOU and fuel across the 2010-12 program cycle follow.

Table 30: Final Savings for 2010-2011 Participants

IOU	Fuel (unit)	Fixed Effects Model (2011 With Comparison Group)											
		Program Participants	Mean Ex Ante Savings per Year (Un-Adjusted)	Mean Ex Ante Savings per Year (Adjusted)	Mean Ex Post Savings per Year	Gross Realization Rate	Net to Gross Ratio	Mean Net Savings Per Year	Mean Net Savings 90% Conf. Lower Bound	Mean Net Savings 90% Conf. Upper Bound	Net Savings as Percent of Ex Ante w/ Applied GRR	Total Gross Savings Per Year	Total Net Savings Per Year
Advanced Path													
PG&E	Electricity (kWh)	692	2,337.9	1,402.7	177.5	7.6%	0.58	103.0	18.09	187.83	7.3%	122,844	71,249
PG&E	Gas (Therms)	944	373.5	224.1	77.6	20.8%	0.58	45.0	38.24	51.74	20.1%	73,226	42,471
SDG&E	Electricity (kWh)	162	1,355.2	542.1	300.5	22.2%	0.64	192.3	10.96	373.68	35.5%	48,640	31,130
SDG&E	Gas (Therms)	158	141.3	113.1	67.0	47.4%	0.64	42.9	28.78	56.98	37.9%	10,557	6,756
SCE	Electricity (kWh)	228	870	347.9	691.4	79.5%	0.68	470.2	304.63	635.67	135.2%	157,719	107,249
SCG	Gas (Therms)	98	25.0	20.0	45.6	182.7%	0.68	31.0	9.38	52.63	155.3%	4,469	3,039

IOU	Fuel (unit)	Fixed Effects Model (2011 With Comparison Group)											
		Program Participants	Mean Ex Ante Savings per Year (Un-Adjusted)	Mean Ex Ante Savings per Year (Adjusted)	Mean Ex Post Savings per Year	Gross Realization Rate	Net to Gross Ratio	Mean Net Savings Per Year	Mean Net Savings 90% Conf. Lower Bound	Mean Net Savings 90% Conf. Upper Bound	Net Savings as Percent of Ex Ante w/ Applied GRR	Total Gross Savings Per Year	Total Net Savings Per Year
Basic Path													
PG&E	Electricity (kWh)	72	135.5	135.5	Not Evaluated	100%	0.80	108.4	19.05	197.75	80%	9,756	7,805
PG&E	Gas (Therms)	72	24.5	24.5	Not Evaluated	100%	0.80	19.6	16.66	22.54	80%	1,764	1,411
SDG&E	Electricity (kWh)	24	1806.5	1806.5	791.6	43.8%	0.80	633.3	135.89	1130.67	35%	18,777	15,022
SDG&E	Gas (Therms)	25	33.88	33.88	67.9	200.4%	0.80	54.3	32.01	76.63	160%	1,695	1,356
SCE	Electricity (kWh)	466	267	267	742.9	278.2%	0.80	594.3	300.62	888.02	223%	346,093	276,874
SCG	Gas (Therms)	0	0	0	0	0%	0.80	0.0			NA	0	0

Table 31: Final Savings for 2012 Participants

IOU	Fuel (unit)			Fixed Effects Model (2012 With Comparison Group)									
		Program Participants	Mean Ex Ante Savings per Year (Un-Adjusted)	Mean Ex Ante Savings per Year (Adjusted)	Mean Ex Post Savings per Year	Gross Realization Rate	Net to Gross Ratio	Mean Net Savings Per Year	Mean Net Savings 90% Conf. Lower Bound	Mean Net Savings 90% Conf. Upper Bound	Net Savings as Percent of Ex Ante w/ Applied GRR	Total Gross Savings Per Year	Total Net Savings Per Year
Advanced Path													
PG&E	Electricity (kWh)	1,958	2,765.1	1,659.1	212.3	7.7%	0.58	123.1	52.72	193.49	7.4%	415,586	241,040
PG&E	Gas (Therms)	2,674	335.3	201.2	72.3	21.6%	0.58	42.0	35.77	48.14	20.9%	193,410	112,178
SDG&E	Electricity (kWh)	156	3,873.7	1,549.5	-15.8	-0.4%	0.64	-10.1	319.50	-339.72	-0.7%	(2,467)	(1,579)
SDG&E	Gas (Therms)	153	292.8	234.2	58.9	20.1%	0.64	37.7	19.47	55.92	16.1%	9,028	5,778
SCE	Electricity (kWh)	464	3,222.3	1,288.9	393.8	12.2%	0.68	267.8	113.43	422.13	20.8%	182,678	124,221
SCG	Gas (Therms)	541	317.3	253.8	154.8	48.8%	0.68	105.3	77.80	132.78	41.5%	83,768	56,963

IOU	Fuel (unit)			Fixed Effects Model (2012 With Comparison Group)									
		Program Participants	Mean Ex Ante Savings per Year (Un-Adjusted)	Mean Ex Ante Savings per Year (Adjusted)	Mean Ex Post Savings per Year	Gross Realization Rate	Net to Gross Ratio	Mean Net Savings Per Year	Mean Net Savings 90% Conf. Lower Bound	Mean Net Savings 90% Conf. Upper Bound	Net Savings as Percent of Ex Ante w/ Applied GRR	Total Gross Savings Per Year	Total Net Savings Per Year
Basic Path													
PG&E	Electricity (kWh)	20	135.5	135.5	Not Evaluated	100%	0.80	108.4	46.42	170.38	80%	2,710	2,168
PG&E	Gas (Therms)	20	24.5	24.5	Not Evaluated	100%	0.80	19.6	16.71	22.49	80%	490	392
SDG&E	Electricity (kWh)	378	802.8	802.8	232.9	29.0%	0.80	186.3	-84.41	457.05	23%	88,101	70,481
SDG&E	Gas (Therms)	368	41.7	41.7	12.6	30.2%	0.80	10.1	-3.87	24.03	24%	4,640	3,712
SCE	Electricity (kWh)	1,073	478.5	478.5	200.4	41.9%	0.80	160.3	-10.36	331.00	34%	215,056	172,045
SCG	Gas (Therms)	170	13.2	13.2	Not Evaluated	100%	0.80	10.6	8.10	13.02	NA	2,244	1,795

4.2 Conclusions

The evaluation concluded that resulting savings were less than planned. These lower savings result from a confluence of factors.

The program used an energy simulation tool to estimate site specific savings. The tool's overestimation of energy consumption has been well documented in the ex ante review and IOU process evaluations. The evaluation team found that gross savings were less than expected despite the adjustments that the IOUs made to the ex ante savings. The actual energy consumption, especially electric consumption, is not normally distributed around the average. Therefore, the assumptions the tool made were based on an incorrect average and did not capture the true extremes of high and low usage. This means that for a given home the estimate of savings could be higher than the estimated usage. This idea is further described in the next section.

In addition to the gross savings, the majority of survey respondents scored as partial free-riders. Survey responses support that many were planning to do a single measure regardless of incentive, and that the program was responsible for inducing additional measures. Estimated free-ridership would be lower if the program claimed only the savings for the additional measures the participants were not already considering prior to the retrofit.

At the time of this report, the IOUs and other stakeholders published a new effort, CALTEST, to better calibrate, or at least compare, simulation estimates to billed energy consumption.

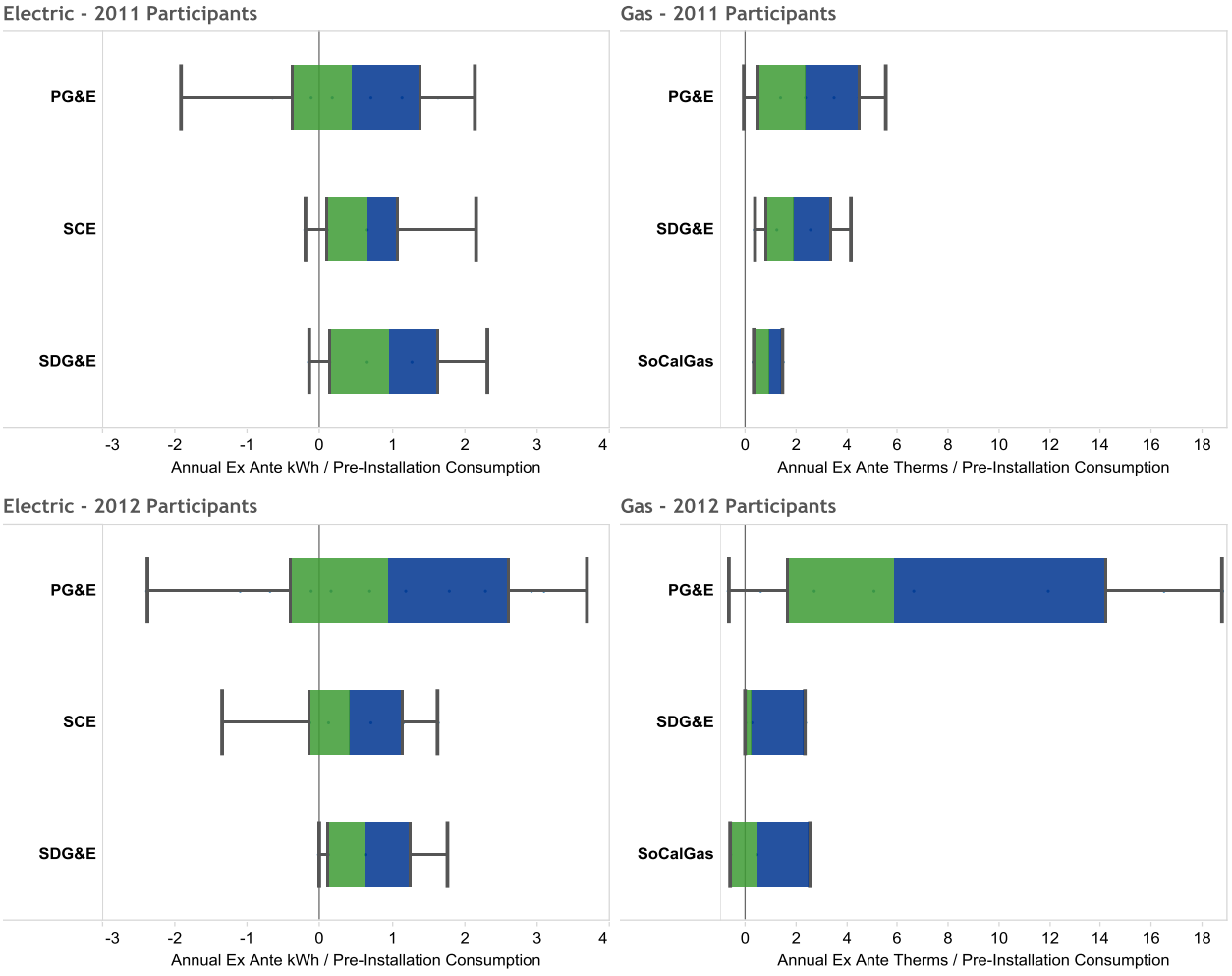
Figure 10 depicts the ratio of ex ante savings divided by consumption in the pre-installation period. On the horizontal axis, a value of 1 means that ex ante savings are equal to consumption; a value of 2 means that the ex ante savings are twice the pre-installation energy use, and so on. Since these analyses exclude net metering sites, any value greater than one would be physically impossible. Figure 10 shows that, for a very large group of participants, the estimated energy savings were simply unattainable.

Energy savings overestimation occurred because the energy savings calculations did not factor prior energy use into the calculations. The two colors separate records on each side of the median. The rectangle in the middle represents 50% of all cases, while the "whiskers" on each side of the rectangle represent 25% of the cases each.

For example, the first quadrant (2011 Electric Participants) shows that:

- All three electric IOUs have cases where the estimated Ex Ante savings are higher than the premise's total energy use.
- Estimated savings of up to 200% of the total annual energy use are observed for all three utilities.
- PG&E: the ex ante savings for approximately 40% of all 2011 participants is 75% or more of annual electricity use.
- SCE: the ex ante savings estimates for approximately half of all participants is 75% or more.
- SDG&E: the ex ante savings estimate for approximately 50% of all participants was greater than 100%.

Figure 10: Distribution of ExAnte Savings and Consumption Ratio



Last, the evaluation team recommends additional work to do targeting and focusing on the homes with consumption that is high enough to compensate for the fact that the program may inherently attract partial free-riders. The following section includes additional support for these ideas that were raised in the non-impact IOU studies.

4.3 Recommendations

The impact evaluation showed energy savings to be lower than expected, with the gas savings across program delivery types and IOUs closer to expectations than electric savings which varied. The evaluation also determined that partial free-riders comprised a majority of program participants in the Advanced Path. The impact evaluation found that like the ex ante disposition and the first IOU process evaluation, the energy simulation software overestimates usage and savings. The evaluation team recommends support for statewide efforts via CALTEST to look at additional software options and program requirements that better predict consumption or that require using billing data to calibrate estimates. Some of the evaluation team members supported these efforts via technical working group. The recommendations suggested in this section require that future estimates are calibrated or are more accurate than current estimates.

The evaluation team developed key recommendations based on the evaluation findings that may inherently improve gross realization rates and net to gross.

- Change from incentives based on percent savings for site energy and provide incentives similar to the non-residential custom programs on a dollar per unit of energy basis ($/kWh and $/therm). Currently the relative savings approach provides the same dollar amount to homes with low and high usage and does not align with the value of electric savings that is part of cost effectiveness calculations. Savings per unit of energy would provide more money to save more energy on an absolute basis and may increase program uptake in hotter climates by properly valuing electric savings.

- Claiming savings only for measures that the customer would not have done in absence of the program will reduce free-ridership. This documentation of which measures the customer would be doing can also support identifying early replacement measures and distinguishing them from replace on burnout. The incentives would also then support "deeper" retrofits as opposed to providing some funding for free rider measures and only partial funding for additional measures.

4.4 Support for Program Recommendations in Process Evaluations

The evaluation team could not develop program recommendations based solely on the impact results, therefore the evaluation team reviewed the relevant process evaluations conducted over

the past few years on the Energy Upgrade California programs. These studies include the following:

- 2010–2012 PG&E AND SCE WHOLE HOUSE RETROFIT PROGRAM PROCESS EVALUATION STUDY – SBW CONSULTING, INC.. December 12, 2012
- 2010–2012 PG&E WHOLE HOUSE RETROFIT PROGRAM PHASE II PROCESS EVALUATION STUDY –SBW CONSULTING, INC.. December 31, 2013
- PG&E WHOLE HOUSE PROGRAM: MARKETING AND TARGETING ANALYSIS - OPINION DYNAMICS CORPORATION April 2014

The recommendations across process evaluations regarding targeting for marketing may be the most important in terms of realizing savings. Refocusing the program toward inland areas with warmer temperatures and providing more support based on household available capital would be the mechanisms to achieve the higher savings. The evaluation team based this recommendation support on the lower than expected gross savings, geographic participation shift in SCE that led to lower savings from 2010 to 2012, and the survey demographics indicating that participants were relatively well paid, highly educated, and many did not take advantage of financing for a relatively expensive project. We do think that location and available capital may be intrinsically linked. When the ARRA funding ended, participation seemed to migrate toward the Pacific coast to ZIP codes that have higher home values and home incomes, but these are also locations with less potential electric savings. This implies that the program may have to provide additional incentives to attract the homes with the greater potential savings from retrofits. The homes with higher consumption near the coast have more base load than cooling load and other measures focused on advanced lighting, appliances, and electronics may have substantial site specific savings.

Overall the most recent study reviewed, the PG&E Marketing and Targeting analysis, may provide the best summary of recommendations, all of which seem to be supported by the impact evaluation. The evaluation thought it best to provide the four complete recommendations from the report's executive summary. These should apply to all IOUs based on our impact analysis.

> *Recommendation #1: Address Constraints in Messaging and Design: Financial constraints are the largest reason for not being able to take action. The program needs to address financial constraints by making customers aware that there is financial support available if they cannot afford the upfront cost of the retrofit.*
>
> *Recommendation #2: Lead with Home Comfort Message but Add Environment: Home comfort is the dominant motivator for whole house upgrades. However, our research*

shows that environmental messaging, when combined with comfort messages, may be the most powerful of all messaging.

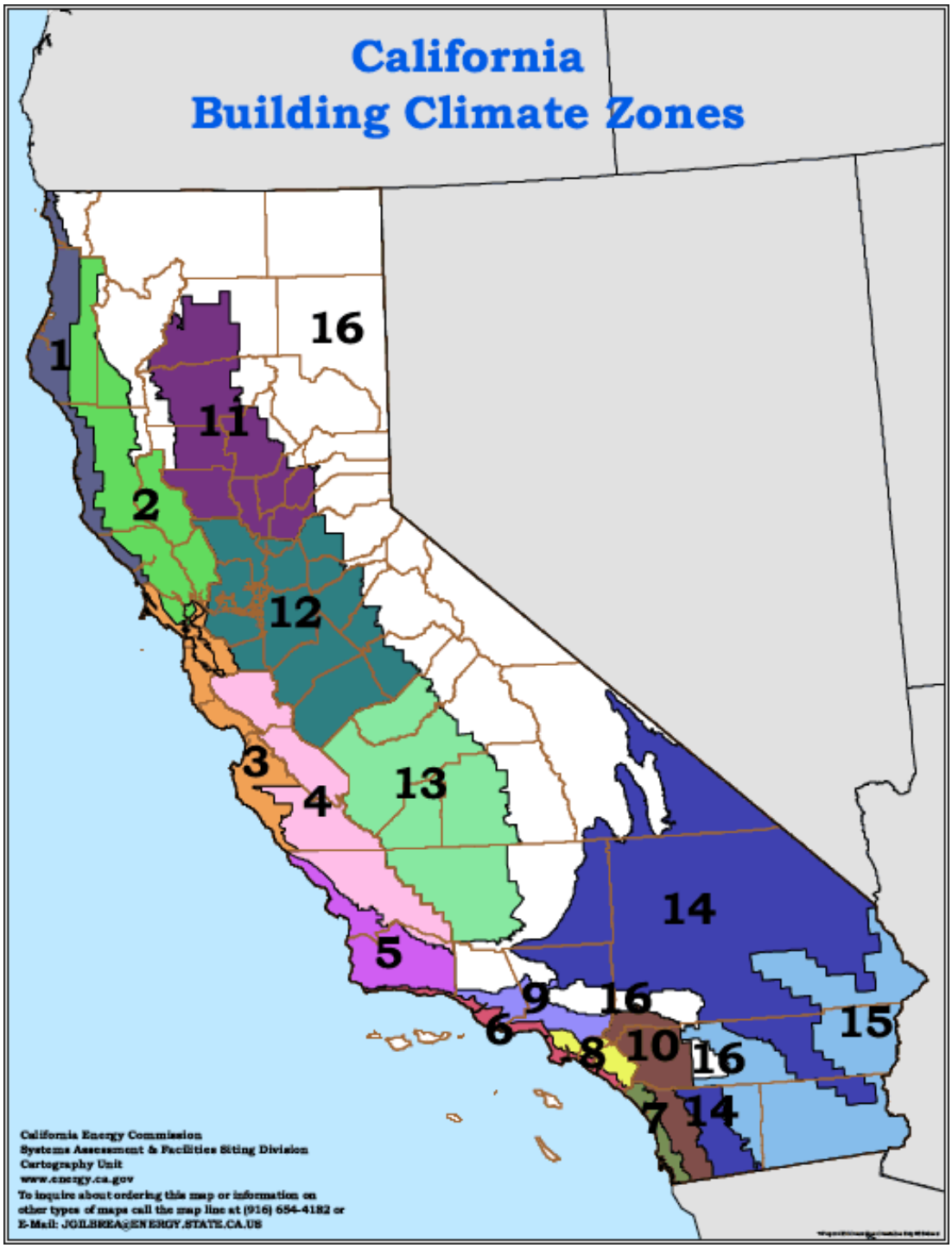
Recommendation #3: Consider New Potential Measure Bundles: Based upon customers' intent to install multiple measures in the near future, there are two potential bundles of measures that could be used for the basic path to help encourage participation.

Recommendation #4: Score and Micro-target Customers: The overall savings from this program are lower than expected. Targeting high savers would help to increase savings (and average savings per home) in the future. Based on our analysis of household-level savings, using a minimum of these 13 key variables, and the stage model that can predict who has intent to do whole house upgrades, PG&E can score its entire residential customer base to identify which customers are more likely to intend to take action along and which customers have the potential for high energy savings. This would help the program target the right customers with direct marketing and outreach.

Appendix

A. Climate Zone Map

Figure A1. California Building Climate Zones



B. Pooled Fixed Effects Model Without Comparison Group

B.1 Method Overview of the Pooled Fixed Effects Model without Comparison Group

As a first step in the billing analysis for this evaluation, DNV GL prepared a Fixed Effects model with no comparison group. For each IOU, all monthly consumption data (both pre- and post-installation) of eligible participants were included in a single model with the following specification:

$$E_{im} = \mu_i + \beta_1 Post_{im} + \beta_2 CDD70_{im} + \beta_3 HDD60_{im} + \beta_4 PostCDD70_{im} + \beta_5 PostHDD60_{im} + \theta_m + \varepsilon_{im}$$

Where:

E_{im}	Average actual electric (or gas) consumption per day for participant *i* during billing period *m*
μ_i	Fixed effect (or specific intercept) for participant *i*
$Post_{im}$	Post-retrofit period indicator (1 for post-installation and 0 for pre-installation period)
$CDD70_{im}$	Average daily cooling degree days (CDD) at 70^{0}F for participant *i* during billing period *m (not included in gas model)*
$HDD60_{im}$	Average daily healing degree days (HDD) at 60^{0}F for participant *i* during billing period *m*
$PostCDD70_{im}$	Interaction term between post indicator and CDD70 *(not included in gas model)*
$PostHDD60_{im}$	Interaction term between post indicator and HDD60
θ_m	Monthly binary variables for each billing month
β_1	Change in energy consumption during post-installation period
β_2	Effect of cooling on energy consumption during pre-installation period
β_3	Effect of heating on energy consumption during pre-installation period
β_4	Change in the effect of cooling on energy consumption during post-installation period
β_5	Change in the effect of heating on energy consumption during post-installation period
ε_{im}	Error term for participant *i* in month *m*

Weather-normalized savings were calculated as:

$$Average\ Normalized\ Daily\ Savings = \hat{\beta}_1 + \left(\hat{\beta}_4 \times \overline{CDD70}_{norm}\right) + \left(\hat{\beta}_5 \times \overline{HDD60}_{norm}\right)$$

Where:

$\widehat{\beta_1}, \widehat{\beta_4}, \widehat{\beta_5}$	Coefficients determined by the fixed effects model
$\overline{CDD70}_{norm}$	Average daily CDD calculated using temperature data from TMY3 or CTZ2 of the

participants *(not included when estimating gas savings)*

$\overline{HDD60}_{norm}$ Average daily HDD calculated using temperature data from TMY3 or CTZ2 of the participants

B.2 Results of the Pooled Fixed Effects Model without Comparison Group

The first set of savings estimates were produced using a pooled fixed effects approach without the use of comparison group. The pooled approach addressed exogenous change without the inclusion of a separate comparison group. In this model, participants who received a measure installation during a certain time interval served as a steady-state comparison for other participants in each other time interval. Table 32 summarizes program savings estimates from the pooled fixed effects approach.

Table 32: Program Savings from Pooled Fixed Effects Model without Comparison Group

IOU	Fuel	Fixed Effects Model (2011 Participants)				Fixed Effects Model (2012 Participants)			
		n (a)	Savings Estimate	Standard Error	% Savings	n (a)	Savings Estimate	Standard Error	% Savings
PG&E	Electric	422	159.1	151.3	1.9%	1,203	199.7	87.4	2.5%
	Gas	707	70.5	17.2	11.8%	2,030	31.7	9.7	5.6%
SDG&E	Electric	137	370.0	227.3	5.2%	421	90.1	152.5	1.3%
	Gas	130	63.0	30.8	16.1%	402	24.0	16.6	6.4%
SCE	Electric	462	270.0	234.5	2.7%	1,024	442.5	133.3	5.2%
SCG	Gas	57	-0.2	34.9	0.0%	479	45.5	17.3	9.5%

(a) The difference between the total number of program participants and the final number of program participants used in this analysis is illustrated in Table 9.

Results from the pooled fixed effects model are summarized below:

Electric

- Overall average savings estimates for 2011 program year range from around 2% to 5%. However, savings were not statistically significant.
- PG&E and SCE savings estimates for 2012 participants were 2.5% and 5.2% and are statistically significant at 95% confidence level while SDG&E program participants in 2012 did not show evidence of program savings.

Gas

- PG&E and SDG&E produced statistically significant savings of more than 10% for the 2011 program year. The savings estimate for SoCalGas is not reported for the 2011 program year because the number of participants is very small.
- Gas savings of 2012 PG&E and SDG&E participants were statistically significant and less than half of the savings generated by 2011 participants. SoCalGas produced around 10% savings for 2012 program year.

C. Regression Parameters for Pooled Fixed Effects Model with Comparison Group

Table 33: Parameter Estimates from Fixed Effects Model for PG&E 2011 Participants (Electric)

IOU	Parameters	Estimates	StdErr	t-stat	p-value
PG&E	post	1.08	0.36	3.04	0.00
PG&E	cdd	2.31	0.13	18.31	0.00
PG&E	hdd	0.47	0.08	5.64	0.00
PG&E	cdd_post	-0.31	0.09	-3.32	0.00
PG&E	hdd_post	-0.12	0.06	-1.88	0.06
PG&E	cdd_treat	-0.26	0.20	-1.25	0.21
PG&E	hdd_treat	0.06	0.06	0.95	0.34
PG&E	post_treat	0.26	0.32	0.82	0.41
PG&E	hdd_post_treat	-0.11	0.05	-2.34	0.02
PG&E	cdd_post_treat	-0.31	0.15	-2.03	0.04
PG&E	bill_period1	4.76	0.99	4.83	0.00
PG&E	bill_period2	3.93	1.00	3.94	0.00
PG&E	bill_period3	2.96	0.92	3.20	0.00
PG&E	bill_period4	2.30	0.81	2.82	0.00
PG&E	bill_period5	-0.50	1.84	-0.27	0.79
PG&E	bill_period6	1.17	1.20	0.97	0.33
PG&E	bill_period7	1.28	1.11	1.15	0.25
PG&E	bill_period8	0.25	0.94	0.27	0.79
PG&E	bill_period9	-0.42	0.88	-0.48	0.63
PG&E	bill_period10	-0.71	0.82	-0.86	0.39
PG&E	bill_period11	-0.60	0.80	-0.75	0.45
PG&E	bill_period12	0.29	0.82	0.35	0.73
PG&E	bill_period13	1.64	0.85	1.94	0.05
PG&E	bill_period14	0.75	0.82	0.91	0.36
PG&E	bill_period15	0.18	0.81	0.23	0.82
PG&E	bill_period16	0.16	0.79	0.20	0.84
PG&E	bill_period17	0.71	0.83	0.85	0.39
PG&E	bill_period18	1.94	0.94	2.07	0.04
PG&E	bill_period19	0.12	1.05	0.12	0.91
PG&E	bill_period20	-0.93	0.97	-0.96	0.34
PG&E	bill_period21	-0.26	0.87	-0.29	0.77
PG&E	bill_period22	-1.02	0.78	-1.30	0.19
PG&E	bill_period23	-1.11	0.76	-1.46	0.14

IOU	Parameters	Estimates	StdErr	t-stat	p-value
PG&E	bill_period24	-0.43	0.75	-0.57	0.57
PG&E	bill_period25	0.13	0.74	0.17	0.86
PG&E	bill_period26	0.47	0.74	0.63	0.53
PG&E	bill_period27	0.07	0.74	0.09	0.93
PG&E	bill_period28	-0.23	0.72	-0.32	0.75
PG&E	bill_period29	0.20	0.80	0.25	0.80
PG&E	bill_period30	0.82	0.98	0.84	0.40
PG&E	bill_period31	0.25	0.97	0.26	0.80
PG&E	bill_period32	-0.76	0.88	-0.87	0.39
PG&E	bill_period33	-1.21	0.84	-1.43	0.15
PG&E	bill_period34	-1.44	0.77	-1.88	0.06
PG&E	bill_period35	-1.34	0.72	-1.87	0.06
PG&E	bill_period36	-0.82	0.73	-1.13	0.26
PG&E	bill_period37	-0.45	0.74	-0.61	0.54
PG&E	bill_period38	-0.29	0.77	-0.37	0.71
PG&E	bill_period39	-0.88	0.75	-1.17	0.24
PG&E	bill_period40	-1.12	0.74	-1.51	0.13
PG&E	bill_period41	-0.49	0.72	-0.67	0.50
PG&E	bill_period42	1.10	0.69	1.59	0.11
PG&E	bill_period43	1.31	1.31	1.00	0.32
PG&E	bill_period44	5.02	4.76	1.06	0.29
PG&E	bill_period45	7.73	4.39	1.76	0.08
PG&E	bill_period46	4.31	2.15	2.01	0.04
PG&E	bill_period47	0.66	0.04	17.40	0.00
PG&E	bill_period48	0.00	0.00	0.00	0.00

Table 34: Parameter Estimates from Fixed Effects Model for PG&E 2011 Participants (Gas)

IOU	Parameters	Estimates	StdErr	t-stat	p-value
PG&E	post	0.12	0.03	3.94	0.00
PG&E	hdd	0.16	0.01	26.76	0.00
PG&E	hdd_post	-0.02	0.00	-3.40	0.00
PG&E	hdd_treat	0.00	0.01	0.83	0.41
PG&E	post_treat	-0.06	0.01	-3.92	0.00
PG&E	hdd_post_treat	-0.04	0.00	-9.66	0.00
PG&E	bill_period1	-0.40	0.06	-6.44	0.00
PG&E	bill_period2	-0.43	0.06	-6.82	0.00
PG&E	bill_period3	-0.43	0.06	-6.94	0.00
PG&E	bill_period4	-0.51	0.06	-8.04	0.00
PG&E	bill_period5	-0.19	0.19	-0.95	0.34

IOU	Parameters	Estimates	StdErr	t-stat	p-value
PG&E	bill_period6	-0.10	0.12	-0.88	0.38
PG&E	bill_period7	0.02	0.09	0.22	0.82
PG&E	bill_period8	-0.23	0.07	-3.22	0.00
PG&E	bill_period9	-0.45	0.06	-7.17	0.00
PG&E	bill_period10	-0.60	0.06	-10.62	0.00
PG&E	bill_period11	-0.78	0.06	-13.33	0.00
PG&E	bill_period12	-0.85	0.06	-13.70	0.00
PG&E	bill_period13	-0.90	0.06	-14.67	0.00
PG&E	bill_period14	-0.88	0.06	-14.54	0.00
PG&E	bill_period15	-0.91	0.06	-16.19	0.00
PG&E	bill_period16	-0.77	0.05	-14.44	0.00
PG&E	bill_period17	-0.44	0.06	-7.97	0.00
PG&E	bill_period18	-0.19	0.06	-2.95	0.00
PG&E	bill_period19	-0.19	0.07	-2.59	0.01
PG&E	bill_period20	-0.22	0.07	-3.29	0.00
PG&E	bill_period21	-0.31	0.06	-5.50	0.00
PG&E	bill_period22	-0.72	0.05	-15.46	0.00
PG&E	bill_period23	-0.81	0.04	-19.26	0.00
PG&E	bill_period24	-0.93	0.04	-23.88	0.00
PG&E	bill_period25	-1.04	0.04	-26.89	0.00
PG&E	bill_period26	-1.06	0.04	-27.21	0.00
PG&E	bill_period27	-1.04	0.04	-26.50	0.00
PG&E	bill_period28	-0.94	0.04	-24.55	0.00
PG&E	bill_period29	-0.52	0.05	-10.52	0.00
PG&E	bill_period30	-0.28	0.07	-3.73	0.00
PG&E	bill_period31	-0.28	0.07	-3.85	0.00
PG&E	bill_period32	-0.45	0.06	-7.58	0.00
PG&E	bill_period33	-0.56	0.05	-10.30	0.00
PG&E	bill_period34	-0.80	0.04	-19.77	0.00
PG&E	bill_period35	-1.03	0.03	-31.70	0.00
PG&E	bill_period36	-1.08	0.03	-32.76	0.00
PG&E	bill_period37	-1.12	0.03	-34.66	0.00
PG&E	bill_period38	-1.16	0.03	-34.47	0.00
PG&E	bill_period39	-1.14	0.03	-34.31	0.00
PG&E	bill_period40	-1.09	0.03	-32.59	0.00
PG&E	bill_period41	-0.79	0.04	-20.46	0.00
PG&E	bill_period42	-0.37	0.07	-5.30	0.00
PG&E	bill_period43	-0.20	0.13	-1.53	0.13
PG&E	bill_period44	-0.63	0.27	-2.34	0.02
PG&E	bill_period45	-0.39	0.17	-2.29	0.02

IOU	Parameters	Estimates	StdErr	t-stat	p-value
PG&E	bill_period46	-0.47	0.05	-9.99	0.00
PG&E	bill_period47	-0.74	0.24	-3.13	0.00
PG&E	bill_period48	-0.86	0.25	-3.51	0.00
PG&E	bill_period49	0.00	0.00	0.00	0.00

Table 35: Parameter Estimates from Fixed Effects Model for PG&E 2012 Participants (Electric)

IOU	Parameters	Estimates	StdErr	t-stat	p-value
PG&E	post	-0.16	0.29	-0.55	0.58
PG&E	cdd	1.90	0.10	19.15	0.00
PG&E	hdd	0.22	0.04	4.89	0.00
PG&E	cdd_post	-0.19	0.06	-3.06	0.00
PG&E	hdd_post	0.06	0.04	1.63	0.10
PG&E	cdd_treat	0.14	0.14	1.02	0.31
PG&E	hdd_treat	0.11	0.04	3.03	0.00
PG&E	post_treat	0.19	0.22	0.84	0.40
PG&E	hdd_post_treat	-0.11	0.03	-3.80	0.00
PG&E	cdd_post_treat	-0.41	0.11	-3.71	0.00
PG&E	bill_period1	-6.71	0.79	-8.46	0.00
PG&E	bill_period2	-11.50	0.78	-14.70	0.00
PG&E	bill_period3	-7.30	0.78	-9.37	0.00
PG&E	bill_period4	-6.45	0.77	-8.38	0.00
PG&E	bill_period5	-6.81	0.77	-8.89	0.00
PG&E	bill_period6	-7.55	0.76	-9.87	0.00
PG&E	bill_period7	-6.03	0.78	-7.77	0.00
PG&E	bill_period8	-11.25	0.78	-14.48	0.00
PG&E	bill_period9	0.00	0.00	0.00	0.00
PG&E	bill_period10	0.00	0.00	0.00	0.00
PG&E	bill_period11	0.00	0.00	0.00	0.00
PG&E	bill_period12	0.00	0.00	0.00	0.00
PG&E	bill_period13	0.00	0.00	0.00	0.00
PG&E	bill_period14	0.64	2.02	0.32	0.75
PG&E	bill_period15	2.33	1.10	2.12	0.03
PG&E	bill_period16	0.68	0.87	0.78	0.44
PG&E	bill_period17	-0.18	0.81	-0.23	0.82
PG&E	bill_period18	-0.33	0.79	-0.41	0.68
PG&E	bill_period19	-1.43	0.79	-1.80	0.07
PG&E	bill_period20	-1.78	0.79	-2.26	0.02
PG&E	bill_period21	-0.83	0.80	-1.05	0.29
PG&E	bill_period22	-0.06	0.80	-0.08	0.94

IOU	Parameters	Estimates	StdErr	t-stat	p-value
PG&E	bill_period23	0.23	0.80	0.29	0.77
PG&E	bill_period24	-0.39	0.79	-0.49	0.63
PG&E	bill_period25	-0.75	0.80	-0.94	0.35
PG&E	bill_period26	0.11	0.78	0.14	0.89
PG&E	bill_period27	1.30	0.77	1.67	0.09
PG&E	bill_period28	0.63	0.77	0.83	0.41
PG&E	bill_period29	-0.90	0.76	-1.19	0.23
PG&E	bill_period30	-1.44	0.76	-1.90	0.06
PG&E	bill_period31	-1.67	0.77	-2.17	0.03
PG&E	bill_period32	-1.49	0.79	-1.89	0.06
PG&E	bill_period33	-0.84	0.81	-1.04	0.30
PG&E	bill_period34	-0.02	0.83	-0.03	0.98
PG&E	bill_period35	0.37	0.83	0.44	0.66
PG&E	bill_period36	-0.76	0.82	-0.93	0.35
PG&E	bill_period37	-0.97	0.81	-1.19	0.23
PG&E	bill_period38	-0.32	0.78	-0.41	0.68
PG&E	bill_period39	1.22	0.74	1.65	0.10
PG&E	bill_period40	-0.07	0.70	-0.11	0.91
PG&E	bill_period41	-1.53	0.70	-2.18	0.03
PG&E	bill_period42	-2.09	0.75	-2.80	0.01
PG&E	bill_period43	-2.05	0.80	-2.57	0.01
PG&E	bill_period44	-1.43	0.82	-1.74	0.08
PG&E	bill_period45	-0.07	0.85	-0.08	0.94
PG&E	bill_period46	0.62	0.89	0.70	0.49
PG&E	bill_period47	0.39	0.88	0.44	0.66
PG&E	bill_period48	-0.28	0.86	-0.33	0.75
PG&E	bill_period49	-1.40	0.79	-1.77	0.08
PG&E	bill_period50	-0.99	0.69	-1.44	0.15
PG&E	bill_period51	0.00	0.00	0.00	0.00

Table 36: Parameter Estimates from Fixed Effects Model for PG&E 2012 Participants (Gas)

IOU	Parameters	Estimates	StdErr	t-stat	p-value
PG&E	post	0.04	0.03	1.14	0.25
PG&E	hdd	0.16	0.01	23.04	0.00
PG&E	hdd_post	0.01	0.00	1.69	0.09
PG&E	hdd_treat	-0.01	0.01	-2.32	0.02
PG&E	post_treat	-0.04	0.02	-2.55	0.01
PG&E	hdd_post_treat	-0.04	0.00	-15.24	0.00
PG&E	bill_period1	0.78	0.12	6.66	0.00

IOU	Parameters	Estimates	StdErr	t-stat	p-value
PG&E	bill_period2	0.61	0.12	5.21	0.00
PG&E	bill_period3	0.13	0.27	0.46	0.64
PG&E	bill_period4	0.05	0.15	0.30	0.76
PG&E	bill_period5	-0.93	0.10	-9.28	0.00
PG&E	bill_period6	0.04	0.11	0.42	0.67
PG&E	bill_period7	0.27	0.12	2.26	0.02
PG&E	bill_period8	0.31	0.27	1.13	0.26
PG&E	bill_period9	0.00	0.22	0.00	1.00
PG&E	bill_period10	0.32	0.45	0.70	0.48
PG&E	bill_period11	-0.41	0.28	-1.45	0.15
PG&E	bill_period12	-1.29	0.12	-11.02	0.00
PG&E	bill_period13	0.00	0.00	0.00	0.00
PG&E	bill_period14	0.00	0.00	0.00	0.00
PG&E	bill_period15	0.00	0.00	0.00	0.00
PG&E	bill_period16	0.00	0.00	0.00	0.00
PG&E	bill_period17	0.21	0.23	0.92	0.36
PG&E	bill_period18	0.29	0.12	2.38	0.02
PG&E	bill_period19	0.26	0.10	2.55	0.01
PG&E	bill_period20	0.27	0.09	2.90	0.00
PG&E	bill_period21	0.16	0.09	1.89	0.06
PG&E	bill_period22	-0.29	0.08	-3.45	0.00
PG&E	bill_period23	-0.38	0.09	-4.40	0.00
PG&E	bill_period24	-0.47	0.09	-5.35	0.00
PG&E	bill_period25	-0.58	0.09	-6.47	0.00
PG&E	bill_period26	-0.61	0.09	-6.74	0.00
PG&E	bill_period27	-0.59	0.09	-6.61	0.00
PG&E	bill_period28	-0.47	0.09	-5.33	0.00
PG&E	bill_period29	-0.05	0.08	-0.59	0.55
PG&E	bill_period30	0.19	0.09	2.22	0.03
PG&E	bill_period31	0.21	0.08	2.52	0.01
PG&E	bill_period32	0.05	0.08	0.59	0.56
PG&E	bill_period33	-0.08	0.08	-0.93	0.35
PG&E	bill_period34	-0.34	0.09	-4.03	0.00
PG&E	bill_period35	-0.56	0.09	-6.15	0.00
PG&E	bill_period36	-0.60	0.09	-6.47	0.00
PG&E	bill_period37	-0.62	0.09	-6.53	0.00
PG&E	bill_period38	-0.63	0.09	-6.69	0.00
PG&E	bill_period39	-0.62	0.09	-6.60	0.00
PG&E	bill_period40	-0.61	0.09	-6.43	0.00
PG&E	bill_period41	-0.29	0.09	-3.25	0.00

IOU	Parameters	Estimates	StdErr	t-stat	p-value
PG&E	bill_period42	0.10	0.08	1.13	0.26
PG&E	bill_period43	0.20	0.08	2.48	0.01
PG&E	bill_period44	-0.09	0.08	-1.12	0.26
PG&E	bill_period45	-0.34	0.09	-3.97	0.00
PG&E	bill_period46	-0.48	0.09	-5.17	0.00
PG&E	bill_period47	-0.63	0.10	-6.52	0.00
PG&E	bill_period48	-0.67	0.10	-6.80	0.00
PG&E	bill_period49	-0.74	0.10	-7.35	0.00
PG&E	bill_period50	-0.75	0.10	-7.29	0.00
PG&E	bill_period51	-0.68	0.11	-6.11	0.00
PG&E	bill_period52	-0.58	0.10	-5.63	0.00
PG&E	bill_period53	-0.35	0.09	-4.07	0.00
PG&E	bill_period54	0.00	0.00	0.00	0.00

Table 37: Parameter Estimates from Fixed Effects Model for SCG 2011 Participants

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SCG	post	-0.06	0.06	-0.97	0.33
SCG	hdd	0.08	0.02	4.42	0.00
SCG	hdd_post	0.02	0.01	1.91	0.06
SCG	hdd_treat	0.01	0.02	0.66	0.51
SCG	post_treat	-0.08	0.06	-1.41	0.16
SCG	hdd_post_treat	-0.02	0.02	-1.08	0.28
SCG	bill_period1	1.72	0.22	7.94	0.00
SCG	bill_period2	1.68	0.18	9.16	0.00
SCG	bill_period3	1.09	0.14	8.08	0.00
SCG	bill_period4	0.54	0.12	4.59	0.00
SCG	bill_period5	0.37	0.11	3.22	0.00
SCG	bill_period6	0.32	0.15	2.20	0.03
SCG	bill_period7	0.09	0.11	0.81	0.42
SCG	bill_period8	0.02	0.11	0.18	0.86
SCG	bill_period9	0.05	0.11	0.43	0.67
SCG	bill_period10	0.13	0.09	1.47	0.14
SCG	bill_period11	0.44	0.09	5.06	0.00
SCG	bill_period12	1.29	0.13	10.06	0.00
SCG	bill_period13	1.64	0.15	10.91	0.00
SCG	bill_period14	1.19	0.13	9.02	0.00
SCG	bill_period15	1.24	0.15	8.53	0.00
SCG	bill_period16	0.65	0.11	5.78	0.00
SCG	bill_period17	0.32	0.09	3.78	0.00

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SCG	bill_period18	0.36	0.07	5.23	0.00
SCG	bill_period19	0.12	0.06	1.90	0.06
SCG	bill_period20	0.07	0.07	0.88	0.38
SCG	bill_period21	0.05	0.07	0.76	0.45
SCG	bill_period22	0.11	0.07	1.67	0.10
SCG	bill_period23	0.44	0.07	6.70	0.00
SCG	bill_period24	1.32	0.12	11.01	0.00
SCG	bill_period25	1.40	0.12	11.57	0.00
SCG	bill_period26	1.18	0.11	11.12	0.00
SCG	bill_period27	0.96	0.12	8.29	0.00
SCG	bill_period28	0.66	0.10	6.49	0.00
SCG	bill_period29	0.37	0.06	5.80	0.00
SCG	bill_period30	0.23	0.06	3.72	0.00
SCG	bill_period31	0.19	0.05	4.20	0.00
SCG	bill_period32	0.05	0.07	0.73	0.47
SCG	bill_period33	0.13	0.08	1.71	0.09
SCG	bill_period34	0.19	0.08	2.46	0.01
SCG	bill_period35	0.25	0.08	3.19	0.00
SCG	bill_period36	0.84	0.19	4.42	0.00
SCG	bill_period37	1.06	0.39	2.70	0.01
SCG	bill_period38	2.74	0.15	18.47	0.00
SCG	bill_period39	0.00	0.00	0.00	0.00

Table 38: Parameter Estimates from Fixed Effects Model for SCG 2012 Participants

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SCG	post	0.17	0.07	2.43	0.02
SCG	hdd	0.12	0.03	4.74	0.00
SCG	hdd_post	0.05	0.01	4.55	0.00
SCG	hdd_treat	-0.03	0.02	-1.37	0.17
SCG	post_treat	-0.27	0.05	-5.12	0.00
SCG	hdd_post_treat	-0.07	0.01	-6.01	0.00
SCG	bill_period1	0.42	0.35	1.19	0.24
SCG	bill_period2	0.47	0.19	2.51	0.01
SCG	bill_period3	0.13	0.13	1.02	0.31
SCG	bill_period4	0.18	0.13	1.35	0.18
SCG	bill_period5	-0.24	0.11	-2.19	0.03
SCG	bill_period6	-0.59	0.11	-5.55	0.00
SCG	bill_period7	-0.60	0.11	-5.47	0.00
SCG	bill_period8	-0.82	0.11	-7.47	0.00

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SCG	bill_period9	-0.88	0.11	-7.86	0.00
SCG	bill_period10	-0.87	0.11	-7.95	0.00
SCG	bill_period11	-0.81	0.11	-7.42	0.00
SCG	bill_period12	-0.50	0.10	-4.92	0.00
SCG	bill_period13	0.30	0.12	2.59	0.01
SCG	bill_period14	0.49	0.11	4.40	0.00
SCG	bill_period15	0.26	0.11	2.42	0.02
SCG	bill_period16	0.03	0.11	0.29	0.77
SCG	bill_period17	-0.29	0.10	-2.79	0.01
SCG	bill_period18	-0.60	0.11	-5.67	0.00
SCG	bill_period19	-0.75	0.12	-6.25	0.00
SCG	bill_period20	-0.82	0.12	-7.03	0.00
SCG	bill_period21	-0.92	0.11	-8.23	0.00
SCG	bill_period22	-0.90	0.12	-7.49	0.00
SCG	bill_period23	-0.88	0.12	-7.18	0.00
SCG	bill_period24	-0.72	0.11	-6.47	0.00
SCG	bill_period25	-0.16	0.11	-1.39	0.17
SCG	bill_period26	0.18	0.14	1.34	0.18
SCG	bill_period27	0.00	0.10	-0.03	0.97
SCG	bill_period28	-0.22	0.10	-2.24	0.03
SCG	bill_period29	-0.61	0.10	-5.81	0.00
SCG	bill_period30	-0.68	0.13	-5.24	0.00
SCG	bill_period31	-0.79	0.13	-6.04	0.00
SCG	bill_period32	-0.92	0.12	-7.97	0.00
SCG	bill_period33	-0.85	0.12	-6.79	0.00
SCG	bill_period34	-0.90	0.14	-6.25	0.00
SCG	bill_period35	-0.82	0.16	-5.21	0.00
SCG	bill_period36	-0.67	0.12	-5.58	0.00
SCG	bill_period37	-0.17	0.07	-2.30	0.02
SCG	bill_period38	0	0	0	0

Table 39: Parameter Estimates from Fixed Effects Model for SDG&E Basic 2011 Participants (Electric)

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	post	0.89	0.47	1.88	0.06
SDG&E	cdd	0.83	0.24	3.44	0.00
SDG&E	hdd	0.33	0.12	2.81	0.01
SDG&E	cdd_post	-0.14	0.23	-0.60	0.55
SDG&E	hdd_post	-0.12	0.08	-1.39	0.17
SDG&E	cdd_treat	-0.17	0.27	-0.61	0.54

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	hdd_treat	0.16	0.40	0.40	0.69
SDG&E	post_treat	-0.06	1.00	-0.06	0.95
SDG&E	hdd_post_treat	-0.41	0.40	-1.03	0.30
SDG&E	cdd_post_treat	-1.02	0.83	-1.23	0.22
SDG&E	bill_period1	0.94	0.93	1.01	0.31
SDG&E	bill_period2	0.74	1.44	0.51	0.61
SDG&E	bill_period3	1.07	1.15	0.93	0.35
SDG&E	bill_period4	-1.00	0.95	-1.06	0.29
SDG&E	bill_period5	-0.67	0.90	-0.75	0.45
SDG&E	bill_period6	-1.20	0.87	-1.38	0.17
SDG&E	bill_period7	-0.83	0.91	-0.91	0.36
SDG&E	bill_period8	-0.43	0.97	-0.45	0.66
SDG&E	bill_period9	-0.31	0.89	-0.35	0.73
SDG&E	bill_period10	0.59	0.91	0.65	0.52
SDG&E	bill_period11	1.21	0.93	1.31	0.19
SDG&E	bill_period12	0.86	0.88	0.97	0.33
SDG&E	bill_period13	0.82	1.06	0.77	0.44
SDG&E	bill_period14	1.57	0.76	2.08	0.04
SDG&E	bill_period15	1.99	0.77	2.60	0.01
SDG&E	bill_period16	0.01	0.75	0.02	0.99
SDG&E	bill_period17	-0.47	0.73	-0.65	0.52
SDG&E	bill_period18	-0.74	0.71	-1.04	0.30
SDG&E	bill_period19	-0.28	0.94	-0.30	0.76
SDG&E	bill_period20	-0.70	0.80	-0.88	0.38
SDG&E	bill_period21	0.64	0.84	0.77	0.44
SDG&E	bill_period22	1.47	0.91	1.62	0.11
SDG&E	bill_period23	1.22	0.92	1.33	0.18
SDG&E	bill_period24	-0.29	0.77	-0.38	0.70
SDG&E	bill_period25	1.06	1.36	0.78	0.44
SDG&E	bill_period26	1.39	0.55	2.53	0.01
SDG&E	bill_period27	1.54	0.56	2.77	0.01
SDG&E	bill_period28	0.00	0.56	0.00	1.00
SDG&E	bill_period29	-0.35	0.54	-0.64	0.52
SDG&E	bill_period30	-0.86	0.60	-1.44	0.15
SDG&E	bill_period31	-0.61	1.01	-0.61	0.54
SDG&E	bill_period32	-1.30	0.80	-1.63	0.11
SDG&E	bill_period33	0.77	1.81	0.42	0.67
SDG&E	bill_period34	0.34	1.14	0.30	0.77
SDG&E	bill_period35	1.22	1.34	0.91	0.37
SDG&E	bill_period36	0.56	1.07	0.52	0.60

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	bill_period37	-0.38	0.92	-0.42	0.68
SDG&E	bill_period38	-0.40	1.38	-0.29	0.77
SDG&E	bill_period39	0.00	0.00	0.00	0.00

Table 40: Parameter Estimates from Fixed Effects Model for SDG&E Basic 2012 Participants (Electric)

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	post	-0.12	0.86	-0.14	0.89
SDG&E	cdd	0.96	0.24	3.97	0.00
SDG&E	hdd	0.05	0.13	0.37	0.71
SDG&E	cdd_post	0.18	0.23	0.79	0.43
SDG&E	hdd_post	0.10	0.16	0.61	0.54
SDG&E	cdd_treat	-0.10	0.25	-0.41	0.68
SDG&E	hdd_treat	0.15	0.11	1.44	0.15
SDG&E	post_treat	-0.02	0.76	-0.02	0.98
SDG&E	hdd_post_treat	-0.16	0.14	-1.09	0.28
SDG&E	cdd_post_treat	-0.26	0.25	-1.04	0.30
SDG&E	bill_period1	-1.69	3.03	-0.56	0.58
SDG&E	bill_period2	-0.07	1.53	-0.05	0.96
SDG&E	bill_period3	-2.46	1.35	-1.83	0.07
SDG&E	bill_period4	-2.01	1.13	-1.78	0.08
SDG&E	bill_period5	-1.58	1.07	-1.47	0.14
SDG&E	bill_period6	-2.04	1.03	-1.97	0.05
SDG&E	bill_period7	-0.62	1.13	-0.55	0.58
SDG&E	bill_period8	-0.22	1.12	-0.20	0.84
SDG&E	bill_period9	-0.59	1.09	-0.54	0.59
SDG&E	bill_period10	-1.41	0.97	-1.45	0.15
SDG&E	bill_period11	0.10	1.36	0.08	0.94
SDG&E	bill_period12	0.59	1.07	0.56	0.58
SDG&E	bill_period13	0.61	1.05	0.58	0.56
SDG&E	bill_period14	-0.83	1.01	-0.82	0.41
SDG&E	bill_period15	-1.38	0.99	-1.39	0.17
SDG&E	bill_period16	-2.00	0.94	-2.13	0.03
SDG&E	bill_period17	-1.84	1.01	-1.83	0.07
SDG&E	bill_period18	-2.52	0.90	-2.80	0.01
SDG&E	bill_period19	-1.15	1.32	-0.88	0.38
SDG&E	bill_period20	-1.52	1.09	-1.40	0.16
SDG&E	bill_period21	0.16	1.03	0.16	0.88
SDG&E	bill_period22	0.04	0.92	0.04	0.97
SDG&E	bill_period23	-1.31	0.83	-1.58	0.12

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	bill_period24	-0.45	0.84	-0.54	0.59
SDG&E	bill_period25	1.93	1.14	1.69	0.09
SDG&E	bill_period26	-0.68	0.82	-0.84	0.40
SDG&E	bill_period27	-1.91	0.79	-2.41	0.02
SDG&E	bill_period28	-2.33	0.80	-2.89	0.00
SDG&E	bill_period29	-1.53	1.15	-1.32	0.19
SDG&E	bill_period30	-2.18	0.83	-2.62	0.01
SDG&E	bill_period31	-2.05	0.93	-2.20	0.03
SDG&E	bill_period32	-2.03	0.88	-2.31	0.02
SDG&E	bill_period33	0.36	1.17	0.31	0.76
SDG&E	bill_period34	-2.13	1.02	-2.09	0.04
SDG&E	bill_period35	-2.20	0.79	-2.80	0.01
SDG&E	bill_period36	-0.94	0.71	-1.34	0.18
SDG&E	bill_period37	0.00	0.00	0.00	0.00

Table 41: Parameter Estimates from Fixed Effects Model for SDG&E Basic 2011 Participants (Gas)

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	post	-0.03	0.05	-0.58	0.56
SDG&E	hdd	0.03	0.01	2.11	0.04
SDG&E	hdd_post	0.03	0.01	3.50	0.00
SDG&E	hdd_treat	0.02	0.03	0.65	0.51
SDG&E	post_treat	-0.04	0.04	-1.09	0.28
SDG&E	hdd_post_treat	-0.05	0.01	-3.74	0.00
SDG&E	bill_period1	-0.43	0.17	-2.57	0.01
SDG&E	bill_period2	0.55	0.20	2.76	0.01
SDG&E	bill_period3	0.56	0.18	3.18	0.00
SDG&E	bill_period4	0.42	0.17	2.47	0.01
SDG&E	bill_period5	0.16	0.16	1.01	0.31
SDG&E	bill_period6	-0.24	0.16	-1.52	0.13
SDG&E	bill_period7	-0.40	0.17	-2.40	0.02
SDG&E	bill_period8	-0.57	0.18	-3.22	0.00
SDG&E	bill_period9	-0.65	0.18	-3.59	0.00
SDG&E	bill_period10	-0.71	0.18	-3.93	0.00
SDG&E	bill_period11	-0.72	0.18	-4.03	0.00
SDG&E	bill_period12	-0.62	0.18	-3.51	0.00
SDG&E	bill_period13	-0.38	0.17	-2.25	0.02
SDG&E	bill_period14	0.33	0.14	2.34	0.02
SDG&E	bill_period15	0.57	0.14	4.10	0.00
SDG&E	bill_period16	0.40	0.15	2.75	0.01

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	bill_period17	0.32	0.14	2.30	0.02
SDG&E	bill_period18	-0.09	0.16	-0.57	0.57
SDG&E	bill_period19	-0.41	0.16	-2.47	0.01
SDG&E	bill_period20	-0.48	0.17	-2.80	0.01
SDG&E	bill_period21	-0.65	0.17	-3.79	0.00
SDG&E	bill_period22	-0.70	0.17	-4.02	0.00
SDG&E	bill_period23	-0.74	0.17	-4.25	0.00
SDG&E	bill_period24	-0.65	0.17	-3.77	0.00
SDG&E	bill_period25	-0.32	0.15	-2.10	0.04
SDG&E	bill_period26	0.26	0.11	2.30	0.02
SDG&E	bill_period27	0.44	0.11	3.90	0.00
SDG&E	bill_period28	0.25	0.12	2.14	0.03
SDG&E	bill_period29	0.11	0.12	0.93	0.35
SDG&E	bill_period30	-0.09	0.13	-0.72	0.47
SDG&E	bill_period31	-0.39	0.16	-2.38	0.02
SDG&E	bill_period32	-0.54	0.17	-3.12	0.00
SDG&E	bill_period33	-0.64	0.18	-3.63	0.00
SDG&E	bill_period34	-0.72	0.18	-4.11	0.00
SDG&E	bill_period35	-0.71	0.18	-4.00	0.00
SDG&E	bill_period36	-0.69	0.18	-3.79	0.00
SDG&E	bill_period37	-0.48	0.18	-2.70	0.01
SDG&E	bill_period38	-0.15	0.24	-0.62	0.54
SDG&E	bill_period39	0.00	0.00	0.00	0.00

Table 42: Parameter Estimates from Fixed Effects Model for SDG&E Basic 2012 Participants (Gas)

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	post	-0.02	0.06	-0.37	0.71
SDG&E	hdd	0.08	0.02	3.77	0.00
SDG&E	hdd_post	0.02	0.01	1.78	0.08
SDG&E	hdd_treat	-0.03	0.02	-1.46	0.15
SDG&E	post_treat	0.01	0.03	0.22	0.83
SDG&E	hdd_post_treat	-0.02	0.01	-1.67	0.10
SDG&E	bill_period1	-0.25	0.16	-1.61	0.11
SDG&E	bill_period2	-0.41	0.15	-2.75	0.01
SDG&E	bill_period3	-0.41	0.15	-2.72	0.01
SDG&E	bill_period4	0.17	0.39	0.44	0.66
SDG&E	bill_period5	0.49	0.19	2.52	0.01
SDG&E	bill_period6	0.29	0.23	1.25	0.21
SDG&E	bill_period7	-0.15	0.23	-0.66	0.51

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	bill_period8	-0.59	0.15	-3.88	0.00
SDG&E	bill_period9	-0.64	0.15	-4.15	0.00
SDG&E	bill_period10	-0.79	0.16	-4.96	0.00
SDG&E	bill_period11	-0.82	0.16	-5.21	0.00
SDG&E	bill_period12	-0.83	0.15	-5.44	0.00
SDG&E	bill_period13	-0.78	0.15	-5.25	0.00
SDG&E	bill_period14	-0.47	0.14	-3.38	0.00
SDG&E	bill_period15	0.10	0.15	0.66	0.51
SDG&E	bill_period16	0.27	0.15	1.83	0.07
SDG&E	bill_period17	0.09	0.14	0.65	0.52
SDG&E	bill_period18	-0.04	0.14	-0.31	0.76
SDG&E	bill_period19	-0.25	0.14	-1.81	0.07
SDG&E	bill_period20	-0.53	0.14	-3.76	0.00
SDG&E	bill_period21	-0.68	0.14	-4.80	0.00
SDG&E	bill_period22	-0.79	0.14	-5.63	0.00
SDG&E	bill_period23	-0.85	0.14	-6.04	0.00
SDG&E	bill_period24	-0.87	0.14	-6.16	0.00
SDG&E	bill_period25	-0.83	0.14	-5.94	0.00
SDG&E	bill_period26	-0.69	0.13	-5.10	0.00
SDG&E	bill_period27	-0.36	0.13	-2.87	0.00
SDG&E	bill_period28	0.32	0.14	2.22	0.03
SDG&E	bill_period29	0.08	0.13	0.58	0.56
SDG&E	bill_period30	-0.15	0.13	-1.20	0.23
SDG&E	bill_period31	-0.47	0.13	-3.60	0.00
SDG&E	bill_period32	-0.61	0.14	-4.49	0.00
SDG&E	bill_period33	-0.74	0.14	-5.33	0.00
SDG&E	bill_period34	-0.80	0.14	-5.78	0.00
SDG&E	bill_period35	-0.84	0.14	-6.06	0.00
SDG&E	bill_period36	-0.88	0.14	-6.29	0.00
SDG&E	bill_period37	-0.84	0.14	-5.99	0.00
SDG&E	bill_period38	-0.65	0.13	-4.92	0.00
SDG&E	bill_period39	-0.33	0.11	-3.06	0.00
SDG&E	bill_period40	0.00	0.00	0.00	0.00

Table 43: Parameter Estimates from Fixed Effects Model for SDG&E Advanced Path 2011 Participants (Electric)

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	post	0.44	0.47	0.96	0.34
SDG&E	cdd	0.86	0.22	3.88	0.00
SDG&E	hdd	0.33	0.11	3.14	0.00

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	cdd_post	-0.19	0.22	-0.86	0.39
SDG&E	hdd_post	-0.10	0.08	-1.20	0.23
SDG&E	cdd_treat	-0.10	0.24	-0.41	0.68
SDG&E	hdd_treat	0.13	0.09	1.42	0.16
SDG&E	post_treat	-0.57	0.75	-0.76	0.45
SDG&E	hdd_post_treat	-0.21	0.12	-1.67	0.09
SDG&E	cdd_post_treat	0.30	0.26	1.16	0.25
SDG&E	bill_period1	0.11	1.29	0.09	0.93
SDG&E	bill_period2	-0.08	1.68	-0.05	0.96
SDG&E	bill_period3	0.31	1.41	0.22	0.83
SDG&E	bill_period4	-1.41	1.26	-1.12	0.26
SDG&E	bill_period5	-1.29	1.21	-1.07	0.29
SDG&E	bill_period6	-1.96	1.22	-1.60	0.11
SDG&E	bill_period7	-1.72	1.25	-1.37	0.17
SDG&E	bill_period8	-1.24	1.29	-0.96	0.34
SDG&E	bill_period9	-0.92	1.23	-0.75	0.46
SDG&E	bill_period10	-0.44	1.21	-0.36	0.72
SDG&E	bill_period11	0.57	1.23	0.47	0.64
SDG&E	bill_period12	0.09	1.21	0.08	0.94
SDG&E	bill_period13	0.09	1.35	0.07	0.95
SDG&E	bill_period14	0.77	1.14	0.67	0.50
SDG&E	bill_period15	1.34	1.14	1.17	0.24
SDG&E	bill_period16	-0.60	1.14	-0.52	0.60
SDG&E	bill_period17	-1.18	1.13	-1.04	0.30
SDG&E	bill_period18	-1.27	1.14	-1.11	0.27
SDG&E	bill_period19	-0.76	1.30	-0.58	0.56
SDG&E	bill_period20	-1.08	1.21	-0.89	0.37
SDG&E	bill_period21	0.08	1.24	0.07	0.95
SDG&E	bill_period22	0.80	1.25	0.64	0.53
SDG&E	bill_period23	0.71	1.27	0.56	0.57
SDG&E	bill_period24	-0.57	1.21	-0.48	0.63
SDG&E	bill_period25	0.75	1.59	0.47	0.64
SDG&E	bill_period26	0.88	1.06	0.83	0.41
SDG&E	bill_period27	1.10	1.06	1.04	0.30
SDG&E	bill_period28	-0.29	1.07	-0.27	0.79
SDG&E	bill_period29	-0.40	1.08	-0.37	0.71
SDG&E	bill_period30	-1.16	1.09	-1.06	0.29
SDG&E	bill_period31	-0.43	1.37	-0.31	0.75
SDG&E	bill_period32	-1.39	1.21	-1.15	0.25
SDG&E	bill_period33	0.61	1.87	0.33	0.74

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	bill_period34	0.01	1.33	0.01	1.00
SDG&E	bill_period35	2.45	1.59	1.54	0.12
SDG&E	bill_period36	0.88	1.24	0.71	0.48
SDG&E	bill_period37	-0.01	1.16	-0.01	0.99
SDG&E	bill_period38	0.66	0.94	0.70	0.48
SDG&E	bill_period39	0.00	0.00	0.00	0.00

Table 44: Parameter Estimates from Fixed Effects Model for SDG&E Advanced Path 2012 Participants (Electric)

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	post	-1.05	0.80	-1.31	0.19
SDG&E	cdd	0.79	0.24	3.25	0.00
SDG&E	hdd	0.04	0.13	0.29	0.77
SDG&E	cdd_post	0.37	0.24	1.55	0.12
SDG&E	hdd_post	0.24	0.15	1.59	0.11
SDG&E	cdd_treat	0.07	0.35	0.19	0.85
SDG&E	hdd_treat	0.09	0.11	0.82	0.41
SDG&E	post_treat	0.97	1.06	0.92	0.36
SDG&E	hdd_post_treat	-0.26	0.15	-1.71	0.09
SDG&E	cdd_post_treat	-0.56	0.32	-1.73	0.09
SDG&E	bill_period1	9.44	2.48	3.81	0.00
SDG&E	bill_period2	5.82	1.50	3.88	0.00
SDG&E	bill_period3	4.29	1.46	2.95	0.00
SDG&E	bill_period4	4.01	1.36	2.96	0.00
SDG&E	bill_period5	3.55	1.26	2.81	0.01
SDG&E	bill_period6	3.48	1.31	2.66	0.01
SDG&E	bill_period7	2.86	1.23	2.33	0.02
SDG&E	bill_period8	4.85	1.36	3.57	0.00
SDG&E	bill_period9	5.63	1.50	3.76	0.00
SDG&E	bill_period10	5.43	1.49	3.64	0.00
SDG&E	bill_period11	3.66	1.31	2.80	0.01
SDG&E	bill_period12	4.09	1.17	3.51	0.00
SDG&E	bill_period13	5.35	1.14	4.71	0.00
SDG&E	bill_period14	5.81	1.14	5.08	0.00
SDG&E	bill_period15	4.51	1.03	4.37	0.00
SDG&E	bill_period16	4.10	0.94	4.34	0.00
SDG&E	bill_period17	3.47	1.00	3.47	0.00
SDG&E	bill_period18	3.16	1.06	2.97	0.00
SDG&E	bill_period19	3.09	1.09	2.82	0.01
SDG&E	bill_period20	3.88	1.15	3.38	0.00

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	bill_period21	5.34	1.41	3.78	0.00
SDG&E	bill_period22	8.57	1.86	4.61	0.00
SDG&E	bill_period23	6.61	1.31	5.04	0.00
SDG&E	bill_period24	5.59	1.45	3.85	0.00
SDG&E	bill_period25	5.08	0.87	5.86	0.00
SDG&E	bill_period26	5.93	0.74	8.02	0.00
SDG&E	bill_period27	4.09	0.63	6.53	0.00
SDG&E	bill_period28	3.04	0.65	4.68	0.00
SDG&E	bill_period29	2.93	0.81	3.61	0.00
SDG&E	bill_period30	3.80	1.13	3.36	0.00
SDG&E	bill_period31	3.83	0.99	3.86	0.00
SDG&E	bill_period32	3.92	1.13	3.45	0.00
SDG&E	bill_period33	3.65	1.08	3.38	0.00
SDG&E	bill_period34	4.90	1.64	2.98	0.00
SDG&E	bill_period35	4.10	1.28	3.20	0.00
SDG&E	bill_period36	1.87	1.60	1.17	0.24
SDG&E	bill_period37	0.17	1.98	0.09	0.93
SDG&E	bill_period38	0.00	0.00	0.00	0.00

Table 45: Parameter Estimates from Fixed Effects Model for SDG&E Advanced Path 2011 Participants (Gas)

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	post	-0.04	0.05	-0.95	0.34
SDG&E	hdd	0.03	0.01	2.44	0.02
SDG&E	hdd_post	0.03	0.01	4.12	0.00
SDG&E	hdd_treat	0.02	0.02	1.02	0.31
SDG&E	post_treat	-0.11	0.03	-3.72	0.00
SDG&E	hdd_post_treat	-0.03	0.01	-3.36	0.00
SDG&E	bill_period1	-0.21	0.23	-0.90	0.37
SDG&E	bill_period2	0.77	0.25	3.06	0.00
SDG&E	bill_period3	0.76	0.23	3.25	0.00
SDG&E	bill_period4	0.67	0.26	2.63	0.01
SDG&E	bill_period5	0.41	0.23	1.78	0.08
SDG&E	bill_period6	-0.02	0.22	-0.09	0.93
SDG&E	bill_period7	-0.16	0.23	-0.69	0.49
SDG&E	bill_period8	-0.33	0.24	-1.39	0.16
SDG&E	bill_period9	-0.40	0.24	-1.69	0.09
SDG&E	bill_period10	-0.47	0.24	-1.98	0.05
SDG&E	bill_period11	-0.49	0.24	-2.07	0.04
SDG&E	bill_period12	-0.39	0.24	-1.65	0.10

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	bill_period13	-0.16	0.23	-0.68	0.50
SDG&E	bill_period14	0.55	0.21	2.59	0.01
SDG&E	bill_period15	0.79	0.21	3.77	0.00
SDG&E	bill_period16	0.59	0.21	2.79	0.01
SDG&E	bill_period17	0.52	0.21	2.49	0.01
SDG&E	bill_period18	0.13	0.22	0.59	0.56
SDG&E	bill_period19	-0.18	0.23	-0.79	0.43
SDG&E	bill_period20	-0.25	0.23	-1.06	0.29
SDG&E	bill_period21	-0.40	0.24	-1.70	0.09
SDG&E	bill_period22	-0.44	0.24	-1.83	0.07
SDG&E	bill_period23	-0.47	0.24	-1.98	0.05
SDG&E	bill_period24	-0.38	0.24	-1.58	0.12
SDG&E	bill_period25	-0.09	0.23	-0.41	0.68
SDG&E	bill_period26	0.45	0.20	2.26	0.02
SDG&E	bill_period27	0.63	0.20	3.16	0.00
SDG&E	bill_period28	0.47	0.20	2.31	0.02
SDG&E	bill_period29	0.31	0.20	1.54	0.12
SDG&E	bill_period30	0.12	0.21	0.56	0.57
SDG&E	bill_period31	-0.14	0.24	-0.60	0.55
SDG&E	bill_period32	-0.29	0.24	-1.20	0.23
SDG&E	bill_period33	-0.38	0.25	-1.54	0.12
SDG&E	bill_period34	-0.47	0.25	-1.91	0.06
SDG&E	bill_period35	-0.45	0.25	-1.80	0.07
SDG&E	bill_period36	-0.42	0.25	-1.68	0.09
SDG&E	bill_period37	-0.23	0.24	-0.98	0.33
SDG&E	bill_period38	-0.03	0.20	-0.16	0.87
SDG&E	bill_period39	0.00	0.00	0.00	0.00

Table 46: Parameter Estimates from Fixed Effects Model for SDG&E Advanced Path 2012 Participants (Gas)

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	post	-0.12	0.07	-1.81	0.07
SDG&E	hdd	0.08	0.03	3.12	0.00
SDG&E	hdd_post	0.05	0.02	2.87	0.00
SDG&E	hdd_treat	-0.01	0.02	-0.22	0.82
SDG&E	post_treat	-0.11	0.04	-2.83	0.01
SDG&E	hdd_post_treat	-0.03	0.02	-1.59	0.11
SDG&E	bill_period1	0.51	0.15	3.34	0.00
SDG&E	bill_period2	0.35	0.14	2.61	0.01
SDG&E	bill_period3	1.11	0.28	3.98	0.00

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SDG&E	bill_period4	1.24	0.27	4.64	0.00
SDG&E	bill_period5	0.98	0.23	4.31	0.00
SDG&E	bill_period6	0.84	0.20	4.20	0.00
SDG&E	bill_period7	0.35	0.15	2.41	0.02
SDG&E	bill_period8	0.11	0.15	0.74	0.46
SDG&E	bill_period9	0.08	0.16	0.52	0.60
SDG&E	bill_period10	-0.09	0.16	-0.52	0.60
SDG&E	bill_period11	-0.12	0.16	-0.72	0.47
SDG&E	bill_period12	-0.11	0.16	-0.68	0.50
SDG&E	bill_period13	-0.05	0.15	-0.31	0.76
SDG&E	bill_period14	0.27	0.13	2.04	0.04
SDG&E	bill_period15	0.81	0.16	5.18	0.00
SDG&E	bill_period16	1.05	0.15	6.84	0.00
SDG&E	bill_period17	0.90	0.14	6.24	0.00
SDG&E	bill_period18	0.72	0.13	5.46	0.00
SDG&E	bill_period19	0.47	0.12	4.07	0.00
SDG&E	bill_period20	0.25	0.14	1.83	0.07
SDG&E	bill_period21	0.11	0.14	0.80	0.43
SDG&E	bill_period22	0.05	0.15	0.31	0.75
SDG&E	bill_period23	0.03	0.15	0.19	0.85
SDG&E	bill_period24	-0.05	0.14	-0.36	0.72
SDG&E	bill_period25	0.02	0.15	0.15	0.88
SDG&E	bill_period26	0.18	0.15	1.26	0.21
SDG&E	bill_period27	0.40	0.12	3.32	0.00
SDG&E	bill_period28	0.87	0.08	10.29	0.00
SDG&E	bill_period29	0.69	0.06	11.57	0.00
SDG&E	bill_period30	0.47	0.06	7.37	0.00
SDG&E	bill_period31	0.33	0.12	2.75	0.01
SDG&E	bill_period32	0.26	0.14	1.88	0.06
SDG&E	bill_period33	0.10	0.15	0.69	0.49
SDG&E	bill_period34	0.10	0.15	0.68	0.50
SDG&E	bill_period35	0.07	0.15	0.45	0.65
SDG&E	bill_period36	0.03	0.15	0.20	0.84
SDG&E	bill_period37	0.06	0.15	0.40	0.69
SDG&E	bill_period38	0.07	0.16	0.42	0.67
SDG&E	bill_period39	0.14	0.18	0.81	0.42
SDG&E	bill_period40	0.00	0.00	0.00	0.00

Table 47: Parameter Estimates from Fixed Effects Model for SCE Basic Path 2011 Participants

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SCE	post	0.67	0.43	1.55	0.12
SCE	cdd	1.64	0.21	7.65	0.00
SCE	hdd	0.28	0.10	2.82	0.00
SCE	cdd_post	0.23	0.20	1.13	0.26
SCE	hdd_post	0.01	0.06	0.19	0.85
SCE	cdd_treat	0.05	0.33	0.16	0.88
SCE	hdd_treat	-0.15	0.12	-1.20	0.23
SCE	post_treat	-1.68	0.53	-3.16	0.00
SCE	hdd_post_treat	0.03	0.10	0.29	0.77
SCE	cdd_post_treat	-0.22	0.23	-0.95	0.34
SCE	bill_period1	16.91	1.34	12.64	0.00
SCE	bill_period2	11.10	1.63	6.82	0.00
SCE	bill_period3	10.23	1.15	8.88	0.00
SCE	bill_period4	9.67	2.77	3.49	0.00
SCE	bill_period5	8.51	1.42	6.00	0.00
SCE	bill_period6	8.99	1.23	7.34	0.00
SCE	bill_period7	7.63	1.21	6.28	0.00
SCE	bill_period8	6.47	1.12	5.77	0.00
SCE	bill_period9	5.80	1.09	5.34	0.00
SCE	bill_period10	6.00	1.08	5.58	0.00
SCE	bill_period11	7.18	1.06	6.76	0.00
SCE	bill_period12	8.74	1.08	8.12	0.00
SCE	bill_period13	8.97	1.14	7.85	0.00
SCE	bill_period14	8.12	1.21	6.73	0.00
SCE	bill_period15	6.28	1.11	5.63	0.00
SCE	bill_period16	6.51	1.01	6.45	0.00
SCE	bill_period17	8.74	1.10	7.92	0.00
SCE	bill_period18	9.06	1.19	7.59	0.00
SCE	bill_period19	6.66	1.09	6.09	0.00
SCE	bill_period20	6.51	1.12	5.80	0.00
SCE	bill_period21	5.74	1.00	5.77	0.00
SCE	bill_period22	5.22	0.95	5.47	0.00
SCE	bill_period23	6.11	0.95	6.41	0.00
SCE	bill_period24	8.64	1.06	8.14	0.00
SCE	bill_period25	9.38	1.10	8.53	0.00
SCE	bill_period26	8.88	1.22	7.26	0.00
SCE	bill_period27	7.03	0.99	7.10	0.00
SCE	bill_period28	6.64	0.98	6.77	0.00

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SCE	bill_period29	8.20	1.14	7.17	0.00
SCE	bill_period30	8.27	1.08	7.66	0.00
SCE	bill_period31	6.57	1.04	6.29	0.00
SCE	bill_period32	5.78	1.05	5.49	0.00
SCE	bill_period33	5.35	0.98	5.48	0.00
SCE	bill_period34	6.01	0.92	6.56	0.00
SCE	bill_period35	7.22	0.94	7.72	0.00
SCE	bill_period36	8.24	0.98	8.38	0.00
SCE	bill_period37	9.16	1.61	5.68	0.00
SCE	bill_period38	9.59	2.35	4.08	0.00
SCE	bill_period39	6.77	1.60	4.23	0.00
SCE	bill_period40	5.31	0.92	5.76	0.00
SCE	bill_period41	6.65	1.02	6.52	0.00
SCE	bill_period42	8.84	2.60	3.40	0.00
SCE	bill_period43	4.35	2.03	2.14	0.03
SCE	bill_period44	4.63	3.14	1.47	0.14
SCE	bill_period45	2.82	2.29	1.23	0.22
SCE	bill_period46	1.42	2.14	0.66	0.51
SCE	bill_period47	5.19	2.01	2.58	0.01
SCE	bill_period48	3.97	2.18	1.82	0.07
SCE	bill_period49	3.82	1.27	3.01	0.00
SCE	bill_period50	-0.33	3.31	-0.10	0.92
SCE	bill_period51	-2.15	0.81	-2.65	0.01
SCE	bill_period52	0.00	0.00	0.00	0.00

Table 48: Parameter Estimates from Fixed Effects Model for SCE Basic Path 2012 Participants

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SCE	post	-0.04	0.39	-0.11	0.91
SCE	cdd	2.67	0.19	13.84	0.00
SCE	hdd	-0.04	0.11	-0.36	0.72
SCE	cdd_post	-0.50	0.15	-3.28	0.00
SCE	hdd_post	0.11	0.08	1.27	0.21
SCE	cdd_treat	-1.03	0.19	-5.57	0.00
SCE	hdd_treat	0.16	0.10	1.63	0.10
SCE	post_treat	-1.01	0.43	-2.35	0.02
SCE	hdd_post_treat	-0.06	0.09	-0.63	0.53
SCE	cdd_post_treat	0.34	0.17	2.06	0.04
SCE	bill_period1	3.42	0.85	4.04	0.00
SCE	bill_period2	1.11	0.83	1.34	0.18

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SCE	bill_period3	3.45	0.84	4.09	0.00
SCE	bill_period4	1.42	0.81	1.75	0.08
SCE	bill_period5	5.17	1.24	4.16	0.00
SCE	bill_period6	5.26	1.18	4.44	0.00
SCE	bill_period7	2.84	1.00	2.84	0.00
SCE	bill_period8	2.72	1.00	2.71	0.01
SCE	bill_period9	1.10	0.86	1.28	0.20
SCE	bill_period10	-0.09	0.81	-0.12	0.91
SCE	bill_period11	0.75	0.81	0.93	0.35
SCE	bill_period12	2.74	0.84	3.25	0.00
SCE	bill_period13	3.29	0.85	3.86	0.00
SCE	bill_period14	2.82	0.92	3.07	0.00
SCE	bill_period15	1.61	0.79	2.04	0.04
SCE	bill_period16	1.75	0.80	2.20	0.03
SCE	bill_period17	3.93	0.94	4.17	0.00
SCE	bill_period18	4.28	0.90	4.75	0.00
SCE	bill_period19	2.31	0.87	2.66	0.01
SCE	bill_period20	1.69	0.87	1.93	0.05
SCE	bill_period21	1.17	0.82	1.42	0.16
SCE	bill_period22	1.01	0.76	1.33	0.19
SCE	bill_period23	2.11	0.77	2.74	0.01
SCE	bill_period24	2.72	0.76	3.58	0.00
SCE	bill_period25	3.06	0.99	3.08	0.00
SCE	bill_period26	1.62	1.27	1.27	0.20
SCE	bill_period27	0.41	0.92	0.45	0.65
SCE	bill_period28	0.73	0.74	0.99	0.32
SCE	bill_period29	2.59	0.77	3.36	0.00
SCE	bill_period30	4.60	1.10	4.17	0.00
SCE	bill_period31	2.36	0.89	2.67	0.01
SCE	bill_period32	0.92	0.78	1.17	0.24
SCE	bill_period33	0.12	0.74	0.16	0.88
SCE	bill_period34	-0.67	0.73	-0.91	0.36
SCE	bill_period35	1.02	0.75	1.36	0.17
SCE	bill_period36	0.48	0.97	0.49	0.62
SCE	bill_period37	2.11	0.92	2.28	0.02
SCE	bill_period38	-0.31	1.35	-0.23	0.82
SCE	bill_period39	-0.34	0.90	-0.38	0.71
SCE	bill_period40	0.00	0.00	0.00	0.00

Table 49: Parameter Estimates from Fixed Effects Model for SCE Advanced Path 2011 Participants

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SCE	post	0.18	0.43	0.42	0.67
SCE	cdd	1.69	0.22	7.83	0.00
SCE	hdd	0.27	0.10	2.72	0.01
SCE	cdd_post	0.25	0.20	1.23	0.22
SCE	hdd_post	0.06	0.06	0.99	0.32
SCE	cdd_treat	0.52	0.23	2.25	0.02
SCE	hdd_treat	0.03	0.09	0.31	0.76
SCE	post_treat	-0.97	0.45	-2.17	0.03
SCE	hdd_post_treat	-0.04	0.07	-0.53	0.60
SCE	cdd_post_treat	-0.55	0.21	-2.67	0.01
SCE	bill_period1	9.37	6.31	1.49	0.14
SCE	bill_period2	3.49	6.38	0.55	0.58
SCE	bill_period3	2.77	6.27	0.44	0.66
SCE	bill_period4	2.21	6.65	0.33	0.74
SCE	bill_period5	1.37	6.30	0.22	0.83
SCE	bill_period6	1.82	6.26	0.29	0.77
SCE	bill_period7	0.45	6.26	0.07	0.94
SCE	bill_period8	-0.75	6.25	-0.12	0.90
SCE	bill_period9	-1.43	6.26	-0.23	0.82
SCE	bill_period10	-1.24	6.26	-0.20	0.84
SCE	bill_period11	-0.13	6.26	-0.02	0.98
SCE	bill_period12	1.37	6.27	0.22	0.83
SCE	bill_period13	1.45	6.27	0.23	0.82
SCE	bill_period14	0.37	6.28	0.06	0.95
SCE	bill_period15	-1.23	6.27	-0.20	0.84
SCE	bill_period16	-0.71	6.25	-0.11	0.91
SCE	bill_period17	1.48	6.24	0.24	0.81
SCE	bill_period18	1.69	6.24	0.27	0.79
SCE	bill_period19	-0.20	6.24	-0.03	0.97
SCE	bill_period20	-0.46	6.24	-0.07	0.94
SCE	bill_period21	-1.22	6.27	-0.20	0.85
SCE	bill_period22	-1.55	6.29	-0.25	0.81
SCE	bill_period23	-0.46	6.30	-0.07	0.94
SCE	bill_period24	1.89	6.34	0.30	0.77
SCE	bill_period25	2.33	6.36	0.37	0.71
SCE	bill_period26	1.37	6.40	0.21	0.83
SCE	bill_period27	0.01	6.34	0.00	1.00
SCE	bill_period28	-0.16	6.30	-0.03	0.98

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SCE	bill_period29	1.06	6.27	0.17	0.87
SCE	bill_period30	1.25	6.27	0.20	0.84
SCE	bill_period31	-0.31	6.27	-0.05	0.96
SCE	bill_period32	-1.26	6.26	-0.20	0.84
SCE	bill_period33	-1.66	6.27	-0.26	0.79
SCE	bill_period34	-0.58	6.31	-0.09	0.93
SCE	bill_period35	0.99	6.33	0.16	0.88
SCE	bill_period36	2.03	6.34	0.32	0.75
SCE	bill_period37	1.74	6.43	0.27	0.79
SCE	bill_period38	-1.60	6.48	-0.25	0.80
SCE	bill_period39	-2.58	6.42	-0.40	0.69
SCE	bill_period40	-1.63	6.34	-0.26	0.80
SCE	bill_period41	-3.13	6.18	-0.51	0.61
SCE	bill_period42	0.00	0.00	0.00	0.00

Table 50: Parameter Estimates from Fixed Effects Model for SCE Advanced Path 2012 Participants

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SCE	post	1.14	0.49	2.32	0.02
SCE	cdd	2.51	0.20	12.39	0.00
SCE	hdd	0.17	0.13	1.29	0.20
SCE	cdd_post	-0.43	0.17	-2.59	0.01
SCE	hdd_post	0.12	0.10	1.16	0.24
SCE	cdd_treat	-0.37	0.20	-1.82	0.07
SCE	hdd_treat	0.09	0.10	0.93	0.35
SCE	post_treat	-0.56	0.41	-1.37	0.17
SCE	hdd_post_treat	-0.12	0.10	-1.26	0.21
SCE	cdd_post_treat	-0.15	0.18	-0.86	0.39
SCE	bill_period1	1.63	1.74	0.94	0.35
SCE	bill_period2	-0.58	1.74	-0.33	0.74
SCE	bill_period3	1.67	1.74	0.96	0.34
SCE	bill_period4	-0.31	1.75	-0.18	0.86
SCE	bill_period5	3.03	2.26	1.34	0.18
SCE	bill_period6	2.42	2.01	1.21	0.23
SCE	bill_period7	0.01	1.84	0.00	1.00
SCE	bill_period8	-0.30	1.84	-0.16	0.87
SCE	bill_period9	-1.83	1.76	-1.04	0.30
SCE	bill_period10	-2.48	1.73	-1.43	0.15
SCE	bill_period11	-1.16	1.73	-0.67	0.50
SCE	bill_period12	2.14	1.82	1.18	0.24

IOU	Parameters	Estimates	StdErr	t-stat	p-value
SCE	bill_period13	2.21	1.80	1.23	0.22
SCE	bill_period14	1.07	1.82	0.59	0.56
SCE	bill_period15	-0.92	1.72	-0.53	0.59
SCE	bill_period16	-1.44	1.70	-0.85	0.40
SCE	bill_period17	0.44	1.71	0.26	0.80
SCE	bill_period18	0.83	1.71	0.48	0.63
SCE	bill_period19	-1.37	1.71	-0.80	0.42
SCE	bill_period20	-2.09	1.71	-1.22	0.22
SCE	bill_period21	-2.30	1.69	-1.36	0.17
SCE	bill_period22	-1.54	1.69	-0.91	0.36
SCE	bill_period23	0.23	1.69	0.14	0.89
SCE	bill_period24	1.22	1.68	0.72	0.47
SCE	bill_period25	1.62	1.74	0.93	0.35
SCE	bill_period26	-0.69	1.85	-0.38	0.71
SCE	bill_period27	-2.74	1.74	-1.57	0.12
SCE	bill_period28	-2.83	1.65	-1.71	0.09
SCE	bill_period29	-1.35	1.64	-0.82	0.41
SCE	bill_period30	-0.79	1.78	-0.44	0.66
SCE	bill_period31	-2.87	1.67	-1.71	0.09
SCE	bill_period32	-3.60	1.64	-2.19	0.03
SCE	bill_period33	-3.82	1.66	-2.30	0.02
SCE	bill_period34	-4.01	1.67	-2.40	0.02
SCE	bill_period35	-2.62	1.67	-1.57	0.12
SCE	bill_period36	-2.79	1.75	-1.59	0.11
SCE	bill_period37	-1.56	1.71	-0.91	0.36
SCE	bill_period38	-3.49	1.85	-1.89	0.06
SCE	bill_period39	-3.77	1.74	-2.16	0.03
SCE	bill_period40	-3.40	1.79	-1.90	0.06
SCE	bill_period41	0.00	0.00	0.00	0.00

D. Additional Discussion on Whether EUC Program Savings Estimated with a Comparison Group of Future Participants are Gross or Net

The counterfactual for a set of participants is that exact set of participants without the program. (e.g., in a parallel universe.) All of the real world participants engaged in installation behavior. Most programs are designed to increase the efficiency of work that would occur without the program but at a lower efficiency. Under this scenario, in the counterfactual group, many or most would have still engaged in installation behavior, either at standard efficiency levels (one of the program target groups) or energy efficient levels (free-riders). Those who, in the counterfactual group, would not have taken part in installation behavior would be early adopters or induced installers. Each of these scenarios has its representative pre-post change in consumption: all other characteristics being equal, existing efficiency to program efficiency should cause the greatest decrease; existing-to-standard efficiency is expected to cause some reduction, while a site that does nothing (existing-to-existing) has no program-related effect.

Removing the pre-/post-installation effect of the counterfactual version of the participant group from the pre-/post-installation effect of the actual participant group would provide a true full net savings estimate. Free-riders would effectively show full "program" effects in both the participant and counterfactual group, producing no net savings. The primary targets of the program would be assigned savings that reflect the difference between standard and program efficiency (counterfactual reductions from the existing-to-standard efficiency measurement removed from the participant existing-to-program efficiency measurement).

A comparison group constructed from the general population would have few similarities with the theoretical counterfactual comparison group described above. Any kind of First, there would be very little installation behavior. Installation behavior would only occur at the natural rate in the population (in this case, the percent of population retrofitting homes in any given year). So, while in the counterfactual group a high percentage would likely engage in installation behavior, either at standard efficiency levels, in the constructed comparison group high percentage would not. In fact, of the small number of sites with installation activity that might be included in the constructed comparison group, we would expect an under-representation of free-rider behavior because of the selection into the program of those intending to install.

For these two reasons, the constructed comparison group will not include the appropriate percentages of sites exhibiting existing-to-standard or existing-to-program reductions in

consumption. In fact, the majority of the constructed comparison group will have no installation-related change during the period (existing-to-existing efficiency) and so will be indistinguishable from the counterfactual early adopters. At the best this constructed comparison group would give mostly gross results relative to the existing efficiency baseline.

We construct the comparison group of subsequent participants precisely because there is a high probability that they did not take part in installation behavior a year or two prior to participating in such a program. This makes them representative of natural, non-program change only.

To reiterate, participant pre-/post- includes program effects and non-program effects. Non-participants are our best estimate of non-program effects only.

E. Free-Ridership by Demographic Variables

We examined free-ridership scores by potential covariates to understand how free-ridership varied as a function of specific customer segments. While there are marginal differences, these were not statistically significant for the majority of the covariates examined below. Free-ridership was significantly higher for the customers with an education level of high school or less (60%) compared with those with an advanced degree or post-graduate work (43%). Free-ridership was significantly higher later in the program cycle, at 46% in program year (PY) 2012 versus 39% in PY 2011.

The covariates examined included several demographic variables and the demographic distribution of participants is of particular interest to understand program participation/adoption. We note that certain customer segments have disproportionately higher representation amongst program participants:

- Almost 60% of the participants in did not avail of project financing
- More than 70% of the participants are aged 45 years or older
- Almost 75% of the participants have a four-year college degree education or higher
- More than 50% the participants who provided income information stated that they had annual household incomes of over $100,000

This indicates that the majority of the participants in the program were highly educated, middle-aged, established customers with a level of affluence that does not necessitate availing of project financing. This is an important finding for the program as in order to achieve its adoption goals, it will require targeted marketing and messaging to reach other key customer segments. .

Table 51: Free-Ridership Scores by Household Characteristics

Group	N	Average Free-Ridership Score	Standard Error of Mean	95% Confidence Limit for Mean	
Project Financing					
Availed of project financing	215	43%	2%	39%	47%
Did not avail of project financing	312	45%	2%	41%	49%
No significant difference in free-ridership by project financing.					
Home Vintage					
Before 1970	347	43%	2%	40%	46%
In the 1970s	90	46%	3%	39%	52%
In the 1980s	56	51%	4%	43%	59%
In the 90s or after	33	48%	5%	37%	58%
No significant difference in free-ridership by home vintage.					
Number of bedrooms					
1-2	80	38%	3%	31%	45%
3-4	419	45%	2%	42%	48%
5 or more	28	54%	6%	41%	67%
No significant difference in free-ridership by number of bedrooms in the home.					
Difference in household size - Post - Pre retrofit					
Increase	63	42%	4%	35%	50%
Same	396	44%	2%	41%	47%
Decrease	68	49%	4%	41%	57%
No significant difference in free-ridership by change in size of household.					
Post retrofit household size					
1	70	38%	4%	30%	46%
2	215	48%	2%	44%	53%
3	80	45%	3%	38%	52%
4	111	41%	3%	35%	46%
5 or more	21	48%	8%	32%	64%
No significant difference in free-ridership by size of household (post retrofit).					
Age					
Under 34	48	47%	5%	38%	56%
35 to 44	96	47%	3%	40%	54%
45 to 54	114	41%	3%	36%	46%

Group	N	Average Free-Ridership Score	Standard Error of Mean	95% Confidence Limit for Mean	
55 to 64	124	45%	3%	40%	51%
Over 65	132	43%	3%	37%	48%
No significant difference in free-ridership by age.					
Education					
Less than high school or high school	26	60%	7%	46%	73%
Some college, trade or technical school	75	45%	4%	38%	52%
Business or technical school (2 year)	21	44%	5%	33%	56%
College graduate (4 year)	152	43%	3%	37%	48%
Post graduate work or advanced degree	238	43%	2%	39%	46%
Barely statistically significant difference in free-ridership between those who have a high school or less than high school degree and those who have an advanced degree or post-graduate work at 60% vs 43%.					
Income					
Income less than $100k	225	41%	2%	37%	45%
Income greater than $100k	229	47%	2%	43%	51%
No significant difference in free-ridership by income.					
Program Year					
PY2010	1	100%	N/A	N/a	N/A
PY2011	132	39%	3%	34%	44%
PY2012	394	46%	2%	43%	49%
Barely statistically significant higher free-ridership later in the program cycle at 46% in PY2012 versus 39% in PY2011.					

F. Survey Instrument

1. WO46 Whole House Impact Evaluation Homeowner Computer-Aided Telephone Interview (CATI) Survey Instrument

2. Introduction

1. [TARGET: Trying to reach current owner or co-owner of home. If co-owners, respondent should have been involved in renovation decisions].

LEAD-IN: Hello, my name is _____ and I am calling from Discovery Research Group. We are conducting a study to help <**IOU>** improve their energy efficiency programs for their customers. May I speak with <Mr/Ms NAME>?

If owner is unavailable, ask: "May I speak to whomever made the decision in your household to participate in Energy Upgrade California?"

- *If owner/decision maker is not home/unavailable: record best time to call back.*

  CALL BACK DATE/TIME: _____

- *If owner lives elsewhere and/or has diff. phone #: record name, phone#, best time to call.*

[REPEAT LEAD-IN FOR RESPONDENT, IF NEEDED]

We are conducting a study of households that participated in the **Energy Upgrade California program to install energy efficiency measures**. The California Public Utilities Commission will use this information to help plan programs to benefit homeowners and save energy.

I want to assure you that this **is NOT A SALES CALL** and your answers will be kept **strictly confidential** and reported only in the aggregate.

[IF REQUIRED]: This study is sponsored by the California Public Utilities Commission.

[IF REQUIRED]: We are calling on behalf of the California Public Utilities Commission. The CPUC is conducting a study to gauge the energy savings from **the Energy Upgrade California program**, in which your household participated.

[IF REQUIRED]: This survey will take about 30 minutes.

[IF REQUIRED]*:* You may confirm that this is a legitimate study by contacting Mona Dzvova, the California Public Utilities Commission study manager, at 415-703-1231 or Mona.Dzvova@cpuc.ca.gov

[CONTINUE ON TO SCREENER]

3. Screener

S1. I'd like to confirm that you are the decision maker for the **energy efficiency project** undertaken at **<ADDRESS>**. Would you describe yourself as the …***[READ LIST, ACCEPT SINGLE RESPONSE ONLY***

1. Homeowner who is occupant @ **<ADDRESS>** and decision maker for the project➔***[Go to S2]***

2. Homeowner who is not occupant @ **<ADDRESS>** but is decision-maker for the project➔***[Go to S2]***

3. Renter @ **<ADDRESS>** and decision maker for the project ➔***[Go to S2]***

4. **NOT** decision maker for the project ➔[*Ask for owner's name and best time to call. If contact has no connection to address, record disposition and Thank and Terminate]*

-97. Don't know➔ Thank and Terminate
-98. Refused ➔ Thank and Terminate

S2. When did you complete the project under the Energy Upgrade California program? ***[READ OPTIONS]***

1. Prior to 2010 ➔ Thank and Terminate
2. Between 2010 and 2012
3. After 2012➔ Thank and Terminate

-97. Don't know➔ Thank and Terminate
-98. Refused ➔ Thank and Terminate

4. Project Details – Warm Up questions

5. 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?

1. Yes ➔ **Proceed to A2**
2. No ➔ **Skip to M1**
-97. (Don't know) ➔ **Skip to M1**
-98. (Refused) ➔ **Skip to M1**

A2. Did the energy assessment/energy audit you received incorporate the following elements? [**READ LIST. CODE: 1 = YES, 2 = NO, -97 = DON'T KNOW, -98 = REFUSED**.]

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

A3. Did the contractor who performed the Energy Audit also carry out the improvements to your home? ***[DO NOT READ LIST]***

1. Yes – all of the improvements
2. Yes – some of the improvements
3. No – none of the improvements

-97 Don't know
-98 Refused

A4. Was there a fee for the Energy Audit?

1. Yes
2. No

-97 Don't know
-98 Refused

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

-97. Don't know
-98. Refused

6. Measures Installed

M1. As part of this project, which of the following home improvements did you have installed? Did you **…**
[READ LIST IN ORDER]

Order	Measure Type	Installed? *1 = YES; 2 = NO; -97 = DON'T KNOW; -98 = REFUSED*	Direction for Measure specific questions
1	Add insulation to the attic or ceiling (*IF REQUIRED: typically attic, but may include flat rof home and vaulted ceilings)*.	M1_1	Ask about next Measure
2	Add insulation to the walls	M1_2	Ask about next Measure
3	Add insulation to the floor (crawlspace)	M1_3	If M1_1 = Y or M1_2 = Y or M1_3 = Y go to Insulation
4	Seal the building envelope (sometimes referred to as weatherization/whole house leakage reduction)	M1_4	If Y go to Whole House Leak Reduction
5	Upgrade the HVAC system (new furnace/air conditioner)	M1_5	If Y go to HVAC System
6	Air seal HVAC ducts and reduce leakage	M1_6	Ask about HVAC Duct Insulation
7	Insulate HVAC ducts	M1_7	If M1_6 =Y or M1_7 =Y go to Duct Improvements
8	Install a new high efficiency water heater	M1_8	Water Heater
9	Insulate hot water pipes *e.g.* Domestic Hot Water Distributions	M1_9	Hot Water Distribution
10	Replace windows	M1_10	Window
11	Install Renewable ^ *e.g.* Solar/PV	M1_11	Renewables
12	Other *e.g.* pool pumps Specify _____	M1_77	

2. If DK/Ref or 97 or 98 to all measures then T&T.

3. If m1_77=Other is the only measure they say they have and m1_1—m1_11=no/dk/ref then T&T

4. **M1 should ASK ABOUT ALL MEASURES** and then move on

7. **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 *[go to QT1]*
2. You considered each measure individually *[go to first applicable measure section, per responses and table in M1]*

5.

6. -97. Don't know *[go to first applicable measure section, per responses and table in M1]*
7. -98. Refused *[go to first applicable measure section, per responses and table in M1]*
8.

[Note: Discovery – for this and any subsequent instance where we skip to **the applicable measure section** please capture in a binary indicator called **MEASURE**=1.

If the respondent is never asked any of the measure by measure questions then **MEASURE** stays at its initialized value = 0.]

8. OVERALL QUANTITY

QT1. In the absence of the program, would you have installed ...***[read each response option]*** **…**of the measures?

1. ALL ***[go to overall efficiency EF1]***
2. SOME ***[go to first applicable measure section]***
3. NONE ***[go to overall efficiency EF1]***

-97. Don't know ***[go to first applicable measure section]***
-98. Refused ***[go to first applicable measure section]***

9. OVERALL EFFICIENCY

EF1. In the absence of the program, would you have opted to install insulation and equipment with the same levels of efficiency?

1. Yes
2. No

-97. [Don't know] ***[go to first applicable measure section]***

-98. [Refused] ***[go to first applicable measure section]***

10. OVERALL PROJECT TIMING

T1. In the absence of the program, would you have undertaken this project… ***[READ LIST,*** *SINGLE RESPONSE****]?***

1. At the same time ***[SKIP TO T3]***
2. Earlier
3. Later
4. Never ***[SKIP to T2_v]***

-97. [Don't know] ***[go to first applicable measure section****]*-98. [Refused] ***[go to first applicable measure section****]*

CONSISTENCY CHECK

T2. How many months **earlier** *(if T1=2)/***later** *(if T1=3)* would you have undertaken this project?
[1 to 48, 97 = Don't know, 98 = Refused]

[RECORD RESPONSE]

T2_v. Why would you have **accelerated** *(if T1=2)***/delayed** *(if T1=3/***never undertaken** *(if T1=4)* this project? ***[OPEN END]***

[RECORD VERBATIM]

T3. *[If T1=1=At the same time]* How long had you been planning to undertake this project?

[RECORD RESPONSE: Number (1 to 96, -97 = Don't know, -98 = Refused) ***and Unit (Weeks, Months, Years,*** -97 = Don't know, -98 = Refused)***]***

T3_1. *[If T1=1=At the same time]* Prior to learning about the program, had you already obtained bids to undertake this project?

1. Yes
2. No

-97. [Don't know]
-98. [Refused]

[For all respondents with M2=1 and MEASURE=0 (those who have not been skipped to the measure sections thro EF*, T* question responses etc), go to C1 (Information received from contractor) and then proceed to PF1 and ask ALL PF* questions, SEG* questions and HH* questions

For all respondents with M2=2, Go to first applicable measure section. CHANGE MEASURE to = 1

]*

11. QUANTITY AND EFFICIENCY QUESTIONS - BY MEASURE

12. INSULATION - (EXCEPT DUCTS)

1. **Measure1 - Attic or Ceiling Insulation**
2. **Measure2 – Wall Insulation**
3. **Measure3 – Floor Insulation**

(Complete the entire INS series of questions for the first applicable measure and then move on to the next measure and so on.)*

INS1_#. In the absence of the program, would you say your likelihood of **hiring a contractor** to install **<MEASURE>** was… ***[READ LIST, SINGLE RESPONSE]***

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely
9. -97. [Don't know]
10. -98. [Refused]

INS2_#. In the absence of the program, would you say your likelihood of installing **<MEASURE>** was…?

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

11.

-97. [Don't know]
-98. [Refused]

13. INSULATION (EXCEPT DUCTS) - QUANTITY

INS3_#. In the absence of the program, would you have installed **more or less <MEASURE>**? Would you have … ***[READ LIST, SINGLE RESPONSE]***

12. Covered LESS area/square feet
13. Covered the SAME area
14. Covered MORE or
15. Would NOT have installed **<MEASURE>**? ➔***[SKIP TO NEXT APPLICABLE MEASURE]***

-97. [Don't know]
-98. [Refused]

14. INSULATION (EXCEPT DUCTS) -EFFICIENCY

Insulation is rated as an "R-Value", where the higher the R-value, the better the insulation's effectiveness ***[READ ONLY ONCE - FOR FIRST APPLICABLE MEASURE WITHIN INSULATION]***

INS4_#. In the absence of the program, how different would your installed R-Value have been? For **<MEASURE>,** would you have installed…***[READ LIST, SINGLE RESPONSE]***
01
1. A lower R value
2. The same R value
3. A higher R value
16. Would not have installed any insulation ➔***[SKIP TO NEXT APPLICABLE MEASURE]***
17.
-97. [Don't know]
-98. [Refused]

15. INSULATION (EXCEPT DUCTS) -TIMING

INS5_#. In the absence of the program, would you have installed <MEASURE>… ***[READ LIST,*** *SINGLE RESPONSE****]?***

1. At the same time
2. Earlier
3. Later
4. Never
-97. [Don't know]
-98. [Refused]

[GO TO NEXT APPLICABLE MEASURE]

16. WHOLE HOUSE LEAKAGE / AIR SEALING

AS1. In the absence of the program, would you say the likelihood of air sealing your home was… ***[READ LIST,*** *SINGLE RESPONSE****]***

18. 1. Very likely
19. 2. Somewhat likely
20. 3. Somewhat unlikely
21. 4. Or very unlikely
22.
23. -97. [Don't know]
24. -98. [Refused]
25.

17. AIR SEALING -TIMING

AS2. In the absence of the program, would you have **air sealed your home**… ***[READ LIST,*** *SINGLE RESPONSE****]?***

1. At the same time
2. Earlier
3. Later
4. Never
-97. [Don't know]
-98. [Refused]

[GO TO NEXT APPLICABLE MEASURE]

18. HVAC SYSTEM UPGRADE

HSU1. You mentioned you undertook an HVAC systems upgrade.

a. Did you install a/an**….[READ LIST. Multiples accepted]**

b. ***[If HUS1a_#=1=Yes]*** What is the efficiency rating**/<EFFICIENCY UNIT>** of your new **<EQUIPMENT>?**

	EQUIPMENT	HSU1a_# Installed? *1 = YES; 2 = NO; -97 = DON'T KNOW; -98 = REFUSED*	EFFICIENCY UNIT	HSU1b_# Efficiency Rating *-97 = DON'T KNOW; -98 = REFUSED*
2	Furnace		AFUE	
3	Air conditioner		SEER	
1	Heat pump		HSPF	

[Questions below asked for HSU1a_#=1=Yes
Cycle back to next equipment installed once section is complete, as required]

HSU2_#. Was the [**EQUIPMENT]** that you installed… **[READ LIST, SINGLE RESPONSE ONLY]**

1. A replacement due to a/an **[EQUIPMENT]** that had failed or was broken
2. A replacement due to the **[EQUIPMENT]** that was not performing well
3. A replacement to improve **[EQUIPMENT]** efficiency
4. A brand new installation where a/an **[EQUIPMENT]** did not exist previously
5. A/ An **[EQUIPMENT]** in addition to an existing one, or

6. Other ___ **[RECORD VERBATIM]**

-97. [Don't know]
-98. [Refused]

HSU3_#. Before getting this **[EQUIPMENT]** installed did you have a current service agreement with an HVAC contractor for this particular system?

1. Yes
2. No
-97. [Don't know]
-98. [Refused]

HSU4_#. In the absence of the program, would you say your likelihood of getting this **<EQUIPMENT>** installed was… ***[READ LIST,*** *SINGLE RESPONSE**]***

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Or very unlikely
-97. [Don't know]
-98. [Refused]

19. HVAC SYSTEM UPGRADE (HSU) –EFFICIENCY

HSU5_#. In the absence of the program, would you have installed…? **…[READ LIST, SINGLE RESPONSE ONLY]**

1. the standard efficiency **<EQUIPMENT>**/to code requirements
2. the same efficiency
3. a lower efficiency than what you installed but higher than standard
4. higher efficiency than what you installed
5. Would not have installed a/an **<EQUIPMENT>** ➔***[SKIP TO NEXT APPLICABLE MEASURE]***

-97. [Don't know]
-98. [Refused]

20. HVAC SYSTEM UPGRADE (HSU) –TIMING

HSU6_#. In the absence of the program, would you have installed **a/an <EQUIPMENT>**… ***[READ LIST,*** *SINGLE RESPONSE****]?***

1. At the same time
2. Earlier
3. Later
4. Never

-97. [Don't know]
-98. [Refused]

[GO TO NEXT APPLICABLE MEASURE]

21. HVAC DUCT LEAKAGE REDUCTION

22. WARM-UP

HDLR1. Where is the majority of the duct system located in your home?

[IF NECESSARY*:* A location could be the first story ceiling, a wall, attic, floor or crawlspace.]

[RECORD VERBATIM. CODE THIS AS LOCATION_REF1, LOCATION_REF2, etc]

23. CONSISTENCY CHECK

HDLR2. Before having your ducts air sealed, did you…***[READ LIST, SINGLE RESPONSE]***

1. **Consider doing it yourself*****(IF REQUIRED****: - such as inspecting the condition, searching for disconnected ducts, searching for leaks or applying mastic tape on your ducts or registers)*
2. **Actually did some part of it yourself**
3. **Did neither**

-97 Don't know
-98 Refused

24. FREE_RIDERSHIP

HDLR3. In the absence of the program, would you say the likelihood of your **air sealing your ducts** was**…** ***[READ LIST,*** *SINGLE RESPONSE****]***

26. 1. Very likely
27. 2. Somewhat likely
28. 3. Somewhat unlikely
29. 4. Or very unlikely
30. -97. [Don't know]
31. -98. [Refused]
32.

25. HDLR –TIMING

HDLR4. In the absence of the program, would you have **air sealed your ducts**… ***[READ LIST,*** *SINGLE RESPONSE****]?***

1. At the same time
2. Earlier
3. Later
4. Never
-97. [Don't know]
-98. [Refused]
33. ***[GO TO NEXT APPLICABLE MEASURE]***

26. HVAC DUCT INSULATION

27. FREE_RIDERSHIP

HDI1. In the absence of the program, would you say the likelihood of your **insulating your ducts/replacing your ducts** was*…* ***[READ LIST,*** *SINGLE RESPONSE****]***

34. 1. Very likely
35. 2. Somewhat likely
36. 3. Somewhat unlikely
37. 4. Or very unlikely
38. -97. [Don't know]
39. -98. [Refused]

28. HDI –TIMING

HDI2. In the absence of the program, would you have **insulated your ducts**… ***[READ LIST,*** *SINGLE RESPONSE****]?***

1. At the same time
2. Earlier
3. Later
4. Never
-97. [Don't know]
-98. [Refused]

29. [GO TO NEXT APPLICABLE MEASURE]

30. RENEWABLE ENERGY

RE1. When did you get Solar PV? ***[READ LIST,*** *SINGLE RESPONSE****]***

1. At the same time as the other measures undertaken
2. Earlier
3. Later
40.
-97. [Don't know]
-98. [Refused]

RE2. Did you participate in the California Solar Initiative? [IF NECESSARY: "It is a program that provides rebates for customers who install solar panels to generate part of their own energy."]

1. Yes
2. No
-97. [Don't know]
-98. [Refused]

31. WATER HEATER

WH1. Please confirm that the water heater you upgraded to was a**…**

[READ LIST, RANDOMIZE, SINGLE RESPONSE]

1. New Tank
2. New Tankless
3. Solar Water Heater
4. Other (Specify)

41. -97. Don't know ➔***Skip to next applicable measure***

42. -98. Refused ➔***Skip to next applicable measure***

WH2. In the absence of the program, would you say the likelihood of installing this water heater was**…** ***[READ LIST,*** *SINGLE RESPONSE**]***

43. 1. Very likely
44. 2. Somewhat likely
45. 3. Somewhat unlikely
46. 4. Or very unlikely
47.
48. -97. [Don't know]
49. -98. [Refused]
50.

32. WATER HEATER – EFFICIENCY

WH3. In the absence of the program, would you have installed a water heater with an Energy Factor/efficiency that was…

[READ LIST, *SINGLE RESPONSE**]..?***

[IF REQUIRED: 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.]*

1. Lower than installed
2. Same as installed
3. Higher than installed
4. Would not have installed ***[SKIP TO NEXT APPLICABLE MEASURE]***
-97. [Don't know]
-98. [Refused]

CONSISTENCY CHECK

WH4_1. What is the Energy Factor/EF of your water heater?
[OPEN END. DON'T KNOW/REFUSED ACCEPTABLE]
[RECORD VERBATIM]

33. WH–TIMING

WH5. In the absence of the program, would you have installed **the water heater**… ***[READ LIST,*** *SINGLE RESPONSE**]?***

1. At the same time
2. Earlier
3. Later
4. Never
-97. [Don't know]
-98. [Refused]

[GO TO NEXT APPLICABLE MEASURE]

34. HOT WATER DISTRIBUTION

HWD1. Please confirm that the Hot Water Pipe Distribution system upgrade was… ***[READ LIST, ACCEPT MULTIPLES]***

1. Insulation on hot water pipes
2. New piping that included insulation
3. Demand-initiated recirculation systems

51. -97. Don't know (Skip to next measure undertaken)
52. -98. Refused (Skip to next measure undertaken)

HWD2. In the absence of the program, would you say the likelihood of upgrading your Hot Water Pipe Distribution System was**…** ***[READ LIST,*** *SINGLE RESPONSE****]***

53. 1. Very likely
54. 2. Somewhat likely
55. 3. Somewhat unlikely
56. 4. Or very unlikely
57. -97. [Don't know]
58. -98. [Refused]
59.

35. HWD –TIMING

HWD3. In the absence of the program, would you have **installed a Hot Water Pipe Distribution System**… ***[READ LIST,*** *SINGLE RESPONSE****]?***

1. At the same time
2. Earlier
3. Later
4. Never

-97. [Don't know]
-98. [Refused]
60.
61. ***[GO TO NEXT APPLICABLE MEASURE]***

36. WINDOW REPLACEMENT

WIN1. What kind of windows did you get?

1. Gas filled, Low-E
2. Vacuum filled, Low-E
3. Other [DESCRIBE] [RECORD VERBATIM]

-97. Don't know

-98. Refused

WIN2. In the absence of the program, would you say the likelihood of your **replacing your windows** was**…** ***[READ LIST,*** *SINGLE RESPONSE****]***

62. 1. Very likely
63. 2. Somewhat likely
64. 3. Somewhat unlikely
65. 4. Or very unlikely
66. -97. [Don't know]
67. -98. [Refused]

37.

38. WIN–TIMING

WIN3. In the absence of the program, would you have **replaced your windows**… ***[READ LIST,*** *SINGLE RESPONSE****]?***

1. At the same time
2. Earlier
3. Later
4. Never
-97. [Don't know]
-98. [Refused]

[GO TO NEXT SECTION –INFORMATION RECEIVED FROM CONTRACTOR – C1]

39. INFORMATION RECEIVED FROM CONTRACTOR

C1. In discussing plans for your project, did your contractor bring up any of the following issues?
[READ LIST. RANDOMIZE. ACCEPT MULTIPLES. OTHER IS ALWAYS LAST]

Issue	*1 = YES; 2 = NO; -97 = DON'T KNOW; -98 = REFUSED*
Energy savings on your monthly bill due to the project	C1_1
Rebates on equipment purchases and contractor services	C1_2
Effect of renovations on comfort, such as eliminating drafts and hot or cold spots in the home	C1_3
Effect of renovations on indoor air quality	C1_4
Effect of renovations on safety of heating and cooling equipment	C1_5
Effect of renovations on controlling mold	C1_6
Other (Specify)	C1_7, C1_other

PROJECT FINANCES (3 MIN)

PF1. As you may recall, you received incentives from Energy Upgrade California to cover some of your improvement costs, but you also had to pay some of those costs. Please tell me if you used financing to pay for any portion of the improvements you made through the program? **[IF NEEDED: Financing could include a credit card, taking out a loan, getting financing through your contractor, refinancing your home mortgage, and other situations where you borrow the money and repay it over time.]**

1. Yes → **GO TO PF2, if MEASURE=0[18], skip to HH1, if MEASURE=1]**
2. No → **Skip to HH1**

-97. Don't know → **Skip to HH1**
-98. Refused → **Skip to HH1**

PF2. What type of financing did you use? ***[ACCEPT MULTIPLES. READ LIST IF NEEDED.]***

68.
69. 1 = YES; 2 = NO; -97 = DON'T KNOW; -98 = REFUSED
70.

1. Credit card
2. Personal loan
3. Energy Upgrade California affiliated loan or energy loan product **[EUC lenders include Matadors Credit Union, San Diego Metropolitan Credit Union, GreenStreet Lending (Umpqua Bank), SMUD, CHF Residential Energy Retrofit]**
4. Home equity line of credit or second mortgage
5. PowerSaver loan **[Sun West or W.J. Bradley]**
6. Contractor sponsored or arranged financing
7. New first mortgage **[Not a PowerSaver loan]**
8. Refinanced mortgage

71. Other **[SPECIFY: _____]**
72.

PF3. What were the most important reasons for using financing to pay for your Energy Upgrade project? ***[DO NOT READ. SELECT ALL THAT APPLY, OPEN-ENDED WITH PRE-CODED LIST]***

73.

1. To spread cost over a longer period (monthly payment vs. large upfront payment)

[18] Ask remainder of Project Finance questions if **MEASURE=0** and PF1=1=used a loan or financing to pay for the project – i.e. we are asking the entire finance series only of those who did **NOT** go through the long form of the questionnaire where they were asked questions from each applicable measure section (rather than the overall quantity, efficiency, and timing questions).
NOTE: Binary indicator MEASURE created per comment (alongside M2), "MEASURE" stays=0 if respondent did NOT go through ANY of the measure sections.]

2. Didn't have the entire amount available in cash at the time of making improvements
3. To take advantage of an attractive interest rate offer
4. To make the improvement cash flow positive (monthly energy bill savings greater than monthly installment)
5. Made financial sense [Specify what this means:____]
6. It was the easiest option
7. 7. Other [SPECIFY: _____]

74.

75. -97. Don't know
76. -98. Refused

77.

PF4. How did you find out about your lender? ***[DO NOT READ, SELECT ALL THAT APPLY, OPEN-ENDED WITH PRE-CODED LIST]***

78.

1. Existing relationship (have worked with them before / do personal banking there)
2. Television
3. Radio
4. Print media (magazine, newspaper article or advertisement)
5. Billboard/outdoor ad
6. Direct mail/brochure/postcard
7. Energy Upgrade California or Utility recommendation
8. Energy Upgrade California website
9. Contractor
10. Realtor
11. Home builder
12. Family/friends/word-of-mouth
13. Social Media
    1. 14. Other **[SPECIFY: _____]**, ***CODE OPEN-ENDED RESPONSE INTO PF4_7_V)***

79.

80. -97. Don't know
81. -98. Refused

PF5. What was the interest rate you were charged? If your loan was variable rate or had an introductory rate, please say it is variable rate. ***[RECORD RESPONSE, acceptable range 0-100 or variable rate]***

82.

83. PF5_v "Is a variable rate"=1

84. -97. Don't know
85. -98. Refused

86.

PF6. How many months was the financing was for? ***[RECORD RESPONSE, IN MONTHS]***

87.

*88. (If respondent states answer in **YEARS**, provide interviewer option to enter into an interim variable for **YEARS** which will then be converted to **MONTHS**. Final data for this question should be in **MONTHS** for all respondents.)*

89.

PF7. How difficult was it for you to obtain your financing? Was it...?

90.

1. Not at all difficult
2. Not too difficult
3. Somewhat difficult
4. Very difficult

91. -97. Don't know

92. -98. Refused

93.

PF8. What about the process was **<PF7>?** ***[[DO NOT READ, SELECT ALL THAT APPLY, OPEN-ENDED WITH PRE-CODED LIST]***

1. Process was simple and straightforward
2. Easy to get approval
3. Could apply online
4. Difficult to get approval **[SPECIFY WHAT WAS DIFFICULT: _____]**
5. Difficult to get pre-approval **[SPECIFY WHAT WAS DIFFICULT: _____]**
6. Had to go to multiple banks to get approved
7. Unresponsive bank **[SPECIFY ANY ISSUES: _____]**
8. Paperwork **[SPECIFY WHAT ABOUT PAPERWORK WAS DIFFICULT: _____]**
9. Hard to make a decision due to too many financing options
10. Hard to make a decision due to a lack of information
11. Could not apply online
12. Had to go to bank to sign the paperwork
13. Had to take time off work
14. Process was complicated or not clear
15. Process took a long time
16. Other **[SPECIFY: _____]**

94. -97. Don't know

95. -98. Refused

96.

PF9. How satisfied are you with the financing? Would you say you are …

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied

97. -97. Don't know

98. -98. Refused

99.

PF10. What about the financing are you **<PF9>** with? ***[DO NOT READ, SELECT ALL THAT APPLY, OPEN-ENDED WITH PRE-CODED LIST]***

1. Process was easy and straightforward
2. Process was quick
3. Good interest rates
4. Good repayment options
5. Can repay/check balance online
6. Lender has good customer service
7. Took too long to secure
8. Too much paperwork and hassle
9. No option to pay/check balance online
10. Interest rate too high
11. Interest rate increased
12. Had to pay fees
13. There was a mistake in my bill
14. Lender has bad customer service
15. Costs or other issues were not fully explained up front
16. Other **[SPECIFY: _____]**

100. -97. Don't know
101. -98. Refused

102.

40. SEGMENTATION ITEMS (3 MIN)

SEG1. Have you had the following installed in your household?

1 = YES; 2 = NO; -97 = DON'T KNOW; -98 = REFUSED

a. Programmable thermostats?
b. Motion detectors for your lights?
c. Vent in your attic area to keep the attic cooler?
d. Ceiling fans ***[ASK ONLY OF HOMEOWNERS, NOT RENTERS]***

103.

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

1 = YES; 2 = NO; -97 = DON'T KNOW; -98 = REFUSED

SEG3. On a scale of 1 to 7, where 1 is Strongly Disagree and 7 is Strongly Agree, please tell me how much you agree or disagree with the following statements:

a. I compare prices of at least a few brands before I choose one. 1 2 3 4 5 6 7 DK Ref

b. I do **not** feel responsible for conserving energy because my personal contribution is very small. 1 2 3 4 5 6 7 DK Ref

SEG4. I'm going to read you a list of 6 reasons why people might change their daily actions to save energy. Please tell me which **ONE** of these would motivate you the **MOST** to save energy? ***[READ CHOICES] [IF DK, PROBE*** "if you had to choose from the following reasons which one would motivate you the most"] [RANDOMIZE]

1. Saving money
2. Maintaining Health
3. Protecting the environment
4. For the benefit of future generations
5. Reducing our dependence on foreign oil
6. Helping California lead the way on saving energy

-97. Don't know

-98. Refused

41. RESPONDENT AND HOUSEHOLD CHARACTERISTICS

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

HH1. About, when was this home/building first built? [RECORD RESPONSE, READ LIST IF NEEDED]

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

113.
114. -97. Don't know
115. -98. Refused

HH2. Roughly how large is the living area of your home in terms of square feet?

ENTER NUMBER OF SQUARE FEET, Don't know = -97, Refused = -98 _____

HH2_TB. Did you increase the living area/square footage of your home at the same time or after you undertook this whole house retrofit project?
-97, Refused = -98 _____

HH3. How many bedrooms does your home have?

[IF NECESSARY: The energy use patterns of homes can be affected by the number of bedrooms.]
Number of bedrooms: ___ **[1 through 25, Don't know = -97, Refused=-98]**

HH4. How many bathrooms does it have?

[IF NECESSARY: The energy use patterns of homes can be affected by the number of bathrooms.]
Number of bathrooms: _____
[1 thru 25, Don't know = -97, Refused=-98]
[If half baths, enter decimal, e.g., 1 and ½ bath = 1.5]

HH5. What is the main fuel used to heat your home? **[READ LIST]**

1. Oil
2. Natural gas
3. Propane
4. Electricity
5. Other [SPECIFY] _____
-97.Don't know
-98. Refused

HH6. [**IF HSU0_2 ≠ 1**] Does your home have central air-conditioning?

1. Yes
2. No

-97. (Don't know)
-98. (Refused)

HH6_TB. Did you have central air-conditioning prior to undertaking this project?

1. Yes
2. No

-97. (Don't know)
-98. (Refused)

HH7. Do you **["also" if HH6=1]** have any window air-conditioning units?

1. Yes
2. No
-97.(Don't know)
-98.(Refused)

HH7_1 (If HH7=1=Yes) How many?

Number of wall units: _____ **[1 through 25, Don't know = -97, REF= -98]**

HH7_TB. Did you have these window/wall air-conditioning units prior to undertaking this project?

1. Yes
2. No

-97. (Don't know)
-98. (Refused)

HH8. Does your home have a pool and/or spa?

1. Pool only
2. Spa only
3. Both pool and a spa
4. Neither a pool nor a spa

-97.(Don't know)
-98.(Refused)

HH8_TB. Did you have this/these prior to undertaking this project?

HH9. How many people, including yourself, lived in this home **before** the retrofit?_____
[Don't know= -97, Refused = -98]

HH10. How many people, including yourself, live in this home **after** the retrofit? _____
[Don't know= -97, Refused = -98]

HH11. Which of the following categories includes your age? **[READ LIST]**

1. Under 25

2. 25 to 34
3. 35 to 44
4. 45 to 54
5. 55 to 64
6. 65 or over

-97. Don't know
-98. Refused

HH12. I'm going to read several education categories. Please stop me when I come to the highest level of schooling you've completed. **[READ LIST]**

1. Less than high school
2. High school graduate
3. Some college, trade or technical school
4. Completed business or technical school (2 year)
5. College graduate (4 year)
6. Post graduate work or advanced degree

-97. Don't know
-98. Refused

HH13. Which of the following ranges includes your total household income in 2012? Please stop me when I come to the appropriate range. **[READ LIST]**

1. Less than $50,000
2. between $50,000 and $75,000
3. between $75,000 and $100,000
4. between $100,000 and $150,000
5. $150,000 or more

-97.(Don't know)
-98. (Refused)

HH14. *[ASK IF PF1=1 and MEASURE=1 and ASKHH14=1]* Would you be willing to participate in follow-up research that is focused on learning more about the financing you availed of for this project?

116. 1. Yes
117. 2. .....No
118.
119. -97. (Don't know)
120. -98. (Refused)

HH15. [INTERVIEWER: RECORD GENDER]

42. Wrap-up – (Use this when respondent completes the survey)

Those are all the questions I have for you today. Thank you very much for your time and cooperation. You are helping us improve energy conservation programs in California.

43. T&T (Use this when respondent does NOT go through the entire survey and is screened out).

Those are all the questions I have for you today. Thank you so much for your time ***[THANK AND TERMINATE]***

G. Phase 1 Gross Savings Estimates

Phase 1 was presented to the ED and other stakeholders prior to having post retrofit data for 2012 participants. The effort helped us test the methodology and get input while awaiting Phase 2 data. The following table illustrates gross consumption and savings by IOU for Phase 1:

Table 52. Energy Use and Program Savings Estimates by IOU for 2010-2011

Consumption/Savings	Annual Electric (kWh)			Annual Gas (Therms)	
	PG&E	SCE	SDG&E	PG&E	SDG&E
No. of sites	389	483	137	648	129
Actual Consumption Per Site (not weather-normalized)					
Avg Annual Usage Before Installation	8,428	9,894	7,096	623	410
Avg Annual Usage After Installation	8,149	9,834	6,780	506	344
Weather-Adjusted Consumption Per Site (Using TMY3)					
Avg Annual Usage Before Installation	8,498	10,076	6,990	604	391
Avg Annual Usage After Installation	8,143	9,588	6,645	492	321
% Change in Energy Use	-4%	-5%	-5%	-19%	-18%
Weather-Adjusted Consumption Per Site (Using CTZ2)					
Avg Annual Usage Before Installation	8,361	9,788	6,922	602	341
Avg Annual Usage After Installation	8,065	9,419	6,579	490	280
% Change in Energy Use	-4%	-4%	-5%	-19%	-18%
Estimated Program Savings					
Normalized annual savings Using TMY3					
Annual Savings Estimate	5.6 [ns]	290.2 [ns]	366.2 [*]	68.0 [**]	59.2 [**]
Standard Error	184.9	224.7	212.1	18.5	29.3
Percent Savings	0.1%	3%	5%	11%	15%
Normalized Annual Savings Using CTZ2					
Annual Savings Estimate	-31.60 [ns]	301.9 [ns]	275.7 [ns]	62.3 [** a]	62.3 [** a]
Standard Error	181.5	225.2	196.6	18.4	28.4
Percent Savings	-0.4%	3%	4%	11%	18.2%
Ex Ante EnergyPro Savings as Percent of Total Annual Usage	35%	11%	27%	60%	40%
Ex Ante Claimed Savings as Percent of Total Annual Usage	21%	6%	18%	36%	34%

[*] Statistically significant at 10% level (90% confidence interval)

[**] Statistically significant at 5% level (95% confidence interval)

[ns] Not statistically significant

[a] Same gas savings estimate for PG&E and for SDG&E

When looking at the table, it is important to consider:

- Actual consumption (not weather normalized) is the energy use average of the 12 months before and 12 months after participation in the program. These two figures cannot be directly compared because weather, the most influential variable in energy use, varies from one year to the next.
- Weather-adjusted consumption is the weather-normalized energy use average of the 12 months before and 12 months after participation in the program, obtained from the PRISM estimates. These estimates may show an increase or decrease in use compared to the prior year, which is not adjusted for program effects, and thus cannot be used directly to estimate savings. For example, if program participants are already reducing their energy use prior to implementing the program measures for reasons that are independent of the program, post-retrofit weather-normal energy use may be lower, but such change cannot be attributed to the program.
- Estimated program savings are the changes in pre-/post- retrofit weather-normalized consumption that are attributed to the program. These savings estimates are calculated from the fixed effects model that controls for site-specific characteristics that do not change over time and for the overall consumption trend that is not program-related.

Overall, we found that:

1. The program generated statistically significant reductions in electricity consumption for SDG&E using TMY3 normal weather, but not using CTZ2 normal weather. Reductions were not significant for PG&E and SCE using either normal weather. For SDG&E, the average estimated savings were 366 kWh per year[19], or about 5% of weather-normalized annual consumption.

   For SDG&E, the average estimated savings are 366 kWh per year[20], or about 5% of weather-normalized annual consumption.

2. The program generated statistically significant reductions in gas consumption for PG&E and SDG&E. For PG&E, the average estimated savings were 63.2 therms per year, or about 11% of weather-normalized annual consumption. For SDG&E, the same 63.2 therms per year amounted to 15% of weather-normalized annual consumption.

3. EnergyPro ex ante savings estimates were a very large percent of annual use. These are presented in the bottom row of Table 52. They rangde from 11% (SCE Electric) to 60% (PG&E Gas).

[19] Using TMY3 weather

[20] Using TMY3 weather

H. Pre-Retrofit Equipment Efficiencies for Advanced Path

For water heating replacements and AC and furnace replacements evidence of "early retirement" is required to claim the pre-existing baseline, and only for the remaining life of the pre-existing equipment (defined as 1/3 the life of the equipment by policy). This report provides information on the pre-existing efficiencies of the equipment replaced, but does not make adjustments to the savings estimates. This Appendix provides a comparison of the pre-retrofit equipment efficiency for Advanced Path simulation models compared to the replace on burnout code baseline for piece of equipment. A short description is followed by the tables.

Central Furnaces: Existing average efficiencies higher than the baseline AFUE value of 0.79 were observed for climate zones 2, 6, 7, 9, 10, 12, and 16. This means that dual baseline is not necessarily an issue for this equipment other than Climate Zone three which is below Baseline and has a high proportion of the PG&E population.

Heat Pump Heating Efficiency: Existing average efficiencies higher than baseline efficiency at 7.7 were observed for climate zones 6, 7, and 9. On the other side, the HSPF values were on the lower end for climate zones 3, 12, 13 and 16. However, for the samples with observed HSPF higher than baseline value do not represent to the majority of the samples. Further, higher than baseline efficiencies were observed for large size houses.

Heat Pump Cooling Efficiency: Existing average efficiencies higher than the baseline heat pump cooling at 13.0 SEER were observed only for climate zone 9, and for all other observed zones the existing heat pump cooling efficiencies were less than the baseline efficiency. The climate zone 9 is evident to have higher cooling demand than the remaining climate zones put in the above table. As the majority of the sampled houses have AC units, the number of houses for this characterization was small in number.

Domestic Hot Water Heater: Existing average efficiencies higher than baseline AFUE efficiencies at 0.62 were observed for those samples with lower sizes, and they were for climate zones 5, 6, 8, 14 and 16 which were for locations both inland and at the southern CA. However, for the samples with bigger sample sizes reported Energy Factors lower than baseline efficiency.

Air Conditioning Unit Efficiency: Existing average efficiencies across all climate zones and sample sizes were observed to be less than the baseline SEER value at 13.0. Lower values for SEER Upper Bound were observed for climate zone 11 and 12, and to some extent in climate zone 13. They all correspond to significantly higher sample sizes. Higher SEER values were observed in climate zone 5 and 6.

The tables presented in this section do not include SoCal Gas. SCG's data could not be processed for these summaries.

Table 53: Central Furnace

IOU	T24 Climate Zone	Heating Efficiency Type	Count	Conditioned Floor Area_Mean	Heating E fficiency _Mean	Heating Efficiency _StdErr	AFUE Upper Bound	Average Higher than Baseline	Heating Efficiency _Min	Heating Efficiency _Max
PG&E	2	AFUE	310	1,879	0.83	0.02	0.85	Yes	0.50	4.20
PG&E	3	AFUE	1663	1,740	0.78	0.00	0.78		0.00	2.20
PG&E	4	AFUE	646	1,992	0.78	0.00	0.78		0.39	0.95
PG&E	5	AFUE	16	1,901	0.76	0.02	0.79		0.64	0.95
PG&E	11	AFUE	286	2,015	0.78	0.00	0.78		0.56	0.97
PG&E	12	AFUE	2767	1,796	0.79	0.00	0.80	Yes	0.00	6.60
PG&E	13	AFUE	261	1,920	0.77	0.00	0.77		0.50	0.96
PG&E	16	AFUE	7	2,297	0.82	0.02	0.84	Yes	0.78	0.90
SCE	6	AFUE	71	1,885	0.78	0.01	0.79	Yes	0.60	0.96
SCE	8	AFUE	50	1,524	0.78	0.01	0.79		0.65	0.95
SCE	9	AFUE	514	1,671	0.81	0.01	0.82	Yes	0.60	4.20
SCE	14	AFUE	10	2,084	0.78	0.00	0.79		0.78	0.80
SDG&E	7	AFUE	177	1,881	0.79	0.01	0.81	Yes	0.50	2.20
SDG&E	10	AFUE	79	2,093	0.80	0.00	0.80	Yes	0.70	0.93

Table 54: Heat Pump Heating Efficiency

IOU	T24 Climate Zone	Heating Efficiency Type	Count	Conditioned Floor Area_Mean	Heating Efficiency _Mean	Heating Efficiency _StdErr	HSPF Upper Bound	Average Higher than Baseline	Heating Efficiency _Min	Heating Efficiency _Max
PG&E	3	HSPF	18	1,736	3.89	0.33	4.21		3.40	7.70
PG&E	4	HSPF	6	2,775	6.73	0.44	7.17		5.60	8.00
PG&E	11	HSPF	133	1,267	5.87	0.07	5.94		3.40	9.50
PG&E	12	HSPF	141	1,922	6.16	0.07	6.23		3.40	9.20
PG&E	13	HSPF	14	2,523	6.20	0.38	6.58		3.40	7.60
PG&E	16	HSPF	4	1,358	4.51	0.63	5.14		3.41	5.60
SCE	9	HSPF	14	2,196	7.53	0.69	8.21	Yes	3.41	12.00
SDG&E	7	HSPF	4	3,612	6.85	1.22	8.08	Yes	3.41	9.20

Table 55: Heat Pump Cooling Efficiency

IOU	T24 Climate Zone	Heating Efficiency Type	Count	Conditioned Floor Area_Mean	Cooling Efficiency_ Mean	Cooling Efficiency_ StdErr	Cooling Eff Upper Bound	Average Higher than Baseline	Cooling Efficiency_ Min	Cooling Efficiency_ Max
PG&E	4	HSPF	6	2,775	11.30	1.10	12.39		8.00	13.00
PG&E	11	HSPF	133	1,267	8.60	0.10	8.77		8.00	16.00
PG&E	12	HSPF	141	1,922	9.10	0.10	9.26		7.00	15.50
PG&E	13	HSPF	14	2,523	10.60	0.60	11.23		8.00	14.00
PG&E	16	HSPF	4	1,358	4.00	2.30	6.31		-	8.00
SCE	9	HSPF	14	2,196	13.90	1.10	15.05	Yes	8.00	26.00
SDG&E	7	HSPF	4	3,612	11.00	1.10	12.17		9.10	13.00

Table 56: Domestic Hot Water

IOU	T24 Climate Zone	Heating Efficiency Type	Count	Conditioned Floor Area_Mean	Energy Factor_Mean	Energy Factor_StdErr	EF Upper Bound	Average Higher than Baseline	Energy Factor_Min	Energy Factor_Max
PG&E	2	AFUE	310	1,879	0.61	0.01	0.61		0.53	0.96
PG&E	3	AFUE	1,663	1,740	0.58	0.00	0.59		-	0.98
PG&E	4	AFUE	646	1,992	0.58	0.00	0.59		-	0.98
PG&E	5	AFUE	16	1,901	0.65	0.03	0.68	Yes	0.53	0.84
PG&E	11	AFUE	286	2,015	0.59	0.01	0.60		0.53	0.99
PG&E	12	AFUE	2,767	1,796	0.58	0.00	0.58		-	0.98
PG&E	13	AFUE	261	1,920	0.57	0.00	0.58		-	0.93
PG&E	16	AFUE	7	2,297	0.65	0.04	0.69	Yes	0.53	0.80
SCE	6	AFUE	71	1,885	0.63	0.01	0.64	Yes	0.52	0.96
SCE	8	AFUE	50	1,524	0.62	0.01	0.63	Yes	0.52	0.84
SCE	9	AFUE	514	1,671	0.60	0.00	0.61		0.53	0.98
SCE	14	AFUE	10	2,084	0.60	0.03	0.62	Yes	0.53	0.80
SDG&E	7	AFUE	177	1,881	0.59	0.00	0.60		0.45	0.84
SDG&E	10	AFUE	79	2,093	0.61	0.01	0.62		0.53	0.95

Table 57: Air Conditioning

IOU	T24 Climate Zone	Heating Efficiency Type	Count	Conditioned Floor Area_Mean	Cooling Efficiency_ Mean	Cooling Efficiency_ StdErr	SEER Upper Bound	Average Higher than Baseline	Cooling Efficiency_ Min	Cooling Efficiency_ Max
PG&E	2	AFUE	310	1,879	10.86	0.19	11.05		0.50	18.00
PG&E	3	AFUE	1,663	1,740	11.00	0.10	11.10		-	40.00
PG&E	4	AFUE	646	1,992	11.62	0.11	11.72		-	24.50
PG&E	5	AFUE	16	1,901	12.00	0.47	12.47		8.00	13.00
PG&E	11	AFUE	286	2,015	9.86	0.10	9.96		6.60	16.00
PG&E	12	AFUE	2,767	1,796	9.45	0.04	9.49		-	18.50
PG&E	13	AFUE	261	1,920	10.16	0.15	10.30		6.00	16.50
PG&E	16	AFUE	7	2,297	11.22	0.63	11.85		9.80	13.00
SCE	6	AFUE	71	1,885	11.02	0.51	11.53		-	17.00
SCE	8	AFUE	50	1,524	11.59	0.26	11.85		7.00	14.00
SCE	9	AFUE	514	1,671	10.83	0.09	10.92		-	16.80
SCE	10	AFUE	35	1,795	10.07	0.40	10.47		0.50	13.10
SCE	13	AFUE	29	1,916	10.05	0.55	10.61		-	15.00
SCE	14	AFUE	10	2,084	9.71	0.42	10.13		8.00	13.00
SDG&E	6	AFUE	2	2,161	12.00	-	12.00		12.00	12.00
SDG&E	7	AFUE	177	1,881	11.21	0.22	11.43		0.50	14.00
SDG&E	8	AFUE	4	2,578	10.53	0.83	11.35		9.70	13.00
SDG&E	10	AFUE	79	2,093	10.93	0.25	11.18		7.80	16.00

I. Public Comments and Responses

Responses to Comments/Questions submitted by PG&E, SCE, SDG&E and SoCalGas on August 28, 2014[21] and Efficiency First California on August 29, 2014[22] regarding the **Draft Evaluation Report: Whole House Retrofit Impact Evaluation – Evaluation of Energy Upgrade California Programs Work Order 46**

#	Subject Source	Ref.	Type (Question or comment)	Comment or Question:	Responses
1.	NTGR Survey / IOU Comments[21]	Section 3	Comment	Response rates for NTGR telephone samples are not reported. Please provide a table for containing a detailed disposition of the sample consistent with Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys developed by the American Association for Public Opinion Research (2009). The following rates should be reported: 1) Response Rate 1 (RR1) and 2) Response Rate 3 (RR3). Definitions of each are provided in the Standard Definitions. Evaluators may report any other measures of survey outcomes that they think are important such as refusal rates, cooperation rates and contact rates.	This was added to the report draft dated 8/11/14
2.	NTGR Survey /	Section 3	Comment	Given that the telephone survey response rate very low, did you investigate whether there were	We did not follow-up with non-respondents (in the survey). While 6 attempts were made, those whom we

[21] File name: IOU-Comments-Questions-Whole-House-Impact-Draft-WO46-080814-Final-Basecamp.docx
Red font denotes additions from filename: IOU-Comments-Questions-Whole-House-Impact-Draft-WO46-082714-Posted-to-Pu....docx

[22] Filename: Comments on WO46 for CPUC.docx

#	Subject Source	Ref.	Type (Question or comment)	Comment or Question:	Responses
	IOU Comments[21]			any systematic differences between the respondents and non-respondent in the telephone surveys that might have produced biased estimates? If this cannot be done in time for the public distribution, can you please insert a section in this study to talk about study limitations, beyond the discussion on the challenge of the comparison groups.	were unable to reach in those attempts are not included in the survey and no separate follow-up effort beyond this was attempted.
3.	NTGR Survey / IOU Comments[21]	pp. 39 - 41	Comment	The report mentions how a number of different topics covered in the Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approaches (SRA Guidelines) were addressed. However, the adherence is less than what is claimed. For example, there is no mention of strategies for ruling out rival hypotheses and conducting sensitivity analyses. In addition, both the efficiency score and the quantity score are based on a single question, an approach that produces answers with low reliability. Also, trying to measure something like program influence with nominal response categories makes little sense when program influence on efficiency and quantity is probabilistic and should be measured along a continuum of, for example, a 0 to 10-point scale. Would you agree that it would add to the integrity of the report to add a statement clarifying that this evaluation adheres to only some of the SRA Guidelines?	Section 3.1.1 clarifies that this survey represents our interpretation of the guidelines. Report also now Added contains a sensitivity analysis and discussion on scoring. to the report. The questions do include a scale that is ordinal. A spectrum from very unlikely to very likely.
4.	Sensitivity	3.5.2 Page	Comment	While DNV-GL conducted the IOU-recommended sensitivity analysis, they draw no	The free ridership estimate is not unstable or inconsistent.

<table>
<tr><th>#</th><th>Subject Source</th><th>Ref.</th><th>Type (Question or comment)</th><th>Comment or Question:</th><th>Responses</th></tr>
<tr><td></td><td>Analysis of Free Rider Calculation</td><td>54</td><td></td><td>conclusions regarding the stability of the estimated free ridership. Isn't the correct conclusion that the estimate of free ridership is very unstable? We assume that this is the unspoken reason for their recommendation " . . . that future versions of the survey include multiple response options that describe differing levels of partial free-ridership that allow the respondent to indicate the degree of (partial) free-ridership that best describes the choice they made." DNV-GL should also consider using multiple response options for the QET (quantity, efficiency, and timing) questions as well.</td><td>The final version of the report will include confidence intervals. For example:
<table>
<tr><th>Group</th><th>n</th><th>Avg FR score</th><th colspan="2">95% CL for Mean</th></tr>
<tr><td>Total</td><td>527</td><td>45%</td><td>43%</td><td>48%</td></tr>
<tr><td>PGE</td><td>423</td><td>46%</td><td>44%</td><td>49%</td></tr>
<tr><td>SCE/SCG</td><td>73</td><td>41%</td><td>34%</td><td>47%</td></tr>
<tr><td>SDGE</td><td>31</td><td>44%</td><td>33%</td><td>54%</td></tr>
<tr><td>Short form</td><td>132</td><td>42%</td><td>35%</td><td>49%</td></tr>
<tr><td>Long Form</td><td>395</td><td>46%</td><td>44%</td><td>49%</td></tr>
<tr><td>Inland</td><td>288</td><td>45%</td><td>42%</td><td>49%</td></tr>
<tr><td>Coastal</td><td>239</td><td>45%</td><td>42%</td><td>49%</td></tr>
<tr><td>One to Two measures</td><td>35</td><td>54%</td><td>42%</td><td>65%</td></tr>
<tr><td>Three to Four measures</td><td>150</td><td>42%</td><td>38%</td><td>47%</td></tr>
<tr><td>Five to Seven measures</td><td>288</td><td>45%</td><td>41%</td><td>48%</td></tr>
<tr><td>Eight to Eleven measures</td><td>54</td><td>50%</td><td>42%</td><td>59%</td></tr>
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					We will revise the text of our recommendation to reflect that to increase the options for partial free ridership would have increased the granularity of the data, if the survey conditions permit it. For example, the survey used in this study asks if the participants would have installed the measure "later". An expanded survey could include multiple choices such as "3 months later", "3 to 6 months later", etc. allowing to develop more detailed estimates for partial free-ridership. As with any survey, balancing respondent fatigue with a desire to capture more granular information was a major consideration for us. This survey had 25 QET questions in total across 11 measures. An additional question and/or 2-3 response options added to each of these could add significantly to the respondent burden.
5.	NTGR Survey / IOU Comments[21]	pp. 77 and 78	Comment	While the SRA Guidelines stress the importance of consistency checks, there was only one consistency check and it was for the Overall NTGR battery (see Question T2 on p. 78). The batteries for the individual measure NTGRs contain no consistency checks. The response options for the timing question (e.g., Question T2 on p. 78) include "Earlier" which seems illogical. That is, if, in the absence of the program, the customer would have installed it earlier, wouldn't they have installed it prior to participating in the program and you wouldn't be interviewing about the installation of the measure through the program? As a	This is true. The questionnaire did not accommodate 11*4=44 potential consistency checks across all measures. Delay is possible, and we see it often in programs. Customers learn that a program is available and wait to do a retrofit so that they can avail of program rebates. In the absence of the program they would have installed earlier and hence are free-riders. "Earlier" is definitely not excluded from the calculation of the NTGR.

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				result, should those who answered "earlier" have the timing question excluded from the calculation of their NTGRs?	
6.	NTGR calculations / IOU Comments[21]	Section 3.4	Comment	Given that the treatment received by participants received varied depending on whether ARRA funding was available, NTGRs should be calculated separately for groups that participated in the IOU programs during periods when ARRA funding was available and for groups that participated in the IOU programs during periods when ARRA funding was not available. See Section 3 of Attachment B section for a more detailed discussion. Since ARRA matching rebate was not at all considered for this study design, would it be appropriate to note this as limitation and an issue that was not addressed?	ARRA can be mentioned more for context. We did not attempt to isolate the effects of ARRA and IOU rebates on attribution. This information was not included in the tracking data. The survey does not include questions that ask respondents if they received rebate checks separately under ARRA and EUC. Therefore, we are unable to perform the requested analysis. Last, it is not clear whether the elimination of dual rebate participants (ARRA and IOU) would increase or decrease program attribution. It is plausible that a non-free-rider is more likely to implement measures he was not considering if the rebate is larger.
7.	Comparison group design / IOU Comments[21]	p. 23	Question	On p. 23, the report states that the comparison captures the natural trends (among the residential population).However, aren't natural trends the very definition of the counterfactual, what would the participants have done absent the program? Consequently, aren't the differences between the participants and comparison group members closer to net savings than gross savings? Is it correct to define these savings a "gross"? See Section 2 of Attachment B for further discussion.	The counterfactual for a set of participants is that exact set of participants without the program. (e.g., in a parallel universe). All of the real world participants engaged in installation behavior. Most programs are designed to increase the efficiency of work that would occur without the program but at a lower efficiency. Under this scenario, in the counterfactual group, many or most would have still engaged in installation behavior, either at standard efficiency levels (one of the program target groups) or energy efficient levels (free-riders). Those who, in the counterfactual group, would not have taken part in installation behavior would be early adopters or induced installers. Each of these scenarios has its representative pre-post change in consumption: all other characteristics

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					being equal, existing efficiency to program efficiency should cause the greatest decrease; existing-to-standard efficiency is expected to cause some reduction, while a site that does nothing (existing-to-existing) has no program-related effect. Removing the pre-/post-installation effect of the counterfactual version of the participant group from the pre-/post-installation effect of the actual participant group would provide a true full net savings estimate. Free-riders would effectively show full "program" effects in both the participant and counterfactual group, producing no net savings. The primary targets of the program would be assigned savings that reflect the difference between standard and program efficiency (counterfactual reductions from the existing-to-standard efficiency measurement removed from the participant existing-to-program efficiency measurement). A comparison group constructed from the general population would have few similarities with the theoretical counterfactual comparison group described above. First, there would be very little installation behavior. Installation behavior would only occur at the natural rate in the population (in this case, the percent of population retrofitting homes in any given year). So, while in the counterfactual group a high percentage would likely engage in installation behavior, either at standard efficiency levels, in the constructed comparison group high percentage would not. In fact, of the small number of sites with installation activity that might be included in the constructed comparison group, we would expect an under-representation of free-rider behavior

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					because of the selection into the program of those intending to install. For these two reasons, the constructed comparison group will not include the appropriate percentages of sites exhibiting existing-to-standard or existing-to-program reductions in consumption. In fact, the majority of the constructed comparison group will have no installation-related change during the period (existing-to-existing efficiency) and so will be indistinguishable from the counterfactual early adopters. At the best this constructed comparison group would give mostly gross results relative to the existing efficiency baseline. We construct the comparison group of subsequent participants precisely because there is a high probability that they did not take part in installation behavior a year or two prior to participating in such a program. This makes them representative of natural, non-program change only. To reiterate, participant pre-/post- includes program effects and non-program effects. Non-participants are our best estimate of non-program effects only.
8.	Comparison group design / IOU Comments[21]	pp. 16, 19 and 64.	Comment	ARRA may have officially ended on March 2012, but there was an ARRA extension to allow the local governments to use their funding. This ARRA extension fueled a substantial round of ARRA matching rebates from SoCalREN, driving the program participants to SoCalRen and more coastal locations, thus making 2012 and 2013 participant characteristics to be substantially different for the SCE/SoCalGas	Note that the comparison is only made to pre-retrofit usage of 2013 participants. The climate zone shift is notable from 2011 to 2012. Subsequent and present participants share the key characteristic of program participation. This implies that both groups consist of households that need a retrofit, can afford a retrofit and would look to a program to do an efficient retrofit. Of equal

#	Subject Source	Ref.	Type (Question or comment)	Comment or Question:	Responses
				joint EUC program. This would make a 2012 and 2013 program comparison to be inappropriate. As indicated on the bottom of page-35, the comparison sample for SCE/SCG did not match well. The comparison sample size for SoCalGas and SDG&E may be too small. Given these disclosure, why would you proceed to produce this gross savings realization analysis result. Would it be better to just say that you are unable to produce a quality result (i.e., allow pass-through)? Since this comparison analysis has so many ~~inherit~~ inherent problems, why not spend more time on your alternative analysis which is buried in the appendix. Please see Section 3 of Attachment B for a more detailed discussion.	importance, the future participation of the comparison group effectively guarantees that there is no installation activity among the comparison group sites during the evaluation period. This is essential to defining the estimated change as gross savings (see question/comment #6). While a geographically dissimilar comparison group is not ideal, the participant characteristics are still of greater importance. The geographical dissimilarity would only be a primary concern if a strong argument could be made that the weather-normalized, pre-post change in consumption for the comparison group was not reasonably representative of the non-program change among participant households. The alternative in the appendix, no comparison group at all, is analogous to assuming that the comparison group has no non-program change. This assumption appears to be more arbitrary than choosing the comparison group based on participation decisions despite geographic dissimilarities.
9.	Comparison group design / IOU Comments[21]	Section 2.1.2	Comment/Question	In responses (5/9/14) to prior IOU comments (4/30/14), DNV-GL responded: "In 2010-12, NTG is effectively "net of free-riders". Free-ridership may be addressed if the comparison group also performed some form of retrofit. For WO46 the comparison group is chosen to have similar characteristics, but they did not perform any retrofit in the analysis period. Therefore the comparison does not seem to represent what the treatment group would have done in the absence of the program. Applying the free-ridership estimate to the pooled fixed effects results WITHOUT	See question/comment #6

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				comparison group would actually produce lower net realization rates which seems counter to the argument of a double negative adjustment. The comparison group is actually a positive adjustment to the gross savings." Our subsequent response is: (1) First, how do you know whether members of the comparison group did not perform any retrofit in the analysis period since you didn't survey them? To the extent that they did, the results are to some extent net. (2) Second, that the "gross" savings increased with the addition of the comparison group might mean that the net savings are higher simply because members of the comparison group increased their energy use in the post period. (3) Finally, it still seems that there is general confusion about the uses of comparison groups and how results using various types of comparison groups should be interpreted. Please see Section 2 of Attachment B for a more detailed discussion.	
10.	Net results / IOU Comments[21]	p. 57	Question	What the achieved relative precision for the total net saving for each IOU and fuel? It would be helpful if you could calculate the relative precision in a way that takes the propagation of error into account.	This will be included in the Report.

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11.	Partial Free-Ridership / IOU Comments[21]	Key Findings Page 2	Question & Comment	As program is designed to guide homeowners to expand from single measure EE installation to address the "whole house" of variety of measures – why is participation of that nature then subjected to partial citation of free-ridership. Program has achieved its goal in these cases. Isn't expanding from single/few measures to more measures exactly what the program is designed to achieve? Why is impact reduced by a partial (-50%) credit. As we have indicated during survey design review and interim report review, it is inappropriate to sort the free-ridership on a measure per measure basis, when the program design is to drive for deeper and more comprehensive energy savings by promotion comprehensive retrofits. Can you show the free-ridership analysis for the short-form versus the long-form survey customer segments by IOU?	Currently, all retrofit savings are considered program savings. If only those measures that are induced by the program are considered in program calculations, program attribution will go up and total savings will go down. This is in line with one of the report's recommendations – to incent only those measures that are induced by the program, and not those originally considered by the program participant without the program. We first asked the decision maker if they decided on package of measures and if they indicated that it was a single purchase decision, their free ridership scores are computed for the whole package. If they indicated that they considered each measure individually, we assess their free ridership levels for each measure, given the variable level of savings for each measure, and then aggregate these up to a free ridership score for the whole package of measures that they installed. With respect to the free-ridership analysis for the short-form versus the long-form survey customer segments, Table 20 in the current version of the report summarizes these scores. Free-ridership for short-form and long-form respondents are 42% and 45% respectively.
12.	NTGR Survey	Section 3.2 Surve	Question	An overall completion rate of 14.5% is stated. Would it be possible to define that figure for the two separate survey efforts, the short form and	It is not possible to answer this question because we do not know if incomplete interviews would have been a long or a short form. In other words, this was

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		y Disposition Pages 45-46		the long form? Different information was garnered in each survey – and it is important to assess this criteria by each survey instrument, in addition to an overall figure/level.	one single survey effort, where the short and long forms were applied based on the responses to the first survey questions. In other words: AAPOR RR3 = Complete / Valid Of the completed surveys, we know how many took the short form versus the long form based on their responses. For those that did not take the survey, but that we attempted to reach, it is not possible to determine which of these would have ended up as short or long form survey respondents. Hence we cannot compute separate response rates and furthermore, short and long form survey respondents is simply our nomenclature for respondents to the same single survey for which we have ONE response rate as reported.
13.	Reasons for negative energy savings / IOU Comments[21]	Conclusions Page 6	Question	The cause of negative energy savings is identified as “”(b) indications of substantial takeback:”. Would authors agree – as revealed in PG&E marketing study – that factors of “occupancy change” and also “replacement of non-functioning equipment, or installation of new equipment” would also be reasons for increased energy usage post-retrofit? Would it be more accurate to state all three of these reasons as possible drivers of higher energy usage post-retrofit? See Appendix B-4. The “Rebound Indicators” stated in this study verify the array and significant levels of this expected and reasonable increase in energy usage within the Whole House program effort.	“Replacement of non-functioning equipment”, and even more so, “installation of new equipment that did not exist before” are forms of take-back. We added a section to the report with indicators of take-back. Survey results indicate that 11% of program participants increased occupancy after the retrofit, and the same percentage (11%) decreased occupancy after the retrofit. On average, increases and decreases in occupancy cancel themselves out. Please see Question 24.

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				All of the above could also be caused by poorly matched and/or controlled comparison group, especially when ARRA funded activities are not properly accounted for.	
14.	Additional analysis of peak savings / IOU Comments[21]	Evaluation Overview Page 8	Question	Please explain how additional analysis of peak savings using interval (smart meter) data from program participants currently being done by the evaluation team will factor into this draft of a final report? Are more evaluation results forthcoming?	We do not expect the Realization Rate estimates to change as a result of forthcoming peak savings analysis. The evaluation team is analyzing peak savings for EUC participants using interval data. Preliminary results show decreases in peak demand; modeling savings is the next step.
15.	Distribution of program participants / IOU Comments[21]	1.4.1 Geographical Distribution Page 14	Question	The report states that the program concentrated on areas that are in mild weather. Would it not be more correct to conclude and state that the program participants were generated from all across the IOU territories, in alignment with population concentrations (see Population Density map vs. Program Participant map in Appendices C1-C3)? There seems to be a very close alignment between "population density" and "program participation". Also the majority of ARRA funding was distributed to homes in the major population centers, therefore higher update in these coast areas. Would it not be more appropriate to state that the program participants aligned with overall population density and the ARRA funding from major population centers, instead of stating that the program concentrated on mild weather areas? See Appendix B-1, B-2 & B-3.	Both are correct: the program concentrated in areas that are more densely populated and in mild weather. This does not change the fact that savings in these areas will be naturally lower. The population density map shows that areas such as San Joaquin and Fresno also have high population concentrations. These areas use more HVAC energy than coastal areas.

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16.	Impact of Double Incentives from ARRA program / IOU Comments[21]	1.5 Timing of Participation Page 17	Question	Figure 5 reveals the higher levels – peaking at two-fold the level of uptake for the "regular" Whole House program that was achieved prior to the March 2012 conclusion of the ARRA programs. As the report states that ARRA and IOU incentives were matching – would it be appropriate to cite the fact that ARRA rebates on top of IOU rebates drove the program participation to levels twice as high – validating the impact of incentives on participation?	The increase in participation peaks at the end of the ARRA program. This is an indicator that the rebates influenced the timing of the retrofits, which in turn increases attribution. However, this will show in the NTGR inasmuch as it shows in the survey responses.
17.	Early retirement vs. burn-out / IOU Comments[21]	1.6 Pre-Retrofit Equipment Conditions for Advanced Path	Question	Is the citation that the program does not make adjustments for savings estimates when some retrofit measures are replaced upon burn-out not a contradiction of the overall goal of the program? The program is designed to guide customers to: 1.) install the most efficient energy efficient appliances possible; and 2.) lower the capacity required for HVAC components by installing the necessary sealing and insulation to achieve the lowest energy production possible; 3.) guide consumers to replace outdated equipment instead of repairing it. Each of these program elements result in significant energy savings whose value would be unfairly reduced by accounting for program burn-out replacement equipment baselines.	It was important to note the requirements as set forth in the Decision. When adjustments for replacement on burnout are possible, these decrease program attribution because burn-out equipment had to be replaced anyway. There is no influence in timing, and the only attribution is if the program influenced the installation of high efficiency instead of regular efficiency equipment. The additional points need to be documented – evidence of reduced sizing will lead to demand savings, but will have marginal energy savings. Early retirement may in fact be a program element, but documentation on the replaced system is required to make that claim. This Advanced program likely collects enough data to make the claim with some simple extraction of data from the model files.
18.	Inclusion of Different Program – SMUD ARRA	2.2 Data Summary Table 9	Question	As the report reveals in Figure 5 for PG&E – overlap with the SMUD "double incentive" ARRA program in 2011 thru March 2012 dramatically impacted cooperation rates for PG&E – but we service only the gas fuel for SMUD homes. As Table 9 reveals – 1,173 of the 3,823 homes analyzed for PG&E were "gas only" – that represents 31% of the total cases included	It is unclear how dual fuel and single fuel homes are affected since the analysis is at the fuel level. Is there a reason to expect gas savings would differ in a whole house treatment depending on the electric utility? The CPUC requires evaluation of all program results. If the IOU claims program savings for Gas-only customers, those savings have to be evaluated too.

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	Funded in Sacramento / IOU Comments[21]			in the analysis. As the highest realization rates are reported for the single fuel services (SCE – 50% and SoCalGas – 64%) – would it not be appropriate to look at PG&E performance for Electric and Gas in combination only among homes where we provide both fuels and are in full control of the program and thus responsible for all the results?	
19.	Appropriate Comparison Groups / IOU Comments[21]	2.3.2 Pooled Fixed Effects Model Results – Page 36	Question	"The analysis team did not consider creating a comparison group by matching participants to the general population because it is not possible to compensate for self-selection… To incorporate these factors… would be very difficult and expensive." Would it not be appropriate to follow this statement with the admission of what the error range of the Pooled Fixed Effects Model" is –based upon this admission of a limitation in quality of the statistical analysis due to analytical and cost challenges?	This statement was included to explain that it is not possible to create a comparison group from the population as a whole. The use of future participants as a comparison group is valid.
20.	Small comparison samples for 2012 / IOU Comments[21]	Page-35	Comment	(1) Please review the comparison sample size for SoCalGas and SDG&E for 2012. They may be too small to have much detection power. (2) Also, you mention the response rate is very low. Can you please provide a disposition on the response rate? A lower than expected response rate could contribute to self-selection biases.	(1) The precision of savings estimates incorporates the effects of small sample sizes. Smaller sample sizes could cause a savings estimate to become non-statistically significantly different than zero. However, this does not appear to be the case in this instance. For example, the Basic path program results for 2012 have much lower magnitude savings than the 2011 results. The Standard errors are also actually lower than the 2011 result standard errors, but compared to the savings magnitude are sufficiently large to make the results non-significant. This comparison points to a change in savings magnitude driving the difference in the statistical precisions of the estimates.

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					(2) A response rate table has been added to the report.
21.	NTGR calculations*/ IOU Comments[21]	Section 3.4	Comment	In addition to case weights, did you weight each respondents NTGR by their ex post gross savings?	No. We did not calculate ex post gross savings on an individual basis. See below for how ex ante estimated savings were used to estimate respondent case weights
22.	NTGR results/ IOU Comments[21]	Page 53	Question	Would you please clarify the calculation and the rationale for the measure cost and measure savings weights and provide examples of how the weights were calculated?	Ex Ante estimated savings were used in case weights as described below. The measure cost weights and measure savings weights for the scoring algorithm were derived from Advanced path ex ante estimates where available. The weights were needed to properly account for the individual measure questions into a respondent level score. Measure savings are used to calculate a weight that represents the relative importance of program participants to the program's overall savings. Measure savings were used in the program participant stratification (the sample design) and the subsequent weight estimation, as explained below. Advanced Path participants were classified in cells based on the IOU that serves them and their T24 climate zone. Within each of these cells, participants were sorted by their ex ante savings, and classified into top third, middle third, and bottom third savings for each commodity, and "zero savings". "Zero savings" are those where the utility does not serve that commodity and a corresponding account at another utility could

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					not be identified. The sum of the weights adds up to the number of Advanced Path participants. An example of the weights calculation is provided below: IOU: PG&E Climate zone group: I (inland) kWh ex ante savings level: 1 (bottom third) Thm ex ante savings level: 1 (bottom third) Advanced Path program participants in this cell: 556 Number of completed surveys in this cell: 63 Weight = 556/63 = 8.8
23.	Section 3.5/ IOU Comments[21]	Page-53	Question	Why is this complicated weighting scheme necessary? When you created weighting, then re-weighting, what are you doing to the confidence and precision of the intended results? In this case, why is case-weighted and measure cost weights necessary in addition to the weights introduced in Section 3.4.2?	Case-weights extrapolate the sample to the population. Measure cost weights and measure savings weights acknowledge the fact that measure costs are different and implemented measures also deliver variable level of savings. This report presents free-ridership scores that have been weighted using just the case weights and also using measure weights.
24.	Change in Normalized Annual Consumption/ IOU Comments[21]	2.3.1 Site Level Model Results Figure 7 Page 33 Reference to Section 3.8	Question	Report states: "We also found that more than 30% of the participants showed an increase in electric NAC after participating in the program…" The IOU Process Evaluation efforts have confirmed some very valid reasons for increased energy usage – in addition to take-back of savings by changing thermostat settings. (Please see Appendix B-4.) Increased energy usage driven by: 1.) changes (increases) in occupancy; and 2.) installation of HVAC equipment that is new – or replaces equipment that was not functioning previously. These are changes in energy usage that are beyond the control of the EUC Whole House program, and	As mentioned in Question 13, increases and decreases in the number of occupants balance each other out. The main purpose of the Whole House Retrofit program is to decrease energy use. Increases in energy use (and comfort) due to equipment that did not exist before are properly accounted as an increase in energy use. Not all additions of equipment that did not exist before result in energy use increases. Some program participants added second units that did not exist before. For example, a house with a CAC that added a second CAC. It is possible that the second unit

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		Rebound Indicators Pages 60 & 61		its energy savings performance should not be diminished by inclusion of these cases. The IOUs request that these cases of 1.) changes in occupancy; and 2.) installation of equipment that is a new energy use – be excluded from the calculation of energy savings. This report references an array of "Rebound Indicators" which include: 1.) adding a 1st or 2nd Central Air Conditioning unit that did not exist before; 2.) adding a 1st or 2nd Furnace that did not exist before; 3.) increasing the square footage of the home; 4.) adding a pool or a spa that did not exist before; as well as 5.) adding room air conditioners that did not exist before. Would it be possible to summarize the percentage of homes that are included across all these "Rebound Indicators" (% that have any of these "Rebound Indicators", so that an overall impact of this additional and very valid increase in energy usage can be assessed?	results in lower energy use because the house was zoned and/or the second unit reduces distribution losses. About 15% of all program participants have at least one rebound indicator. This was included in the report.
25.	Comparison Group/ IOU Comments[21]	Page 35	Question	On page 35, the Report states: "Specifically, we used 2012 program participants as the comparison group for 2011 program participants and used 2013 program participants as a comparison group for 2012 program participants. Details about comparison group specification are described in the methodology section." In the remainder of the report, no information is presented on the members of the 2013 participants. For example, there is no information presented on the number of sites in the participant and comparison groups or their energy use.	Table 10 presents information on the number of sites in the participant and comparison groups. Table 10: Number of Sites Used in Analysis in the Participant and Comparison(a) Groups for Program Year 2011 and 2012

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IOU	Fuel	Group	Basic 2011	Basic 2012
PG&E	Electric	Comparison	--	--
		Participants	--	--
	Gas	Comparison	--	--
		Participants	--	--
SCE	Electric	Comparison	712	340
		Participants	313	721
SCG	Gas	Comparison	--	--
		Participants	--	--
SDG&E	Electric	Comparison	302	32
		Participants	19	303
	Gas	Comparison	296	38
		Participants	20	295

The Table below will be added to the report. It summarizes average consumption for each group, fuel type, IOU and program year

IOU	Fuel	Group	2011 Program Year Pre	2011 Program Year Post
PGE	Electric	Comparison	7,996	8,00
		Treatment	8,327	8,09
	Gas	Comparison	604	58
		Treatment	620	50
SDGE	Electric	Comparison	6,474	6,68
		Treatment	7,123	6,92
	Gas	Comparison	396	40
		Treatment	413	34
SCE	Electric	Comparison	7,821	8,10

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		Treatment	9,948	9,906	8,308
		Comparison	531	508	565
SCG	Gas	Treatment	477	388	495

26.	Comparison Group/ IOU Comments[21]	Page 36-37	Question	The Report states: "Because it is likely that 2013 Program participants are different from the 2010-2012 Program participants, creating a valid comparison group from 2013 participants to mirror 2012 participant characteristics is difficult. We identified the following differences: for PG&E, we found that the percentage of 2013 participants was higher in CZ 12 and 13 compared to 2012. Also, PG&E consumption trends between the two groups diverge. SCE had a higher percentage of 2013 participants from CZ8 compared to 2012. We also found that consumption trends of 2012 and 2013 participants during the pre-program period were not similar for SCE." Despite this, fixed effects regression model were estimated comparing the 2012 participant to the comparison group composed of 2013 participants. Why aren't the resulting estimates biased? In addition, the standard errors for the savings reported in Table 11 are quite large. For example, the standard error for the fixed effects electric model for 2012 participants with a comparison group is 73.6. Using the critical value of 1.645, the 90% level of confidence, the relative precision of the estimated savings is	The precision of billing analysis results reflect the natural variability of consumption data. This shortcoming of billing analysis is balanced by the fact that the approach measures empirical change in consumption unlike so many other evaluation approaches. Given small sample sizes at the year, IOU and program-type level, it is not a surprise that the results have relatively low precisions. We discuss elsewhere the reason for sticking with the comparison group despite these concerns. There is always the possibility that results are biased, and it is the job of the evaluator to attempt to minimize that bias. Though there may be bias related to the CZ differences, etc, there is no evidence of a systematic positive or negative bias.

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				57%. Or, for the same model for SCE, the relative precision of the estimated savings is 56%. Or, for the same model for SDG&E, the relative precision of the estimated savings is 3,260%. Similar calculations for all the results with and without the comparison groups show that the relative precision is very poor. The high level of uncertainty and their implications for the resulting realization rates are not discussed in the report. Given the potential for bias and the poor relative precision, can the savings estimates and the realization rates presented in Tables 11 and 12 be trusted?	
27.	Reporting/ IOU Comments[21]	Appendix B	Comment	The full results of the various regression models are not reported. The estimated coefficients, their standard errors, their t values and accompanying p values are not reported for any of the models. Table 29 only reports for each final model the n, the savings estimate, the standard error of the savings estimate and the savings as a percent of pre-installation consumption. In addition, there is no information on the performance of the model like R^2 and any of the standard regression diagnostics to detect such things as autocorrelation, omitted variables, collinearity, and heteroscedasticity. This report fails to meet the basic reporting requirements as outlined in the *California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals*.	DNV GL apologizes for this omission. Coefficients, clustered standard errors, t-values and accompanying p values have been added in the report as they were in the preliminary results. We used robust-clustered standard errors to allow for arbitrary correlation among errors within each site. We controlled for within cluster correlations to avoid misleading confidence intervals of savings estimates and large t-statistics.

<table>
<tr><th>#</th><th>Subject Source</th><th>Ref.</th><th>Type (Question or comment)</th><th>Comment or Question:</th><th>Responses</th></tr>
<tr><td>28.</td><td>Need for Financing/ IOU Comments[21]</td><td>Key Findings Page 3</td><td>Question</td><td>Is “Finding” that Pacific Coast homes have little need for financing correct when the overall finding states: “Almost 60% of participants did not avail of project financing” (Appendix C. Page 70). This means that more than 40% plus of all participants DID need financing. This brings into question the statement that Pacific homes have little need for financing as these Pacific homes represent a large component of all homes. Therefore, it is doubtful that their financing utilization is “little”. Can this statement refer to the exact percentage of Pacific homes that did use financing, or be deleted from the key findings?</td><td>The following table will be added to the report to confirm the statement in the report. 9.4% of the total sample were coastal homes that used financing. This table will be added to the report to support this finding.
Table of PF1 by coastal
PF1 | coastal | Frequency | Weighted Frequency
0=No financing | Inland | 129 | 13
0=No financing | Coastal | 183 | 14
0=No financing | Total | 312 | 28
1=Yes, used financing | Inland | 159 | 15
1=Yes, used financing | Coastal | 56 | 45
1=Yes, used financing | Total | 215 | 19
Total | Inland | 288 | 28
Coastal | 239 | 19
Total | 527 | 48</td></tr>
<tr><td>29.</td><td>Recommendations/ IOU Comments[21]</td><td>Page 64</td><td>Question</td><td>The report states: “Only provide incentives and claim savings for measures that the customer was not already considering. Only modeling the measures the customer would not have done in absence of the program will reduce free ridership. This documentation of which measures the customer would be doing can also support identifying early replacement measures and distinguishing them from replace on burnout. The incentives would also then support “deeper” retrofits as opposed to providing some funding for free rider measures and only partial funding for additional measures.” This may also allow the programs to begin to track how much “deeper the retrofit goes than what the customer may have be doing without the program.” You are not suggesting</td><td>This statement has been edited. We agree separation for incentives may be difficult. This changed to only talk about claiming savings above what the customer would have done anyway. For simulated savings, wouldn't it be best for the IOUs to track what measures the customer was already considering and look at the impacts only of the measures above and beyond what the program induced.

This does not suggest the comparison group addition results in net savings estimates. Only that to exclude self-identified free-rider behavior from program incentives and savings calculations will reduce the program’s free-ridership scores.

In this instance, “modeling the measures” refers to building modeling – determining the savings expected from each particular site.</td></tr>
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				that a customer who is only considering the installation of a particular measure is by definition a free rider? Do you have a method that would reliably identify free riders before they receive any incentives? In addition, the second sentence ("Only modeling the measures the customer would not have done in absence of the program will reduce free ridership.") also suggests that the regression models with participant and comparison groups are estimating net savings, not gross savings.	
30.	Climate impact on Realization Rates/ IOU Comments[21]	Program Impacts Page 3	Question	If the impact of "coast compared to inland" on energy savings estimates is cited, shouldn't the impact of "northern" vs. "southern" climate zones also be specified?	Each of the IOUs has a coastal area that tends to be milder, and an inland area that tends to be warmer. Since we report results at the IOU level, a "northern" vs "southern" distinction is not necessary.
31.	Ventilation vs. Air Conditioning/ IOU Comments[21]	Program Impacts Page 3	Question	Should statement: "…realization rates are the worst for PG&E which had participation in areas with good opportunities for night cooling with *air-conditioning*." not instead refer to "…good opportunities with *ventilation*."?	Yes – Change to night ventilation
28	Application of Energy Saving	Recommendations Page	Question	Should the following sentence be re-phrased since we don't understand it: "The recommendations in this section require that future estimates are calibrated or are more	Yes. "The recommendations in this section assume that future ex ante estimates will be more accurate than

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	Estimates/ IOU Comments[21]	5		accurate than current estimates."	the ex ante estimates that were used in the first three program years. A comparison to recent billed energy use for each program participant prior to approving program participation and rebate levels will reveal whether these estimates are realistic or not. When compared to actual energy use, a high percentage of the program's 2010-2012 projects claimed energy savings that were unrealistically high."
32.	Difficulty and cost of generating data/ IOU Comments[21]	Recommendations Page 6	Question	Report states that including factors in analysis that "would be difficult and very expensive" (page 36) is acceptable rationale for excluding from the analysis. Would authors agree that "identifying early replacement measures and distinguishing them from replace on burnout" would also be difficult and very expensive data to accurately define and collect from customers? Therefore is this really a fair recommendation to direct to the IOUs?	Early retrofit Vs replace-on-burnout questions are not difficult or expensive to collect in the Advanced program since all pre-retrofit conditions are collected to inform a building model. If a program participant is going to replace their CAC, the question would be limited to "Is the CAC unit you are replacing in working order? Yes/No" (or similar wording.) Utilities collect similar information for other appliance programs.
33.	Assumption regarding coastal home baseload/ IOU Comments[21]	Recommendations Page 6	Question	On what basis is the statement made that: "Homes with higher consumption near the coast have greater baseload than cooling load"? Isn't that issue highly dependent upon the key factors of home size, layout and construction, micro-climate location, and energy usage behavior within the home? Is there any data that the report authors can state that can validate this general statement about the specific cases of coastal homes included in this report?	The relative size of the baseload can be estimated by comparing summer consumption to consumption at times of the year when cooling and heating loads are minimal to non-existent. A home for which summer consumption is no different than "shoulder" (for example, March or April) consumption is assumed to have no cooling load (either because they do not have air conditioning or because they choose to not turn it on). Baseload consumption can be measured in months when there is no cooling or electric heating, and it is typically defined as the months of lowest consumption in the year. There are "baseload only" months both before and after the summer months. The ratio of summer to shoulder consumption is lower for coastal homes than it is for inland homes. DNV GL examined the relative size of the baseloads of program participants by comparing the

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					distribution of monthly energy use at the climate zone level. These distributions are reported in the preliminary results published in October of 2013.
34.	Advanced Lighting, Home Appliances, electronics/ IOU Comments[21]	Page 6, last recommendation	Question	Re: statement: "… the program should emphasize measures that focus on advanced lighting, appliances and electronics…." The EUC program is designed to encourage loading order of EE enhancements. Are you saying that the program is not achieving this loading order priority? What is the basis for this recommendation?	This recommendation is based on our assessment that coastal homes do not have high summer space conditioning loads, and as such, measures that are designed to reduce HVAC energy use do not have a high electric impact. Please see Question 33.
35.	Program offering of Financing/ IOU Comments[21]	1.2 Program Descriptions and Participations Page 8	Question	What program is referred to by: "…use the Energy Upgrade California… financing program"? The financing pilots have not launched yet, so there is no Statewide financing program directly tied to the IOUs at this time. What financing program is the report referring to?	Changed to private financing or IOU Financing Pilots
36.	IOU and CEC/ARRA programs/ IOU Comments[21]	1.2 Program Descriptions and Participations Page 9	Question	Report states: "… the IOU programs offered matching rebates to the CEC programs." The IOUs recollect that it was the reverse situation – that the local ARRA programs matched (doubled) the rebates that the IOU programs offered. Would you agree that it would be appropriate to state the correct history as regards "matching rebates"?	Changed to - the IOU programs and CEC programs offered matching rebates
37.	Performance	1.2 Progr	Question	What is a "*performance rating*" as mentioned in statement: "…the ARRA Whole House Programs	ARRA in some cases paid no money for rebates, but did pay for initial assessments. In those cases if the

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	Rating/ IOU Comments[21]	am Descriptions and Participations Page 9		did not provide direct rebates, but paid for a performance ratings that can lead customers…"? The IOUs are not familiar with this term "*performance rating(s)*" – what does it mean?	customer did not go forward with the retrofit then the IOU would not have claimed the project.
38.	Inclusion of Different Program – SMUD ARRA Funded in Sacramento/ IOU Comments[21]	2.2 Data Summary Table 9	Question	As the report reveals in Figure 5 for PG&E – overlap with the SMUD "double incentive" ARRA program in 2011 thru March 2012 dramatically impacted cooperation rates for PG&E – but we service only the gas fuel for SMUD homes. As Table 9 reveals – 1,173 of the 3,823 homes analyzed for PG&E were "gas only" – that represents 31% of the total cases included in the analysis. As the highest realization rates are reported for the single fuel services (SCE – 50% and SoCalGas – 64%) – would it not be appropriate to look at PG&E performance for Electric and Gas in combination only among homes where we provide both fuels and are in full control of the program and thus responsible for all the results?	It is appropriate to evaluate results in the PG&E service territory based on all rebates issued by PG&E. Since the program was not analyzed this way, we do not have evidence that evaluating results of only those that participants where PG&E serves both commodities would increase attribution. However, if PG&E feels strongly about this, PG&E may propose to limit its program activity to only those customers for which PG&E serves both commodities, or electricity only in the case of homes that do not have gas service from any provider.
39.	Time Frame for Job Completion/ IOU Comments[21]	2.1.2 Construction of the Comparison Group Page 22	Question	A "blackout period" for the completion of the retrofit job was arbitrarily assigned the timeframe of 60 days. Please explain the rationale for a specific date range of 60 days for the retrofit process. (Note: PG&E Program team is checking on an issue here – our "start" and "stop" dates may be defined by "participation submission" and "rebate check issued" – those can (respectively) far precede and far follow actual dates of the retrofit work. So a 60 Day range based on one or the other of these – may	We realize that the 60-day period will not conform to all program participants. Not having individual information about each program participant, we chose a blackout period that appears to conform to most. DNV GL is interested in learning about PG&E's findings regarding these tracked dates. The 60-day blackout was discussed during the presentation of preliminary results and received no

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<tr><td></td><td></td><td></td><td></td><td>be an erroneous range of project work dates).</td><td>substantial comments from any of the stakeholders.</td></tr>
<tr><td>40.</td><td>Examples of Pre- and Post-Data Designation</td><td>Table 6 Page 23</td><td>Question</td><td>It is not clear what Table 6 is attempting to explain. The statement: “Future installers for comparison (move installation date back by 14 months)” is unclear in meaning. Would you please re-state this concept and insert a figure so that we can understand what you are attempting to communicate?</td><td>Thank you for the observation. The text surrounding the table will be improved, and the table re-worded as follows:

Table 1: Example of Pre- and Post-Retrofit Designation
<table><tr><th>Program</th><th>Group</th><th>Install date</th><th>First Billing Period</th></tr><tr><td>2011 Evaluation</td><td>2011 Participants</td><td>Jan2011</td><td>Pre-Retrofit: Dec2009 – Nov2010</td></tr><tr><td></td><td>Future installers (2012 Participants)</td><td>Mar2012</td><td>Pre-Retrofit: Feb2011 - Jan2012</td></tr><tr><td></td><td>Future installers (2012 participants) used as comparison group</td><td></td><td>Pre-Retrofit: Dec2009 – Nov2010</td></tr><tr><td>2012 Evaluation</td><td>2012 Participants</td><td>Jan2012</td><td>Dec2010 – Nov2011</td></tr><tr><td></td><td>Future installers (2013 Participants)</td><td>Mar2013</td><td>Feb2012 - Jan2013</td></tr><tr><td></td><td>Future installers (2013 participants) used as comparison group</td><td></td><td>Dec2010 – Nov2011</td></tr></table></td></tr>
<tr><td>41.</td><td>Distribution of Participants</td><td>Figure 7 Page 31</td><td>Comment</td><td>Figure-7 is also confusing. It is not clear what the figures at the end of each bar represent. We understand that the numbers listed far within the range of that column title – but what do they actually represent?</td><td>Please see Question 42</td></tr>
</table>

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42.	PG&E Performance Analysis by Change in Normalized Energy Consumption	2.3.1 Site-Level Model Results Page 31	Question	The review of PG&E performance for Electric states: "slight *decrease* in the percent of participants in the lower bin". But the analysis of the other IOUs cite the consistent theme of "*increases*" in either lower bin (SDG&E) or upper bin "SCE". Would it not be appropriate to refer to PG&E performance as "slight *increase* in the upper most bin"? This communicates the same message – but in a positive tone – consistent with the focus on "increases" offered for the other IOUs.	This was done only to vary the text and did not mean to portray any utility in a negative light We removed these descriptions, as the changes from one year to the next are minimal.
43.	PG&E Performance Analysis by Change in Normalized Energy Consumption	2.3.1 Site-Level Model Results Page 31 – Figure 7	Question	The review of PG&E performance in Gas states: "increase in the percent of 2012 participants in the lowest bin". But the actual numbers showing in the chart are "Less than 0%" – 2011 -28.2% to -25.2%. A decrease in a negative number is positive and should be considered an "increase". But it is confusing to mix analysis of positive and negative performances in this regard – where the descriptions of "increase" and decrease" are reversed – depending upon the positive or negative status of the numbers analyzed. Would it not be clearer to state: "increase in all positive performance bins"?	The numbers on the axis at the bottom of the chart, "% of Sites", is the percent of program participants in each Change in NAC bin. The lengths of all bars for each utility and year add up to 1. The numbers next to the bars indicate the average for the customers in each bin, not the length of the bar. For PG&E, the percent of customers with negative savings went from less than 20% (the size of the horizontal bar) to more than 20%. The average amount of the negative savings (increase in energy use) went from -28.2% to -26.2%. We removed some of the text surrounding this graph.
44.	More complete assessment of Distribution of Participants by	2.3.1 Site-Level Model Results Figure 7 Page	Question	The summary explanation offers a summary statement about the overall trend of savings in electric NAC, but no assessment of changes in gas usage nor any comparison between electric and gas usage. Would it be helpful to state: "The tendency of customers to increase usage was revealed in this analysis to range in the 40% level. For electric usage, all three programs analyzed show that ~40% of their customers	Thank you for the observation. We will add Gas to the report.

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	the Change in Normalized Annual Consumption	31		resulted in using more electricity post-retrofit. In Gas – the increase in usage ranged from 20% to 40% of participating customers, across the three IOUs and two years analyzed."?	
45.	Mis-quote? – the description is not consistent with the graph (figure-7)	Page 31	Question	It looks like there was an increase in percent of 2012 SoCalGas participants in upper bin – looking at the > 30% bin x-axis, 2011 has about 23% participants and 2012 has about 28%. Again - this figure-7 is extremely confusing. Is it trying to cover too much information thus making this illustration unclear for the reader?	Thanks for the feedback. We will work on improving the text surrounding this figure.
46.	Explanation for the correlation cited	Page-33	Question	Can you explain these correlations on the bottom half of page 33?	We improved the explanations in the NAC section that lead to these correlations. We hope that clarifies them. .
47.	Analysis of Change in Normalized Annual Consumption by Quartile	2.3.1 Site-Level Model Results Figures 8 Page 33	Question	In association with Statement "d) For electric…" Would it be appropriate to note that the largest positive change in Normalized Energy Consumption (-11.43% to -5.70% - with a large/stable sample size) is achieved by PG&E in terms of diminishing the amount of "negative energy savings" (increased energy usage) in comparing Participants in 2011 to 2012?	Main purpose was to show that the bottom quartile is very unreliable, not to compare performance from 2011 to 2012. We removed this statement.

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48.	Analysis of Change in Normalized Annual Consumption by Quartile	2.3.1 Site-Level Model Results Figures 8 Page 33	Question	Is it appropriate to state as a summary analysis that "in terms of achieving the goal of decreased energy usage, each of the positive quartiles achieved more savings in Gas than in Electric?" If this chart reflects Quartiles ranked by savings realized – why are the SoCalGas quartiles not declining in Changes in NAC from Top Quartile thru Q3 and Q2?	Yes, there were more savings in Gas than in Electric. The quartiles reflect annual energy use, not savings realized.
49.	Analysis of Change in Normalized Annual Consumption by Quartile	2.3.1 Site-Level Model Results Figures 8 Page 33	Question	The headline states "Overall, we found that there is a correlation between greater household consumption before participating in the program and greater savings". Statement "c) continues "On average, households in the bottom quartile increased gas and electric consumption from the pre- to the post-installation periods…This finding shows the savings uncertainty of low users is high". Would it be insightful to clarify that: "Some of the homes in the bottom quartile of low energy usage had either 1.) increased occupancy; and/or 2.) installation of new equipment that replaced non-functioning equipment – or non-existent equipment – thus causing a significant increase in energy usage"?	We cannot make this statement because it does not derive directly from the data we analyzed. In particular: • We used all program participants with sufficient pre-/post-retrofit data in the calculation of NAC and energy savings, but we have survey data for only a fraction of these. • Based on our survey, the number of participating households that increased occupancy is roughly the same as those that reduced occupancy.
50.	Change in Normalized Annual Consumption by Quartile	Figure 8 Page 33	Question	The analysis states "b) Households in the top quartile reduced gas consumption at an average of around 20% or more for all IOUs except SoCalGas." Do you have any idea of why that might happened – that you can share in the analysis?	The number of participants for SoCal gas is very small. We see that, in 2012, the relative magnitude of the bars (biggest bar on top) starts to resemble that of the other IOUs as the number of participants increases.

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51.	Appropriate Comparison Groups	2.3.2 Pooled Fixed Effects Model Results Page 35	Question	Is it valid to establish comparison groups only on the variables of 1.) climate zone; and 2.) category of energy usage? Aren't there many other essential variables amongst households that can help define "similar energy users" – example: income; type of home; classification of residential area, etc.?	Categories are established based on known characteristics of all program participants. While there is no doubt that income is a determinant of pre-/post- energy use and the type of measures adopted, the program cannot use income to determine an applicant's eligibility to participate.
52.	Misspelling	Table 13 Page 41	Comment	Word "efficiency" is misspelled – in row titled "Partial Free-Ridership" – mid-page	Fixed
53.	Typo	Page 45	Comment	The title for Table 15 is missing.	Fixed
54.	Qualification of Short vs. Long Survey	3.1.2 Survey Version: Short-form vs. Long-form Page 42	Question	The report defines a "short" vs. a "long" survey. Would the authors please validate those titles by stating the average amount of time it took to complete those two respective survey instruments? How much time does "short" vs. "long" actually represent? Survey length is a very sensitive factor as it impacts cooperation rates, completion rates, and the quality of answers.	The average amount of time taken to complete the short form and the long form of the survey is 14.7 minutes and 17.1 minutes respectively. Respondents who took the short form of the survey are those that indicated that they considered all the measures installed as a single package for which they made a single purchase decision. A subset of short form survey respondents also availed of financing and were hence asked the entire series of financing questions. Short form respondents who did not avail of financing had an average completion time of 11.9 minutes and short form respondents who did avail of financing and proceeded to answer the finance question series had an average completion time of 17.6 minutes.
55.	Free-rider	Section	Question	Would you please report the free-ridership analysis results separately for the short-form	Have inserted additional rows in Table 20 with the information shown below.

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<tr><th>#</th><th>Subject Source</th><th>Ref.</th><th>Type (Question or comment)</th><th>Comment or Question:</th><th>Responses</th></tr>
<tr><td></td><td>survey results</td><td>3.1.2, starting Page 42</td><td></td><td>participants versus long-form participants by IOUs? You are currently showing this information in aggregate form only.</td><td>
<table>
<tr><th>Group</th><th>n</th><th>Free-ridership score</th><th>Std Error of Mean</th></tr>
<tr><td>PGE, short-form</td><td>106</td><td>42%</td><td>4%</td></tr>
<tr><td>PGE, long-form</td><td>317</td><td>47%</td><td>2%</td></tr>
<tr><td>SCESCG, short-form</td><td>15</td><td>42%</td><td>11%</td></tr>
<tr><td>SCESCG, longform</td><td>58</td><td>39%</td><td>3%</td></tr>
<tr><td>SDGE, short-form</td><td>11</td><td>43%</td><td>12%</td></tr>
<tr><td>SDGE, long-form</td><td>20</td><td>43%</td><td>5%</td></tr>
</table>
</td></tr>
<tr><td>56.</td><td>Scoring Examples</td><td>Page 45</td><td>Comment</td><td>We believe this formula is incorrectly stated. Suggest expressing as: (1.0+1.0+0.5)/3 = 0.83</td><td>Fixed.</td></tr>
<tr><td>57.</td><td>Calculation of Free Ridership Scores</td><td>3.3.3 Aggregated Overall Free Ridership: Page 48</td><td>Question</td><td>Would it be appropriate to weight the overall Free Ridership scores by the relative importance and energy impact of the various measures, where Free Ridership factors for each are aggregated into one number?</td><td>See section 3.6 for a discussion of free-ridership scores with measure savings weights incorporated. The example in 3.4.3 only illustrates the raw scoring algorithm without application of any weights (case-weights or measure savings weights).</td></tr>
<tr><td>58.</td><td>Free-ridership Case Weighted Scores</td><td>Table 19 & 20 Page 49</td><td>Question</td><td>These tables are confusing, and there is a lack of explanatory text. Note that there is a typo/extra text in one of the column titles in Table 19.
In Table 20, Row Number of Measures Installed 1-2, it is unclear how the formula with input values of 1 or .5 could result in results that range “>.75, <1”?</td><td>Free-ridership scores are computed at the respondent level and since each respondent could have installed a different number of measures, their overall free-ridership score is an average of their measure level free-ridership scores. Refer to sections 3.4.1 and 3.4.2 for a discussion on the exact scoring algorithm used.</td></tr>
<tr><td>59.</td><td>Distribution of Free-Ridershi</td><td>Section 3.4.2 &</td><td>Question</td><td>The statement “The majority of the respondents could have been described as partial free-riders at more than 80%, and significantly smaller segments of the sample could have been</td><td>Text revised.
“Overall free-ridership scores were computed for short-form and long-form survey respondents, as detailed in the scoring examples above (Table 18 and</td></tr>
</table>

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	p Scores	Table 23 Page 51 & 52		described at pure free-riders a 7% and 12% respectively." - is not evident from a review of Table 23. What does "…could have been described as…" mean? Is the majority of respondents described this way or not? The percentages of 80%, 12% and 7% are not evident in Table 23. What is the report trying to present here?	Table 19). The distribution of free-ridership scores across the total sample, both long-form and short-form survey respondents, are as displayed in **Error! Reference source not found.** below. Results specific to short-form and long-form survey respondents are summarized in Table 21. The majority of the respondents may be described as partial free-riders with more than 80% with free-ridership scores that are greater than zero and less than one , and significantly smaller segments of the sample were non free-riders and pure free-riders at 7% and 12% respectively".
60.	Chart Design & Spelling	Table 27 & 28 Pages 57 - 60	Comment & Question	Word "Evaluated" is misspelled with two "t's" in both of these tables. Should Table 28 also have a "Fuel Unit" column (#2) as included in Table 27?	Fixed both. Thanks.
61.	Distribution of Ex-Ante Savings …	Figure 9 Page 62	Question	Figure 9 is difficult to understand and interpret. There does not appear to be any explanation offered in association with this chart. Would it be possible to explain what this chart is presenting? (Note – typo bottom of page 61, extra period ".").	This figure presents the ratio of Ex Ante energy savings to pre-retrofit energy use. Its main purpose is to show that, for a very large group of participants, the estimated energy savings were unattainable. A ratio of 1 indicates that the ex ante savings is expected to be equal to the full amount of energy use in the pre-retrofit period. Any value larger than 1 is physically impossible. Energy savings overestimation occurred because the energy savings calculations did not factor prior energy use into the calculations. The two colors separate records on each side of the median. The rectangle in the middle represents 50% of all cases, while the "whiskers" on each side of the

#	Subject Source	Ref.	Type (Question or comment)	Comment or Question:	Responses
					rectangle represent 25% of the cases each. For example, the first quadrant (2011 Electric Participants) shows that: • All three electric IOUs have cases where the estimated Ex Ante savings are higher than the premise's total energy use. • Estimated savings of up to 200% of the total annual energy use are observed for all three utilities. • PG&E: the ex ante savings for approximately 40% of all 2011 participants is 75% or more of annual electricity use. • SCE: the ex ante savings estimates for approximately half of all participants is 75% or more. • SDG&E: the ex ante savings estimate for approximately 50% of all participants was greater than 1.
62.	Omission in Appendix	Appendix F – Page 101	Question	Should Table 1 "Central Furnace" have any rows to include SoCal Gas?	The format of files received for SoCal Gas Advanced path were not readable into the database, therefore those projects could not be summarized.
63.	**Energy Use Increase** / Efficiency First California			The whole-house efficiency market is new and very diverse. The finding that 70 percent of Energy Upgrade CA homeowners received significant energy savings supports the potential for wide spread adoption of the whole-house approach. Averaging this result with the 30 percent who experienced a post-project energy use increase does not do justice to the complexity of the market. We recommend these	Please note that we cannot estimate individual savings with the pooled models that were used for this evaluation. We believe that the takeback effect is an outcome for this program contributing to lower savings. Increases and decreases not attributable to the program should balance out for a large sample. Programs that claim

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				two groups be addressed separately. As any contractor can tell you, homeowner goals vary widely and any given project is likely serving multiple needs. In fact, the value that homeowners seek ranges from energy savings to comfort to indoor air quality to optimizing a renovation project. So why would energy use go up after an energy retrofit? Real world scenarios not related to the program can include: An increase in number of occupants (new baby, kids come home from college, mom moves in), installation (and use) of air condition equipment where it did not exist before, use of HVAC equipment to obtain increased indoor air quality to benefit respiratory-challenged occupants (asthmatic child), or including energy measures in a renovation that adds modern features (lighting, restaurant-style stove, media room) or increases the house footprint and heating/cooling load. Energy Upgrade California™ Home Upgrade contractors can provide valuable insight into why homeowners undertake an energy retrofit. Even if a homeowner uses more energy post-project, their experience of the full spectrum of whole-house benefits (savings, comfort, IAQ) is an invaluable word-of mouth resource for building scalable market demand.	savings and have ex ante estimates are expected to reduce energy use on a per-participant basis. Occupancy change and pre-retrofit usage level can be part of the energy reductions as much as they may be part of energy increases. There is no reason to believe these effects bias the savings estimate. Note that square footage addition should be going through new construction not EUC as the ex-ante modeling doesn't allow for the building footprint to change. The addition of HVAC is a reasonable area of further review. We added a section to the report that will provide a few takeback indicators. This section will not provide a full takeback assessment because the survey was not designed to address this issue. Specifically, the survey did not address: occupancy changes (increases in number of people in HH, homeowners retiring or starting to work at home, etc.) or additions of water heaters. The takeback indicators that can be included are the following: Furnace addition (where none existed before or added equipment in addition to existing one) CAC addition (where none existed before or added equipment in addition to existing one) Heat pump addition (where none existed before or added equipment in addition to existing one) Room AC addition (where none existed before or added equipment in addition to existing one) (this share is not weighted)

#	Subject Source	Ref.	Type (Question or comment)	Comment or Question:	Responses
					SqFt addition (this share is not weighted) Pool or Spa addition (this share is not weighted)
64.	**Free ridership deduction**/ Efficiency First California		Comment	Trigger events, such as a broken furnace or air conditioner, are how the majority of homeowners become aware of the science-based whole-house potential in their home. It is the first step toward turning an old-school, and often unpermitted, box swap into a loading-order game plan with the potential (whether all at once or over time) to harvest deep energy savings and deliver other very important pain point solutions (comfort, indoor air quality). The recommendation to only model savings and base measures directly attributed to the program is short-sighted in the following ways: ☐ Trigger events are the most common "market transformation" entry point into the whole-house approach, and an indispensable lead generation resource. These are the projects that draw both homeowners and single-measure contractors into the whole-house market where deep and lasting energy savings occur. ☐ Determining if an equipment replacement/repair is a non-program measure is a daunting task fraught with potential for confusion and gaming. ☐ A free ridership deduction would further complicate an already cumbersome rebate program process while decreasing homeowner value and increasing contractor costs, which	We do not know of any programs that are entirely void of free riders. Free ridership is natural and expected in this and other programs. DNV GL does not determine the level of acceptable free ridership for this program. As with takeback, this is entirely in the Energy Division's purview. This study did not focus on Market Transformation. We do not believe, however, that the Market Transformation aspect of this or other programs precludes the evaluation requirement to estimate and apply net-to-gross ratios. Last, the methods utilized in this evaluation require a substantial amount of pre- and post-retrofit energy use data. As such, new homeowners that take advantage of the program soon after acquiring the home are not used to estimate program savings. A requirement to wait for at least 9 months after moving in would allow the program to collect enough baseline data to include these new owners on energy savings calculations. An alternative, if the program targeted time-of-sale retrofits, would be to calibrate savings estimated to post retrofit usage since change of occupants at the time of retrofit cannot be separated in billing analyses.

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				goes against recent Commission guidance (D.12-05-015 and D.12-11-015). ☐ A free ridership deduction would penalize early adopter and early majority homeowners even as they lead the market to the whole-house model, which requires a greater financial investment. ☐ Eliminating the trigger event measure from the whole-house project rebate would be an unprecedented strategy.	
65.	**Recommendations:** Energy First California		Comment	Building a scalable market means accommodating variety, innovation, and real world market conditions set by homeowner needs and goals. We recommend the WO46 team consider the following: ☐ Align analysis method with market conditions: Do not apply a generic "energy retrofit" model (only energy measures, no safety or differed maintenance repairs or renovations) to a diverse market. Seek analysis methods that can accommodate multiple project models, such as PG&E's proposal to remove 25 percent of project costs from program cost effectiveness calculations to account for non-energy homeowner goals and needs. ☐ Rebate full energy retrofit measure scope: Trigger events (such as emergency HVAC replacements) are gateway needs that lead to whole-house projects and should be included in the rebate program. ☐ Adopt a market-building framework: State energy goals require a market-building approach that can fully engage homeowners, contractors, financing and insurance providers,	None of these recommendations flows from the impact evaluation report directly. This is not to say that they are not valuable or actionable. Only that they are grounded on commenter's experience, not the results presented in this evaluation. As such, we recommend against their inclusion in this report verbatim. The recommendations are included in the Appendix as comments. Note, The recommendation regarding savings claims in the report was modified based on comments prior to the release of the report. The idea of the recommendation is such that incentives would remain based on the full savings, but the utilities would modify the claimed savings as opposed to applying a single net to gross estimate.

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				utilities, and program partners in a robust energy efficiency market. It is time to move beyond a programcentric framework and seek sustainable results at scale.	

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