DNV·GL

Universal Audit Tool Impact Evaluation – Residential

California Public Utilities Commission

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Glossary	
UAT	Universal Audit Tool
Opt-in	Voluntary use of the UAT
Matched comparison group	Comparator group of UAT non-users matched to users based on energy consumption
Engaged	Descriptor used by the IOUs to flag tool users who have used the tool but are yet to complete the online audit or survey on the tool
Complete	Descriptor used by the IOUs to flag tool users who complete the online audit or survey on the tool
Low engagement	Tool users who have not yet created an action plan or savings plan on the tool
High engagement	Tool users who have created an action plan or savings plan on the tool
Length of engagement	Refers to the length of time since user first began using the tool.
Depth of engagement	Refers to low/high engagement the tool.

1 EXECUTIVE SUMMARY

This section contains a summary of more detailed findings found in this report.

1.1 Introduction

This report contains findings from DNV GL's evaluation of the Universal Audit Tool (UAT). The UAT is offered to customers by California's investor owned utilities (IOUs) branded under different names, such as Home Energy Checkup by Pacific Gas and Electric Company, My Energy Survey by San Diego Gas and Electric Company, and Ways to Save by Southern California Gas Company, but the underlying tool is broadly similar across the IOUs. It provides residential customers with advice on energy efficiency, insight into areas of high energy use, and tips and suggestions for saving both energy and money based on responses to an online survey regarding household appliances, occupancy, and other dwelling characteristics. There is an analogous version of the tool for business customers. This report focuses on the evaluation of the UAT for residential customers.[1] This report presents findings based on an evaluation of participants who first used the tool in 2014 and tracks the impact of tool use through 2014 and 2015.

1.2 Purpose of the evaluation

The program theory underlying the UAT is that customer engagement with the tool will lead to savings and that increased engagement will translate to deeper savings. The researchable questions this evaluation seeks to answer include those shown in Table 1, next.

[1] The findings presented here pertain to the tool for residential customers of PG&E, SCG, and SDG&E. At the time of this evaluation, SCE had not rolled out their tool widely like the other IOUs and are hence not included in this impact evaluation. See 5.1APPENDIX. A for further detail.

Table 1: Key research questions

Key Research Questions	
	Do the online tools capture data that can support the impact evaluation? Do the available data provide qualitative/anecdotal evidence that can provide insight regarding the impact results?
	What are the energy savings, in kWh and therms, from residential participants when compared to the matched-group?
	What are the energy savings, in kWh and therms, from engaged vs completed participants when compared to the matched-group?
	Are there significantly different energy savings from those users that have multi-year engagements?
	Does AMI data facilitate a more accurate matched comparison group?
	How does the participant group differ demographically from the general population?
	How does the high engagement group differ demographically from the low engagement group?
	Do the online tools sustain online interaction over time? i.e. How many repeat visits were made by customers? How many visits were required to complete the survey? How often did customers update their energy plan?
	Do the online tools increase participation in other IOU rebate or upstream programs?
	What marketing efforts have IOUs deployed to drive engagement to completions? How do these efforts correlate to the levels of success observed?

1.3 Approach

The evaluation answers the above questions with an impact evaluation based on energy consumption data, a process evaluation that includes a customer survey among tool users and non-users, and review of information gathered from IOU program staff[2].

1.3.1 Methods

We employ propensity-score matching (PSM) method to construct a comparison group for the purposes of generating a counterfactual for the impact evaluation. We establish a group of households that are as close as possible to the group of tool users – the "treatment" group - before any interaction with the tool. We use a pooled fixed-effects modeling approach to estimate the potential savings realized by the treatment group due to tool use. The pooled model combines all IOU participants and time intervals into a single regression model specification. The fixed-effects aspect of the model will control for effects that are constant across time within a household and effects that are constant across all households during a specific time period.

While the impact evaluation quantifies potential savings attributable to the tool, the process evaluation employs primary research among users/participants to uncover the customer choices and behaviors that lead to potential savings. We also include non-participants in this research. The survey gathers self reported data on tool use, energy consumption behavior, and attitudes that reveal both the motivation to participate and the variability in participant behavior. Information gathered from IOU program staff such as their marketing strategy and changes made to the tool provide important context to the findings from this evaluation.

1.4 Findings

The key findings stemming from our evaluation are summarized below (Figure 1). More detail on these findings can be found in Sections 3 and 4 of this report.

Figure 1: Key findings

Area of Research	Finding
Savings	The results from the impact evaluation validate the program theory and we estimate electric savings of around 1.2% to 2% and gas savings of 1.7% to 2.9% of baseline consumption for users of the tool.
Depth of engagement	Savings estimates for high engagement customers (those who interacted with the tool by creating an Action Plan) can be as much as 2x to 3x the savings estimates for low engagement customers.
Length of engagement	The effect of engagement duration on savings is a positive one and supports program theory that length of association with the tool is related to ongoing savings.
Marketing efforts	IOUs have employed a multi-pronged marketing strategy to reach new and current users. IOU program staff indicate a focus on improving the level of engagement among current users.

[2] Information from IOU program staff gathered via email, phone calls, monthly Energy Advisor reports, and regular monthly PCG III meetings for this UAT evaluation.

	Completion ratios for users are the highest in 2015 and 2016 relative to previous years.
Tool use	The majority of users (62%) did not feel it necessary to use the tool more than once because nothing in their home had changed or because they got sufficient information after the first use.
Cross-program participation	While over half of all users stated that the tool influenced their participation in at least one other utility program, the analysis of joint savings did not find any evidence of an increased participation relative to the comparison group.
Customer Profile	Users are different from non-users in terms of their energy use behavior but not in their attitudes towards the environment and technology adoption.

1.4.1 At a glance

A snapshot of the results for all users and by level of engagement with the tool is presented in

Table 2. The table is organized to present a picture of baseline use, estimated savings in total and by household for both fuels, and selected indicators of depth of engagement with UAT from premise level tracking data, aggregated monthly web metrics, and survey responses. There are significant savings for users of the UAT across all IOUs. Savings range from 1% to 4% for electricity and 1% to 3% for gas. SDG&E has the highest savings per household of the three IOUs for electricity and gas.

These differences could be due to the presence of more HER participants among PG&E's UAT users. The overlap in behavioral and conservation messaging may mean that prior HER involvement depresses UAT savings. If we assume that both HER and UAT attempt to motivate customer action, then the prior presence of HER participants would mean those savings are less available to the UAT program. The greater prevalence of HER involvement among PG&E UAT participants is a possible explanation for why PG&E UAT participants appear to save less than SDG&E. Engagement metrics indicate that SDG&E's UAT users had a higher frequency of tool use and also a higher creation rate for action plans.

Additionally, the spread of UAT users across the three main climate zones varies among utilities in notable ways. As summarized in the UAT participation maps in Section 3, SDG&E's participation rates appear to be higher inland whereas PG&E's participation rates appear to be spread out evenly throughout both inland and mild/coastal climate zones. The relatively higher participation rates of SDG&E's UAT users in the inland climate zone, where higher cooling loads offer more savings opportunities, could also explain the greater savings for SDG&E.

Table 2: Results at a glance

	SDG&E			SCG			PG&E		
	Users	Low	High	Users	Low	High	Users	Low	High
N	9,989	8,165	1,824	31,611	29,679	1,932	31,185	26,875	4,310
Average annual baseline use (kWh)	7,706	7,619	8,079	N/A			7,637	7,587	7,945
Average annual baseline (therm)	283	282	288	365	363	390	371	370	375
HER in UAT	27%			N/A			45%		
	Savings[3]								
Electric (% savings)	1.8%	1.3%	3.6%	N/A			1.2%	1.0%	2.4%
Gas (% savings)	2.6%	2.4%	3.3%	1.8%	1.8%	1.5%	1.5%	1.2%	3.0%
Electric (total kWh)	1,980,102	1,185,172	787,201	N/A			3,895,238	2,798,020	1,111,215
Gas (total therm)	75,056	56,717	18,453	301,939	284,005	16,589	192,820	138,967	53,864
Electric (2015 kWh savings per household)	126	93	271	N/A			86	70	185
Gas (2015 therm savings per household)	7	6	10	5	4	3	4	3	10
	Engagement - Tracking Data								
Created action plan	18%			6%			14%		
Average number of visits per household	5	2	18	3	2	18	4	3	5
	Engagement - Monthly Web Metrics								
Return visit rate (RVR)	65%			19%			20%		
Time on page - minutes	3.4			4.0			2.4		
	Engagement – Evaluation Survey								
UAT recall	59%	56%	69%	29%	28%	34%	30%	29%	39%
Frequency of UAT use - at least once month	51%			43%			18%		

[3] Section 3.3.2.2 provides detail on formulas used to compute savings estimates

1.5 Recommendations

The key recommendations from our evaluation are summarized below. Further detail on these recommendations can be found in Section 5 of this report.

- Prioritize converting current users to a higher level of engagement. Survey and impact results in combination indicate increased savings from moving already acquired users up into higher levels of engagement is likely to be greater than the yield from new users with high acquisition costs.
- Prioritize electronic methods of promotion and outreach for this web-based tool. When asked about the channel where they first learned of the tool, the majority of users indicated that they followed a link/banner ad from their utility website or received an email with a link to the tool.
- Message the value of repeat visits. Messaging, possibly derived through self-learning algorithms underlying the tool, which underscores the value of repeat visits/the next visit – such as continued, customized and valuable information that encourage the customers to continue to engage with the tool – will be more effective.
- Target customer testimonials of successful savings through engagement to low engaged customers. Testimonials segmented by baseline energy consumption, daily use pattern and other relevant dimensions will provide empirical evidence of tool efficacy that they can trust and that will spur them to action.

2 INTRODUCTION

2.1 Background

This report presents findings from DNV GL's evaluation of the Universal Audit Tool, referred to as UAT or tool, which is funded by the California Public Utilities Commission (CPUC) and offered by investor-owned utilities (IOUs). The tool provides a platform for educating and promoting residential and small business customer engagement with their energy consumption that leads to lasting behavior change. The UAT is dynamic; the more information the customer provides, the more customized the recommendations become. Customers are encouraged to set up plans, update the tool, monitor changes, and then gain more information about ways to save energy in a recursive loop.

Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), San Diego Gas and Electric Company (SDG&E), and Southern California Gas Company (SCG) provide mailed comparative energy usage reports to certain customers. They also provide comparative energy use feedback reports through the UAT, which is accessible on their respective websites. Customers gain access to these UAT reports once they sign up for online services through My Energy or Energy Advisor web portals.

These online feedback reports provide information to customers regarding how they are using energy compared with their neighbors and with more efficient homes of similar size. Customers can also follow links on the site that lead them to information on how they can take action to save energy and explore scenarios with different rates that will indicate how much they could save if on a different rate. Customers can personalize their experience by completing a home energy survey that results in an analysis of where energy is consumed within their home. A key difference for the online comparative report versus the mailed

report is that the customers will access the online report voluntarily versus the experimental design approach where customers would have to opt out of receiving them in the mail.[4]

2.2 Evaluation objectives

The key research questions and the corresponding evaluation types are summarized below (Table 3).

Table 3: Key research questions

	Key Research Question	Evaluation Types
	Do the online tools capture data that can support the impact evaluation? Do the available data provide qualitative/anecdotal evidence that can provide insight regarding the impact results?	Data review
	What are the energy savings, in kWh and therms, from residential participants when compared to the matched-group?	Impact Evaluation
	What are the energy savings, in kWh and therms, from engaged vs completed participants when compared to the matched-group?	
	Are there significantly different energy savings from those users that have multi-year engagements?	
	Does AMI data facilitate a more accurate matched comparison group?	
	How does the participant group differ demographically from the general population?	Process Evaluation
	How does the high engagement group differ demographically from the low engagement group?	
	Do the online tools sustain online interaction over time? i.e. How many repeat visits were made by customers? How many visits were required to complete the survey? How often did customers update their energy plan?	
	Do the online tools increase participation in other IOU rebate or upstream programs?	
	What marketing efforts have IOUs deployed to drive engagement to completions? How do these efforts correlate to the levels of success observed?	

[4] We discuss the HER-UAT overlap and the implications for UAT savings in Section 3.4.9.

2.2.1 Description and status of the tool

The UAT is offered to customers by IOUs branded under different names, such as Home Energy Checkup by PG&E, My Energy Survey by SDG&E, and Ways to Save by SCG, but the underlying tool is broadly similar across the four IOUs[5]. It provides residential customers with advice on energy efficiency, insight into areas of high energy use, and tips and suggestions for saving both energy and money based on responses to an online audit or survey regarding household appliances, occupancy, and other dwelling characteristics.

There are some differences among the IOUs' tools. Some require logging in and others do not, but all of them allow customers to create an action plan or energy savings plan and provide estimates of annual savings that they can expect to see by implementing each recommended energy-saving tip.

Over the years, the IOUs have continued to make changes to improve engagement and use of the tool through deploying various marketing strategies and adjustments to tool functionalities. The most significant recent changes to the tool across the IOUs are:

- Enabling one-click or single sign-on features to help customers be recognized by the tool if they are already logged in to their utility account
- Integrating the tool with links to other rebates and energy efficiency programs for applicable measures
- Improving tips to be more helpful and drive customers to programs
- Increasing co-branding with ENERGY STAR®

The number of customers participating has grown over the four years since the tool has been active. The proportion of customers completing the survey on the tool varies by IOU and year (Table 4). While the number of new customers engaging with the tool has been increasing for SCG, and SDG&E, they have declined for PG&E. Completion rates for the survey, however, have risen significantly for PG&E with highs of over 50% and 33% in the years 2015 and 2016. It should be noted that variable levels of marketing efforts at each IOU are confounded with the other factors that lead to observed levels of participation.

Table 4: UAT participation by IOU

Year	SCG			PG&E			SDG&E		
	Engaged	Completed	Complete/ Engaged	Engaged	Completed	Complete/ Engaged	Engaged	Completed	Complete/ Engaged
2012	19,675	1,198	6%	256,031	6,904	3%	32,921	3,834	12%
2013	116,392	5,725	5%	354,803	35,454	10%	37,400	3,923	10%
2014	123,343	3,838	3%	248,639	29,085	12%	45,388	4,216	9%
2015	123,343	5,771	5%	196,233	101,051	51%	34,160	5,875	17%
2016	119,595	6,133	5%	241,865	97,612	40%	33,974	5,909	17%
Total	502,348	22,665	5%	1,297,571	270,106	21%	183,843	23,757	13%

The report presents the results from the impact evaluation in Section 3 and the results from the process evaluation in Section 4. A summary of conclusions and recommendations are in Section 5. Appendix A includes an evaluability assessment for SCE' UAT program. Appendix B presents a summary of recommendations. Details of the impact analysis methodology are in Appendices C, D, and E. Appendix F provides detail on the sample weights used for the survey and Appendix G provides the surveys used in the process evaluation.

[5] PG&E's UAT program implementer is OPower and SCG and SDG&E's UAT program implementer is Aclara.

3 IMPACT EVALUATION

The purpose of the impact evaluation is to assess whether the UAT has a real effect on energy consumption using data from tool users of San Diego Gas & Electric (SDG&E), Pacific Gas & Electric (PG&E), and Southern California Gas (SCG).

For the three California IOUs, data from the tool permits the identification of the level of engagement customers have with the tool. We focus on two levels of engagement in this study. The first level of engagement captures a more limited interaction with the tool where participants mostly browse the website and, in some cases, complete surveys (audits) on the tool (possibly picking up information on savings), but do not take further action. We call this low level of engagement. The second level of engagement is where participants create an Action Plan based on recommendations they get from the tool. We call this high engagement level.[6]

Participation in the UAT program or tool use is summarized below (Figure 2, Figure 3, and Figure 4). While the absolute number of UAT users is clustered around areas where the population density is high, the charts below normalize UAT use by population and display participation rate[7] by zip. We observe that participation rates above a minimum threshold are not concentrated in specific areas but diffused throughout PG&E territory. SCG participation rate patterns are similar to PG&E. The analogous chart for SDG&E shows relatively higher participation rates inland.

[6] We have noted in the introduction that the UAT administrator for SDG&E and SCG is Aclara and that for PG&E is Opower. The definitions used to gauge engagement level, dates of participation and other program features are defined differently by these implementers. We have, nevertheless, used concepts that are similar to define engagement level. For example, the definition of action plan creation for the UAT program run by Aclara for SCG & SDG&E is based on data that indicates action plan creation dates. For the UAT program run by Opower for PG&E, we rely on tip action date from the tracking data to define this high level of engagement.

[7] Participation rate is computed as total number of users relative to the population in a given zipcode.

Figure 2: UAT Participation – PG&E

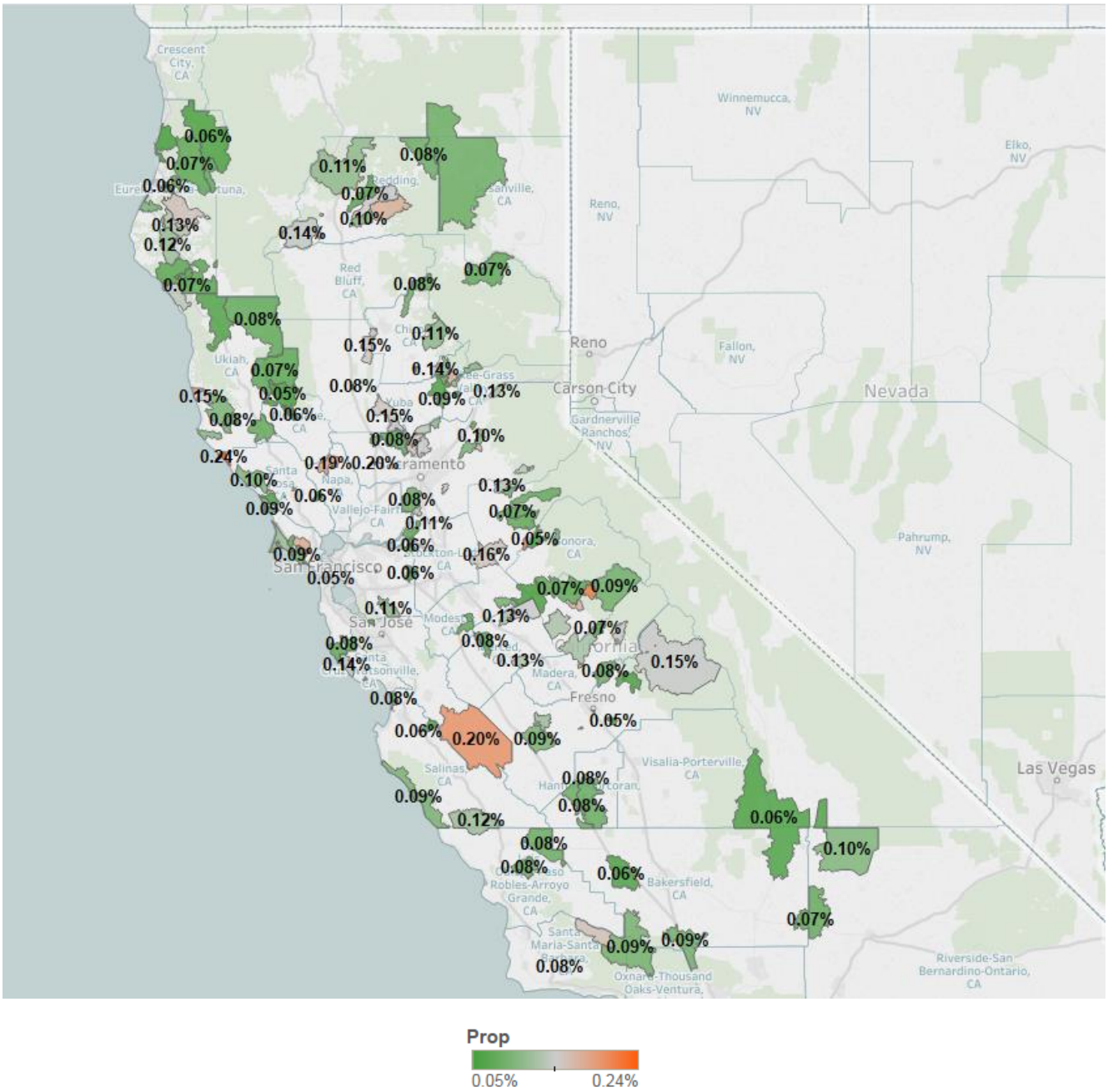


Figure 3: UAT participation - SDG&E

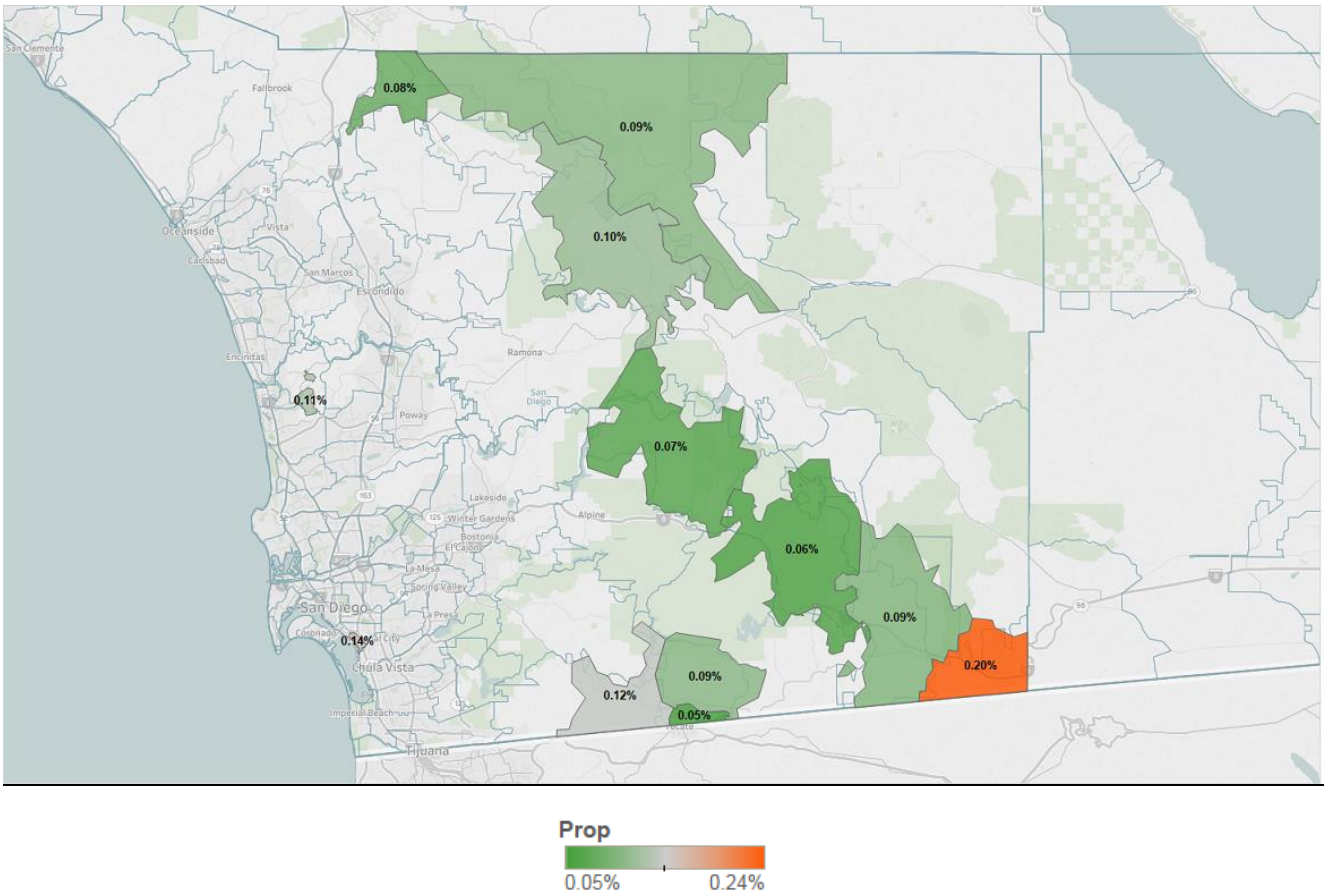
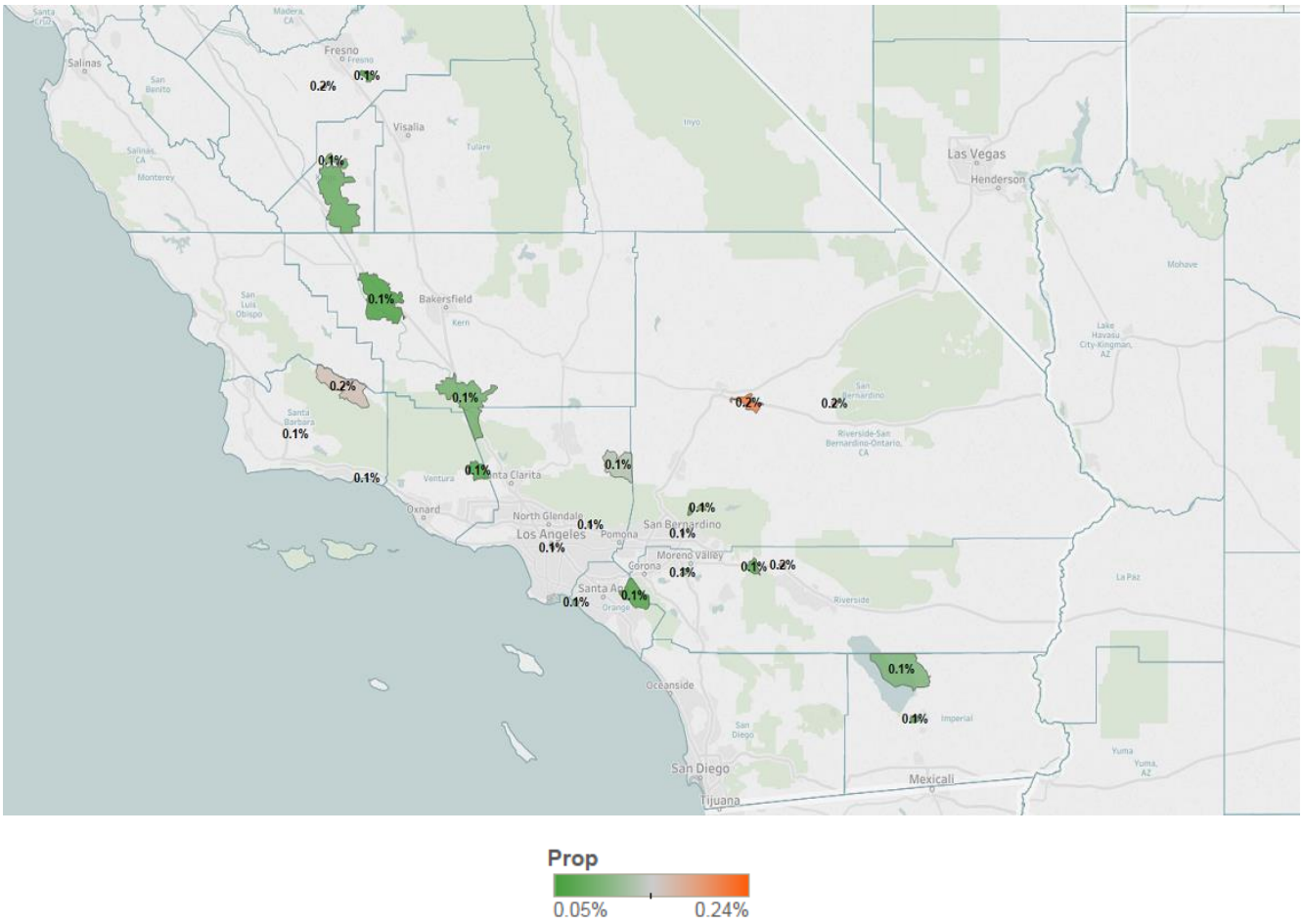


Figure 4: UAT participation - SCG



DNV GL used monthly data to support a two-step based impact evaluation. The first step involves the identification of a match comparison group while the second step provides an assessment of the effect on energy consumption of engagement with the tool based on the matched data. Detailed program tracking data for the UAT provide the participant population (including program rosters), and information on timing and extent of participation in the program. In addition, tracking data for other energy efficiency programs determine if the UAT motivates an increase in activity in other utility rebate programs.

DNV GL also used daily AMI and weather data in the form of degree days from NOAA[8] to develop an improved matching algorithm. This approach, matching on pre-period model-based parameter estimates rather than actual energy consumption, has the potential to more completely characterize the household energy consumption dynamics with fewer variables.

[8]The National Weather Service National Oceanic and Atmospheric Administration (NOAA) http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/cdus/degree_days/

3.1 Overall results

Engagement with the tool has reduced energy consumption materially for electricity as shown in Table 5. Over the study period that covers the start of 2014 until the end of 2015, SDG&E electricity consumers that used the tool reduced their electricity consumption by a total of 1,980 MWh. This is a reduction of 1.8% relative to their baseline of total electricity use. PG&E's customers that used the tool reduced their electricity consumption by 1.2% over the same time frame, which amounts to 3,895 MWhs. Both declines in electricity consumption are statistically significant.

Table 5: Total residential electric savings by IOU

Residential	SDG&E Electric		PG&E Electric	
	kWh	percent	kWh	percent
Total	1,980,102	1.8%	3,895,238	1.2%

Note: all savings statistically significant at least at the 95% confidence level

We present the reduction for gas consumption in Table 6. SDG&E gas UAT users reduced their gas consumption relative to their baseline use by almost 3% (about 75,000 therm) while SCG gas UAT users used almost 2% less gas (301,939 therm) relative to their baseline use. PG&E's gas customers that used the tool similarly reduced their gas consumption by almost 2% (about 200,000 therm) relative baseline consumption. These reductions are also statistically significant.

Table 6: Total residential gas savings by IOU

Residential	SDG&E Gas		SCG		PG&E Gas	
	therm	percent	therm	percent	therm	percent
Total	75,056	2.6%	301,939	1.8%	192,820	1.5%

Note: all savings statistically significant at least at the 95% confidence level

It appears that total electric savings for SDG&E is 50% of PG&E's. Similarly, SDG&E's total gas savings is also about 40% of PG&E's total gas savings and a quarter of SCG's total gas savings. Comparisons of savings across IOUs, however, are made best on a per household basis. We present estimates of savings per household in Table 7 for electricity and Table 8 for gas. All estimated savings are statistically significantly different from zero.

We note SDG&E's annual electricity savings per household, based on 2015 activity when the full set of 2014 users is active, is about 1.5 times that of PG&E's. Moreover, SDG&E's savings of 126 kWh per household is statistically significantly different from PG&E's 86 kWh annual savings. On the gas side, SDG&E's annual savings per household are similarly higher than both SCG's and PG&E's. The difference among all the estimated gas savings per household are statistically significantly different. SDG&E's gas savings per household are greater than the gas savings for the other two utilities.

Table 7: Residential electric savings per household by IOU

Residential	SDG&E Electric (kWh)	PG&E Electric (kWh)
2015	126	86

Note: all savings statistically significant at least at the 95% confidence level

SDG&E appears to be the leader in both electric and gas savings. While PG&E's gas savings are lower than SCG's across all households, its savings among high engagement customers is greater (Sections 3.4.3 and 3.4.6).

Table 8: Residential gas savings per household by IOU

Residential	SDG&E gas (therm)	SCG Gas (therm)	PG&E Gas (therm)
2015	6.9	4.7	3.9

Note: all savings statistically significant at least at the 95% confidence level

There are several possible factors for the estimated differences in savings among the utilities. First, while Table 4 indicates higher tool survey completion rate of 12% for PG&E in 2014, the year for which we evaluate the program, relative to SDGE's value of 9%, evidence from the tracking data indicates that action plan creation was higher for SDG&E's UAT users relative to PG&E's users. (Table 9).

Table 9: Engagement by IOU

Residential	SDG&E	PG&E	SCG
High engagement - Created action plans	18%	14%	6%

Second, the extent of HER participation among UAT's opt-in population is relatively higher for PG&E compared to SDG&E as we discuss in Section 3.4.9. Although we find no joint savings as a result of the HER-UAT overlap, greater HER related activity could leave less room for UAT motivated savings. Third, PGE's UAT participants appear to use the tool less frequently compared to SDG&E and SCG UAT users. The average number of visits to tool and the return visit rate are lower for PG&E compared to the SDG&E. Self-reported visits are also less frequent for PG&E than SDG&E as we discuss in Section 1.4.1.

The comparison in gas savings between PG&E and SCG is not as straightforward. As we already noted, SCG's overall gas savings are higher than PG&E's. PG&E's high engaged customers, however, save more than SCG's high engaged customers. This may be explained by the higher action plan creation rate among PG&E's tool users relative to SCG. SCG's customers, however, have more visits to the tool per household and a greater self-reported frequency of tool use. The mixed outcome in savings is thus not a surprise.

What is clear is that depth of engagement translates to higher savings.

3.2 Data sources used

This section describes the data used for the impact evaluation.

3.2.1 Energy consumption data

DNV GL used monthly billing data from each of the IOUs. Information pertaining to kWh and therm consumption quantities were the primary variables of interest. Billing data reflect customer utility bills that do not align with calendar months. For both the matching and savings calculation portions of this analysis we use a calendarized version of the billing data. We generate weighted averages of monthly electricity and gas consumption using data from either side of billing month to allocate energy consumption to calendar months. Calendarized data allow us to compare energy consumption across matched groups that fall within the same month (time-frame) as well as generate savings that are associated with the same interval.

We used average daily energy consumption in each month in statistical models to capture variation in energy consumption during the pre-and post-periods. Estimates of savings were measured at the monthly level of granularity.

We used AMI data, aggregated to the daily level, to support an alternative matching approach based on site-level modeled parameters. Section 3.3.1 provides the details of the matching procedure used on monthly as well as AMI data.

3.2.2 Customer information data

We used general customer information from the IOUs to identify basic household characteristics of participating households and similar non-participant households. We defined comparison group households by IOU and climate zone.

3.2.3 Weather data

We used weather data (in the form of degree days) for the alternative matching approach described in Section 3.3. Site-level model parameters with a measure of model goodness-of-fit were used in propensity score matching to produce AMI data and model-based 1:1 matches.

NOAA weather data were matched to premises based on Euclidean distance matching by zip code. For each weather station, we matched hourly dry-bulb temperatures with site-level interval energy consumption data.

3.2.4 Tracking data

We obtained participant population data (including program rosters[9]) from the detailed UAT tracking database. We also obtained information on the timing and extent of program participation from the database. The tracking database also served as a resource for the process analysis and all other rebate programs that we used to calculate joint savings.

We used the date when a participant first engaged with the UAT to identify the start of engagement and the time when change in energy consumption could begin. For the evaluation, the period before the engagement date serves as the pre-engagement period and data one month after the engagement period serves as the post-period. In addition, we used survey (audit) completion or action-plan creation dates to identify the start of a higher level of engagement. All participating households had first engagement dates and the subset of those who went on to complete audits or create an Action Plan had dates associated with such activities that were later than their first engagement dates.

3.3 Methodology

3.3.1 Matching

Our study aims to identify the energy consumption effect of engaging with the UAT administered by the IOUs. We determine the effect of such engagement by comparing the consumption outcomes of those who use the tool to a suitable comparison group of customers who do not. We use a matching procedure to identify a suitably matched comparison group.

Under the matched comparison approach the treatment effect is estimated by comparing the difference in outcomes before and after treatment of opt-in and comparison groups. In experimental studies, a randomized control trial (RCT) design ensures subjects are assigned to treatment or control groups

[9] We learned from IOU staff that the roster indicates unique number of participants in each month that are aggregated at the year level.

randomly. Due to this random assignment, the only differentiating factor between the two groups is treatment. Thus, difference in outcome pre- and post-treatment can be attributed to treatment.

In observational studies, of the kind under consideration, subjects self-select into treatment. Since treatment assignment is not random and may be tied to the intrinsic characteristics of the subjects in this group, estimated treatment outcomes will reflect self-selection bias. Matching is a process that aims to circumvent such bias by identifying comparison subjects whose characteristics closely match those of the opt-in subjects. Matching methods try to replicate RCT design by selecting opt-in and comparison group subjects that are balanced in key characteristics. Balance is indicated by identical distributions of these characteristics of both groups.

3.3.1.1 Matching procedure

There are various matching techniques that attempt to mimic the RCT design in observational studies. In this study, we used propensity score matching (PSM) to match opt-in and comparison subjects and reduce selection bias. As the name indicates, PSM is based on propensity scores, which are probabilities that subjects are assigned to the treatment group given certain characteristics they have. Subjects were matched based on these probability scores.

The PSM process involves the following general steps that we used in this evaluation:

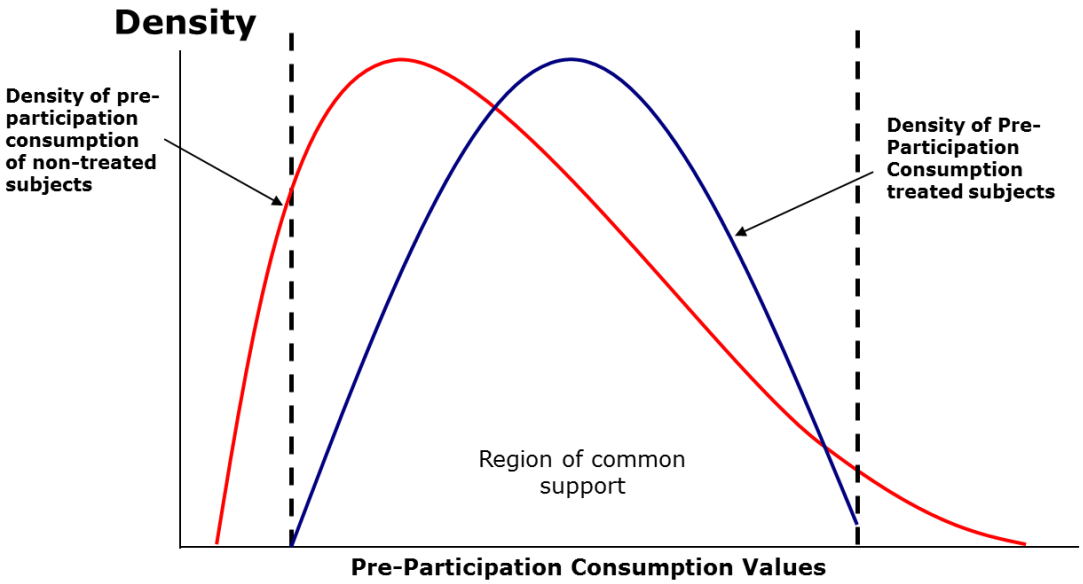
1. Select subjects' characteristics that are related to treatment assignment.
2. Examine the distributions of these characteristics and exclude observations of the comparison group where these do not overlap as a first round of identifying common support for matching.
3. Fit a logistic regression model using these variables to estimate the probability that each subject gets assigned to the treatment group.
4. Conduct a second round of trimming or common support identification based on propensity scores.
5. Select a matching method, the number of controls in the many-to-one matching, and whether to match with or without replacement; match opt-in subjects' scores to non-treated (comparison) subjects based on these selections.
6. Conduct diagnostic checks to see selected matches are well-balanced.

To avoid correlation between treatment selection and outcome, by construction, we needed to match on variables other than the dependent variable. Such variables can include any characteristics such as household size, heating and cooling source, and rate groups that may affect treatment assignment. They can also include variables measured before participation, such as pre-evaluation period consumption data. We took the latter approach, as comprehensive data on household characteristics were not readily available. Specifically, we used monthly data from the year 2012 that pre-date any consumption data that were used in the savings regressions. We also used climate zone information to stratify the data for matching. This involved implementing the matching procedure within three pre-defined climate zones for California - mild (coastal), inland, and desert.

Prior to estimating a propensity score model, we identified a first round of common support for matching by trimming the data based on the distribution of pre-participation consumption. Variable values of the comparison subjects that do not overlap with the values of the opt-in subjects were trimmed. In all the cases where we undertook matching, trimming pre-participation consumption values of the comparison

subjects that are outside of the 1st and 99th percentiles resulted in the overlap of the distribution of these values with those of the opt-in. Figure 5 provides an example of how we established a region of common support.

Figure 5: Region of common support for matching



We fitted a logistic regression model using data that reflects common support and used the propensity scores from the regression to find matches for each opt-in subject based on k:1 matches. We used the nearest neighbor matching (NN) algorithm for this purpose. The approach produces matches for each opt-in subject, selected in random order, by searching for k propensity scores from the comparison group that are nearest to those of the opt-in subject's. We selected matches without replacement. Thus, a comparison subject selected as a match for a given opt-in subject was not available for matching again. This sort of matching is called 'greedy' because matches are made by only looking at distances of scores of randomly selected opt-in vs. comparison subjects. Optimal matching, on the other hand, considers the overall distance between opt-in and comparison scores to select matches. The matches generated using either, however, are equally well-balanced.

Initially, we selected 5 best matches ($k = 5$) to identify an oversized matched comparison group for which to request AMI data. Within the 5:1 matched comparison group, we identified the optimal 1:1 matched comparison group for the purpose of final models. As with the 5:1 matched comparison group selection, the 1:1 matched group was selected by identifying a comparison subject whose propensity score is closest to that of a opt-in subject selected randomly. Once selected, a comparison subject was not available for matching with any other opt-in household. We also conducted a matching exercise using AMI data for five of the selected comparison subjects that we discuss next in Section 3.3.1.2.

3.3.1.2 Model-based matching

Results from an energy-consumption model estimated using AMI data allowed us to investigate if such data facilitate more accurate matching. The energy consumption model we estimated helped us identify baseload, heating and cooling loads, and varying heating and cooling-degree bases that reflect the consumption-weather dynamics of each household. We applied the PSM procedure to household-level model coefficients generated using such a model and AMI data. The steps involved were:

1. Estimate energy consumption as a function of heating- and cooling-degree days (HDD and CDD, respectively) using AMI data.
2. Obtain base load estimates; HDD and CDD effects; estimates of optimal HDD and CDD bases; and model goodness-of-fit for each household.
3. Apply the PSM procedure using model coefficients to obtain 1:1 matches out of the 5:1 preliminary match comparison group for which we requested AMI data. The two different approaches that result in 1:1 matches are each optimally matched comparison groups from the same set of 5:1 households.

As we discussed above, we requested AMI data from each IOU for five of the best matches for each participant identified by the consumption-based approach outlined in the previous section. We received either 15-minute or 60-minute interval kWh data and daily-interval therm data in response. After examining the sufficiency of the data (the number of households for which non-missing data is available in the matching year of 2012), we determined we could apply model-based matching using AMI data for electric customers of SDG&E and PG&E. SDG&E and PG&E had at least 80% of the AMI data we requested for electricity, whereas PG&E and SCG had no more than 20% of such data for gas in 2012.[10] We aggregated the AMI data to daily energy use and estimated a model of daily electricity consumption as a function of weather. As we indicated above, we used coefficients from this model to conduct matching.

3.3.1.3 Test of balance

The final step in the matching process was to check the generated matches are well-balanced. This helps to ensure that treatment outcomes are not dependent on the probability of treatment assignment (participation). Checking matches are well-balanced involves ascertaining the distribution of the variables (on which matching is done) of the comparison and opt-in subjects are the same.

We determined this by examining values at various percentiles of pre-participation consumption for opt-in and comparison subjects that summarize their distributions. The difference in the values between the two groups should be negligible.

We also tested the quality of the matches using the Kolmogorov–Smirnov test (KS test), which is a nonparametric test that examines the equality of the (cumulative) distributions of two samples. Under the null hypothesis of equality between the distributions, the KS test allows us to determine if the matched samples are statistically identical or not.

3.3.2 Energy consumption and impact modeling

Using the matched data, we evaluated the effect of using the tool on energy consumption by estimating a fixed-effects model with a difference-in-difference structure. This fixed-effects model identifies the effect of treatment through indicator values for the opt-in in the post treatment period after considering household and other time specific effects.

We used average daily consumption per month as the unit of analysis in the model. Our methodological approach is based on identifying changes in this level of consumption after using the tool over the specified pre- and post-periods for the two groups. We present the model in the next section.

[10] Although SDG&E had close to 80% of the gas interval data we requested, we concentrated our efforts on matching electricity data using AMI.

3.3.2.1 Pooled fixed-effects model

We specified a fixed-effects model that estimates participation effect based on panel data, where monthly observations for each opt-in and comparison household were stacked. In addition to estimating treatment effect by month, we also included a term to capture the average trend in savings over the specified period following treatment.

This model is given by:

$$C_{jt} = \mu_j + \lambda_t + \gamma_t I_{jt} P_{jt} + \delta_t \tau_{jt} + \alpha_t I_j \tau_{jt} + \varepsilon_{jt}$$

- Cjt = average daily consumption during interval t for household j
- μ_j = unique intercept for each household j
- λt = 0/1 indicator for each time interval t (month-year) that tracks systematic change over time
- Ijt = 0/1 dummy variable equal to 1 if household j is a program participant in period t, 0 if household j is in the comparison group in period t
- P_{jt} = 0/1 indicator variable equal to 1 if period t (month-year) is post opt-in for household j
- $\tau_{jt} = (P_{jt} - P_{jo})$ = time in months (P_{jt}) since opt-in (P_{jo}) for household j; comparison group households are assigned a proxy "opt-in" date that is the matched households actual opt-in date
- ε_{jt} = error term of the model

In this fixed-effects model, the coefficient on the month-year term (λ_t) captures marginal monthly baseline use while the term (γ_{jt}) reflects marginal effect on energy use of treatment (or savings) in the post-treatment period. The latter reflects average daily savings per household in time-period t. We also include a term that reflects average savings (or participation effect) changes over the time under study. The coefficient (δ_t) measures baseline use trend since opt-in while (α_t) reflects the average savings trend since opt-in.

The model was estimated with errors clustered at the household level to address the fact that monthly consumption values for a given household are not independent. This is a standard approach for behavioral program evaluations and avoids estimated standard errors that over-estimate the precision of estimated coefficients.

3.3.2.2 Savings Estimates

We calculated various measures of savings using parameter estimates from the fixed-effects model. One such measure is savings per household per month over the entire post-participation period. We denote this using:

$$saving\ per\ household\ per\ month = \left(\frac{avg\ savings}{household\ Day}\right) * \frac{days}{month} = -1 * (\gamma_{jt} + \alpha_t \tau_t) * \frac{days}{month}$$

This measure allowed us to obtain an estimate of total percent savings in the post-participation period using:

$$total\ percent\ savings = sum(savings\ per\ household\ per\ month)/sum(monthly\ energy\ use)$$

Each sum is taken over the months in the post opt-in period. It reflects total estimated savings as a percent of total baseline energy use.

We also obtained total kWh or therm savings in the post-participation period by multiplying the estimated savings per household by the total number of households that participated in the program in each month of the post-period. This estimate is given by:

$$total\ household\ savings = sum(savings\ per\ household\ per\ month * number\ of\ households)$$

3.4 Impact evaluation results

3.4.1 Matching framework

Our statistical framework relies on the comparison of energy use before and after engagement with the tool of groups of participants and non-participants. The matching procedure that we used provides us comparison households whose pre-study period consumption is sufficiently like that of participants or opt-in households. The matching process was applied to electric and gas customers of the three IOUs. The matching was done for dual-fuel (electric and gas) and electric-only households of SDG&E and PG&E, and gas-only households of these utilities as well as SCG.

We received rosters of participants[11] from the IOUs that we used in our matching work (Table 10). Participants who have consumption data available are eligible for inclusion in the study.

Table 10: Residential UAT unique participant counts by IOU with billing data for study period

Year	SDG&E		SCG		PG&E	
	Engaged	Completed	Engaged	Completed	Engaged	Completed
2013	23,077	3,877	91,526	5,640	71,176	58,469
2014	27,044	4,221	81,444	3,805	88,826	42,608
2015	20,998	5,874	82,769	5,702	146,921	96,207

In general, we need a full year of data before and a full year after participation to evaluate the effect of treatment. In addition, we need data that is as recent as possible to study the effect of a more recent vintage of the tool. Based on these criteria, we selected 2014 as the participation year for which to evaluate the effect of engagement with the tool. We examined the effect of the UAT for those whose first enagement with the tool is 2014.

The information for matching and impact analysis we use comes from various datasets provided by the IOUs. In general, we received datasets that:

- List the number of visitors to the tool or audit website and the date of first visit
- Inventory a subset of those that provided some level of response to the audit and date of response
- Provide a further subset of those that created action plans to save energy and are in various stages of implementing those actions
- Contain various supplemental files that provide information on HVAC, appliances, lighting and dwelling characteristics based on audit responses provided by participants that are used to provide savings recommendations

[11] We learned from IOU staff that the roster indicates unique number of participants in each month that are aggregated at the year level. The numbers summarized in the tool status section earlier in the report, on the other hand, indicate all participants in each month (and not just unique ones) that are aggregated at the year level.

3.4.2 Matching data

Starting with the 2014 analysis time frame, we selected household data for matching based on several criteria. First, we restricted households for the matching exercise to those with suitable billing data from 2012-15. Since 2014 is the program period we analyzed, we needed at least 12 months of pre- and post-participation data that required us to use data from 2013 and 2015. In addition, as we indicate in Section 3.3.1.1, the matching approach necessitates we use consumption data outside of the evaluation period of 2013-15, so data from 2012 serves this purpose. Second, suitable 2012-15 billing data were those where consumption is non-negative, not missing, and did not come from households with net electricity metering.

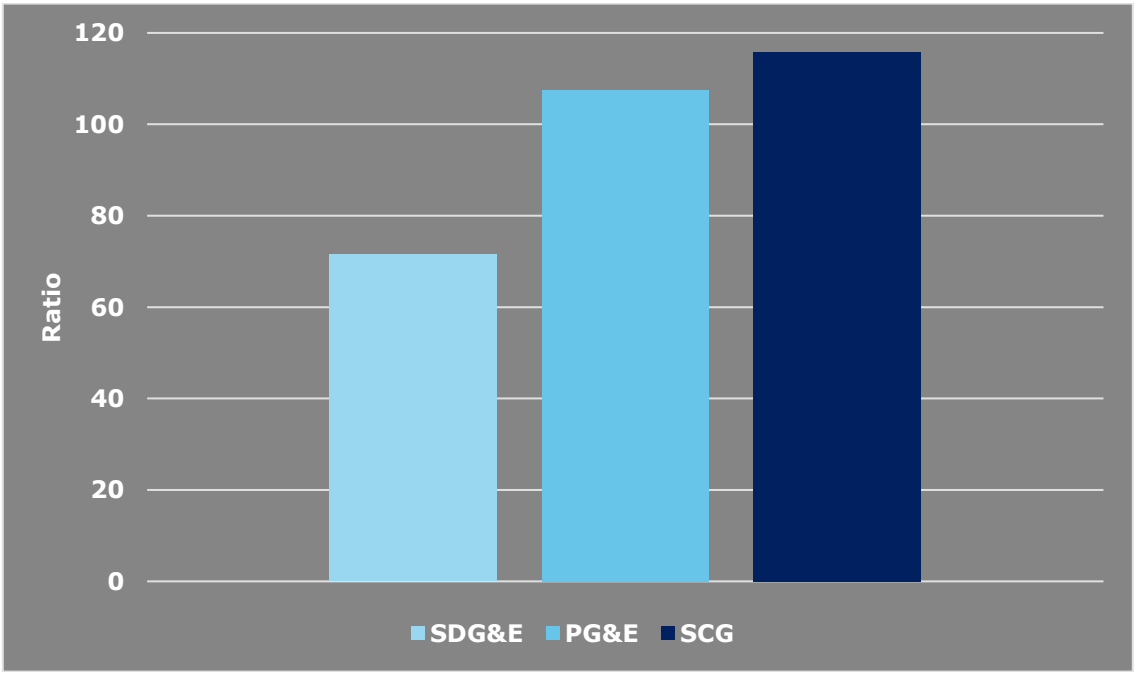
After the application of these rules, we had our sample of participants for opt-in households that were used in matching. Table 11 provides the total number of participants by utility. Roughly 40% of engaged participant numbers were used in the matching process.

Table 11: Residential UAT 2014 participant numbers used in matching

Utility	Utility Source	Participant Numbers Used in Matching	% Utility Source
SDG&E	27,077	9,989	37%
SCG	82,323	31,611	38%
PG&E	89,307	31,185	35%

We selected matches for the opt-in households from many potential comparison households with energy consumption within the range of common support as discussed earlier. Figure 6 presents the ratio of comparison-to-opt-in subjects used in this process.

Figure 6: Residential UAT ratio of comparison-to-opt-in households used in matching by IOU



Finally, matching was stratified by climate zone using information from the California Energy Commission (CEC). The CEC provides climate zone classifications that cover all the service territories served by the IOUs. We consolidated CEC's classifications into three climate zones indicating desert, inland, and mild climate conditions. Table 12 presents where CEC's classifications fall in the three groupings and the number of participants within each climate zone used in matching.

Table 12: Climate zone groups for stratified matching

Climate Zone Group	Title 24 Climate Zone	SDG&E Participant Counts	SCG Participant Counts	PG&E Participant Counts
Desert	15	12	1,124	N/A
Inland	8, 9, 10, 11, 12, 13, 14	3,634	25,949	16,249
Mild/Coastal	1, 2, 3, 4, 5, 6, 7, 16	6,343	4,538	14,936

3.4.3 Engagement level

We use data from the roster and related files to define two levels of engagement with the tool. The first level of engagement captures a more limited interaction with the tool where participants mostly browse the website and, in some cases, complete surveys (audits) on the tool (possibly picking up information on savings), but do not take further action. We call this low level of engagement. The second level of engagement is where participants create an Action Plan based on recommendations they get from the tool. We call this high engagement level.[12] The total number of participants by engagement level and IOU is provided in Table 13.

Table 13: Residential UAT engagement levels and customer numbers by IOU

Engagement Level	Engagement Indication	Number of Participants		
		SDG&E	SCG	PG&E
Low	Browsed the tool, did not create an action plan	8,165	29,679	26,875
High	Browsed the tool and created an action plan	1,824 (18%)	1,932 (6%)	4,310 (14%)

3.4.4 Matching results

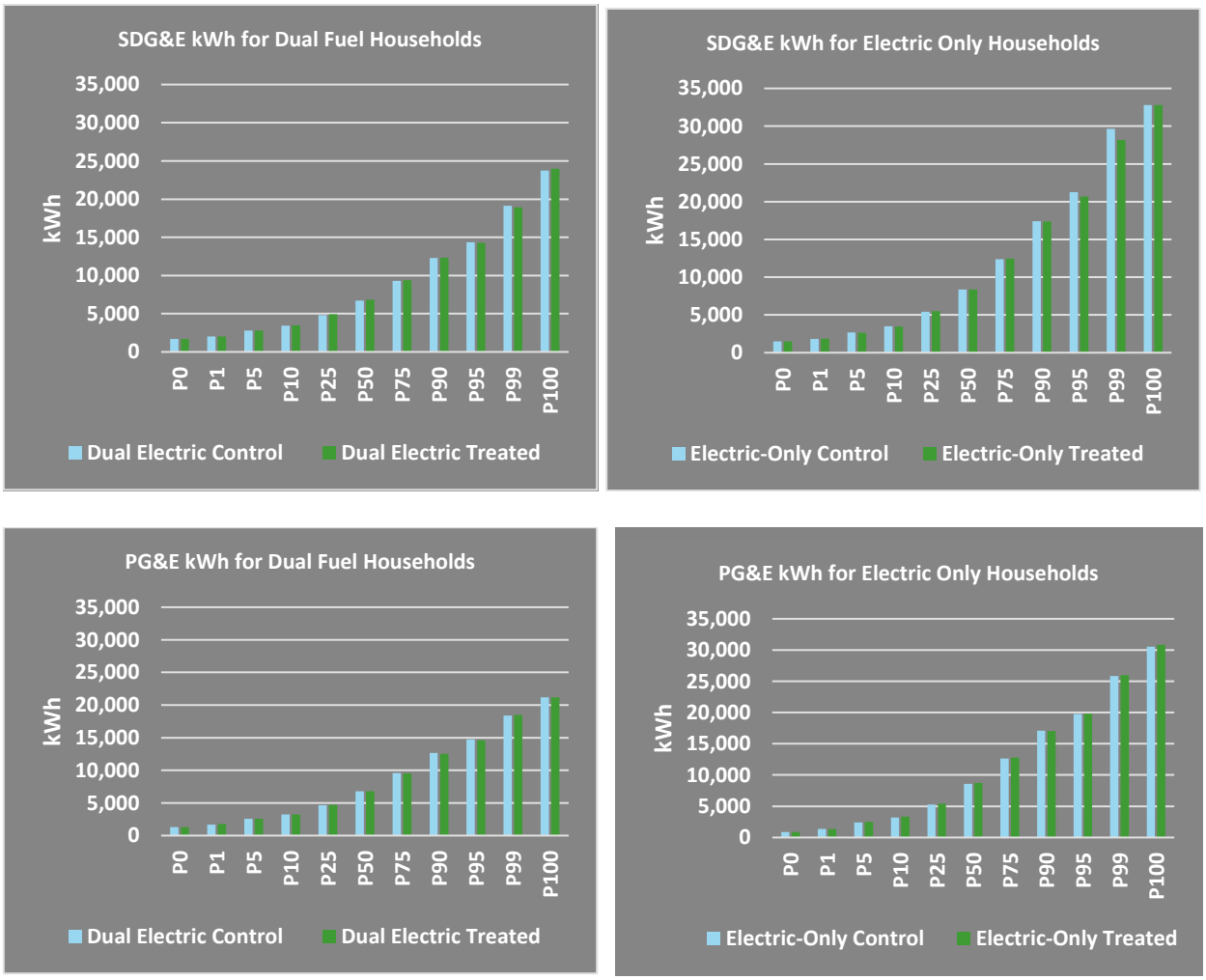
As we discuss in Section 3.3.1.1, we selected 1:1 comparison-to-treatment households in our matching process out of the initial outsized 5:1 matches generated for the purpose of requesting AMI data. In other words, we selected the best match for each opt-in household in our study frame. We ascertained balance in

[12] We have noted in the introduction that the UAT administrator for SDG&E and SCG is Aclara and that for PG&E is Opower. The definitions used to gauge engagement level, dates of participation and other program features are defined differently by these implementers. We have, nevertheless, used concepts that are similar to define engagement level. For example, the definition of action plan creation for the UAT program run by Aclara for SCG & SDG&E is based on data that indicates action plan creation dates. For the UAT program run by Opower for PG&E, we rely on tip action date from the tracking data to define this high level of engagement.

our resulting matches by examining how close the distribution of the pre-study period (2012) consumption of the selected comparison-to-treatment households were. We took two approaches for this purpose.

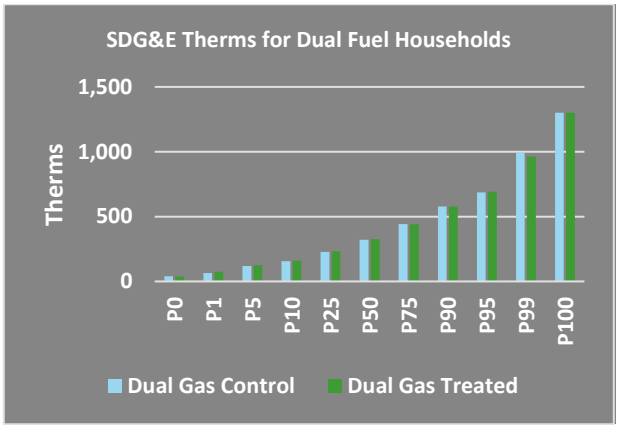
First, we examined the level of consumption of each group using the cumulative distribution at various percentiles presented in Figure 7 for electricity and Figure 8 for gas[13]. Visual inspection of the figures makes it evident that the samples are well-balanced (matched). The values of consumption for the opt-in and comparison group at various percentiles are very close.

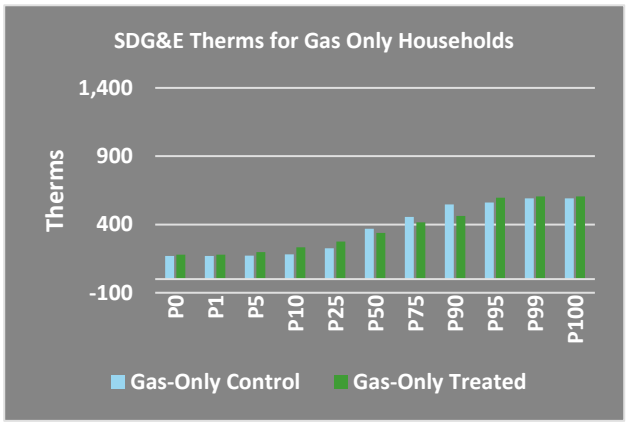
Figure 7: Distribution of electricity consumption of matched comparison and opt-in households

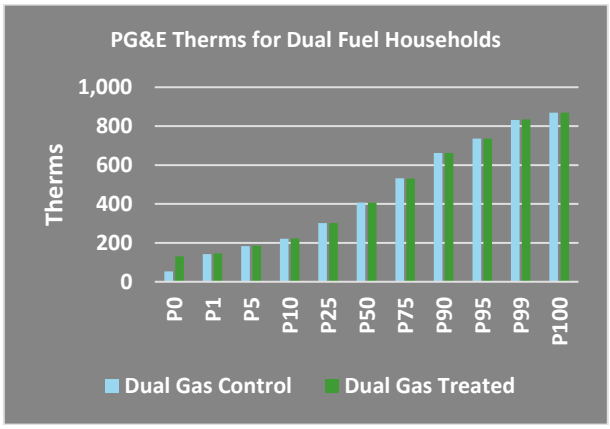


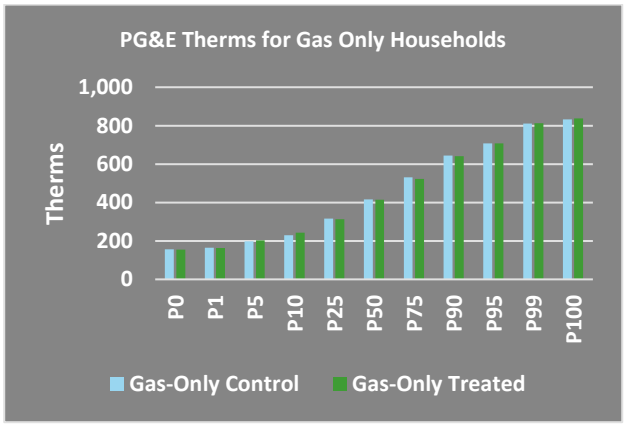
[13] Figures 7 and 8 summarize the cumulative distribution of electiricity and gas consumption for the opt-in users and matched comparison groups at various percentiles.

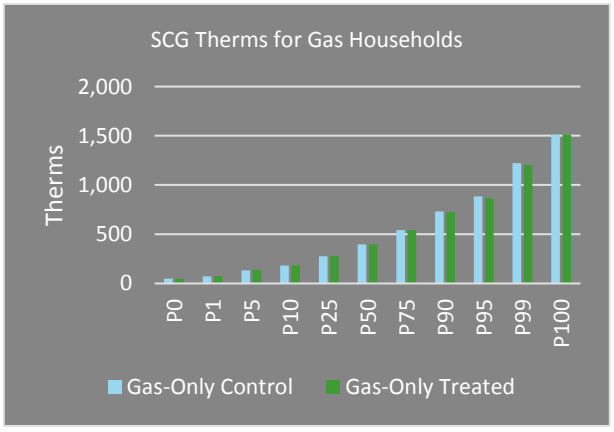
Figure 8: Distribution of gas consumption of matched comparison and opt-in households











Second, we tested if the distributions of the matched samples are the same using the two-sample Kolmogorov-Smirnov (KS) test (see Section 3.3.1.3). We present the results from the two-sample KS test in Table 14 for electricity and Table 15 for gas. In general, the test results indicate samples whose distributions are not statistically different. With probability values (p-value) of 0.05 or greater, we fail to reject the null that the sample data for both the matched comparison and opt-in groups come from the same population at the 95% confidence level. For example, the p-value of 0.43 for PG&E electricity data matched using monthly

consumption indicates that we cannot reject that the matched comparison and opt-in samples have identical distributions.

The KS test results for the model-based matching generated using AMI data also indicate well-balanced comparison and treatment matches. In addition, the quality of matches improved substantially for SDG&E electricity data while the conclusion on PG&E electricity data remains unchanged[14]. Therefore, this exploratory work in model-based matching suggests there could be benefits from using AMI data in matching in specific cases.

Table 14: Statistical test of balance for matched electricity data

Matching Technique	SDG&E Electric		PG&E Electric	
	Test Statistic	P-value	Test Statistic	P-value
Monthly Consumption	1.36	0.05	0.88	0.43
Model-Based Matching	0.51	0.96	1.29	0.07

Table 15: Statistical test of balance for matched gas data

Matching Technique	SDG&E Gas		SCG Gas		PG&E Gas	
	Test Statistic	P-value	Test Statistic	P-value	Test Statistic	P-value
Monthly Consumption	0.98	0.29	1.21	0.11	0.59	0.88

3.4.5 Savings estimates

We find that engagement with the tool reduces energy consumption materially. We present these reductions in Table 16 for electricity. Over the study period that covers the start of 2014 until the end of 2015, SDG&E electricity consumers that used the tool reduced their electricity consumption by a total of 1,980 MWh. This is a reduction of 2.0% of their total electricity use. PG&E's customers that used the tool also reduced their energy consumption by 1.2% over the same time frame, which amounts to 3,927 MWhs. Both declines in electricity consumption are statistically significant.

Table 16: Total residential electric savings by IOU

Residential	SDG&E Electric		PG&E Electric	
	kWh	percent	kWh	percent
Total	1,980,102	1.8%	3,895,238	1.2%

Note: all savings statistically significant at least at the 95% confidence level

We present the reduction for gas consumption in Table 17. SDG&E gas customers reduced their gas consumption relative to their baseline use by almost 3% for a total of about 75,000 therms while SCG gas customers used almost 2% less gas relative to their baseline use for a total of about 304,561 therms. PG&E's gas customers similarly reduced their gas consumption by almost 2% totaling in use of about 200,000 fewer therms relative their baseline consumption. These reductions are also statistically significant.

[14] While using certain elements of AMI data led to a stronger match for SDG&E than for PG&E, this is not definitive evidence that AMI data improves matches in all cases.

Table 17: Total residential gas savings by IOU

Residential	SDG&E Gas		SCG		PG&E Gas	
	therm	percent	therm	percent	therm	percent
Total	75,056	2.6%	301,939	1.8%	192,820	1.5%

Note: all savings statistically significant at least at the 95% confidence level

It appears that total electric savings for SDG&E is 50% of PG&E's. Similarly, SDG&E's total gas savings is also about 40% of PG&E's total gas savings and a quarter of SCG's total gas savings. Comparisons of savings across IOUs, however, are made best on a per household basis. We present estimates of savings per household in Table 18 for electricity and Table 19 for gas. All estimated savings are statistically significantly different from zero.

We note SDG&E's annual electricity savings per household, based on 2015 activity when the full set of 2014 users is active, is about 1.5 times that of PG&E's. Moreover, SDG&E's savings of 126 kWh per household is statistically significantly different from PG&E's 86 kWh annual savings. On the gas side, SDG&E's annual savings per household are similarly higher than both SCG's and PG&E's. The difference among all the estimated gas savings per household are statistically significantly different. SDG&E's gas savings per household are greater than the gas savings for the other two utilities.

Table 18: Residential electric savings per household by IOU

Residential	SDG&E Electric (kWh)	PG&E Electric (kWh)
2015	126	86

Note: all savings statistically significant at least at the 95% confidence level

SDG&E appears to be the leader in both electric and gas savings. While PG&E's gas savings are lower than SCG's across all households, its savings among high engagement customers is greater (Sections 3.4.3 and 3.4.6).

Table 19: Residential gas savings per household by IOU

Residential	SDG&E gas (therm)	SCG Gas (therm)	PG&E Gas (therm)
2015	6.9	4.7	3.9

Note: all savings statistically significant at least at the 95% confidence level

There are several possible factors for the estimated differences in savings among the utilities. First, while Table 4 indicates higher tool survey completion rate of 12% for PG&E in 2014, the year for which we evaluate the program, relative to SDGE's value of 9%, evidence from the tracking data indicates that action plan creation was higher for SDG&E's UAT users relative to PG&E's users. (Table 20).

Table 20: Engagement by IOU

Residential	SDG&E	PG&E	SCG
High engagement - Created action plans	18%	14%	6%

Second, the extent of HER participation among UAT's opt-in population is relatively higher for PG&E compared to SDG&E as we discuss in 3.4.9. Although we find no joint savings as a result of the HER-UAT overlap, greater HER related activity could leave less room for UAT motivated savings. Third, PGE's UAT

participants appear to use the tool less frequently compared to SDG&E and SCG UAT users. The average number of visits to tool and the return visit rate are lower for PG&E compared to the SDG&E. Self-reported visits are also less frequent for PG&E than SDG&E as we discuss in Section 1.4.1.

The comparison in gas savings between PG&E and SCG is not as straightforward. As we already noted, SCG's overall gas savings are higher than PG&E's. PG&E's high engaged customers, however, save more than SCG's high engaged customers. This may be explained by the higher action plan creation rate among PG&E's tool users relative to SCG. SCG's customers however, have more visits to the tool per household and a greater self-reported frequency of tool use. The mixed outcome in savings is thus not a surprise.

What is clear is that depth of engagement translates to higher savings.

3.4.6 Depth of engagement

We also examine the consumption effect of different levels of engagement with the tool. We are interested in gauging the extent of reductions in kWh and therms for those who use the tool with different levels of intensity. As noted earlier, we define two levels of engagement based on whether users simply browsed the tool, and in some cases filled out surveys on the tool, but took no further energy saving actions (low engagers) and those who, in addition to browsing the tool and/or completing tool surveys, created action plans on the tool to get tailored energy saving recommendations (high engagers).

The definition of action plan creation for the UAT program run by Aclara for SCG & SDG&E is based on data that indicates action plan creation dates. For the UAT program run by Opower for PG&E, we rely on tip action date from the tracking data to define this high level of engagement.

We examine the effect of engagement level on consumption by looking at the percent declines in energy use across these two groups. We present the results for electricity in Table 21 including the overall reduction in electricity consumption relative to baseline that we presented in Table 16. We note high engagers, defined in Section 3.4.2, of both utilities reduce their electricity consumption more than their low-engagement counterparts. SDG&E's high engagers reduce electricity use relative to baseline by 3.6% while PG&E's high engagers reduce their electricity use by 2.4%. Comparatively, the low engagers of SDG&E and PG&E use 1.3% and 1% less electricity, respectively, relative to baseline. All the reductions are statistically significant.

Table 21: Percent residential electric savings by engagement and IOU

UAT Engagement Level	SDG&E Electric	PG&E Electric
Overall	1.8%	1.2%
Low	1.3%	1.0%
High	3.6%	2.4%

Note: all savings statistically significant at least at the 95% confidence level

We present the results for gas in Table 22. The reduction in gas use among high and low engagers is greater overall than for electricity but there is less distinction in savings levels for the two engagement levels. We note that low engagers realize significant savings. This level of engagement includes users who complete the tool survey. It could be that this subset gains additional information on energy efficiency by completing the survey and thus realizes more savings.

Table 22: Percent residential gas savings by engagement and IOU

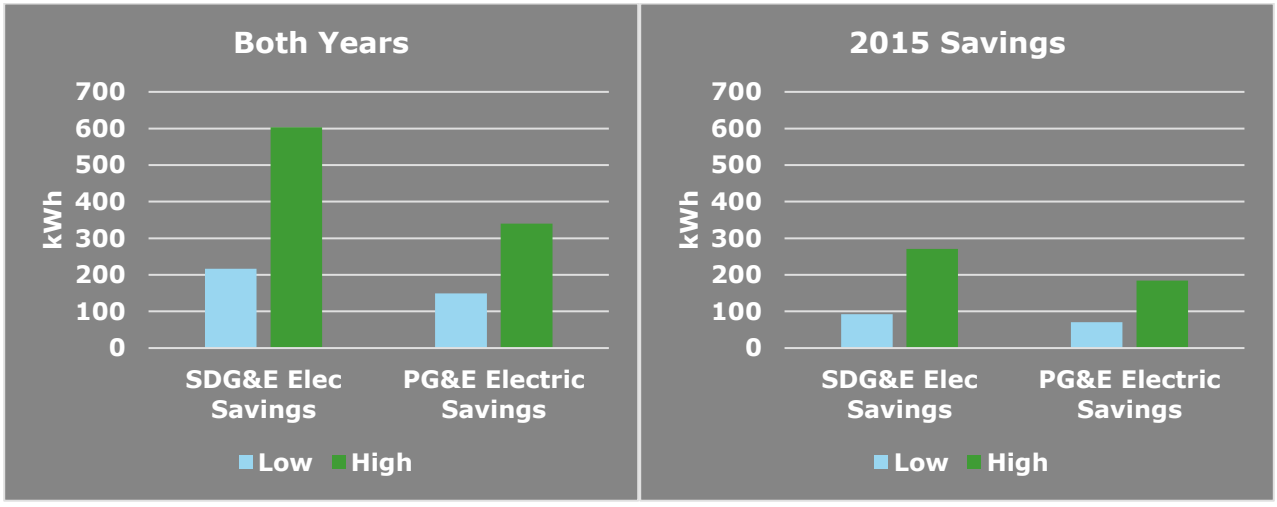
UAT Engagement Level	SDG&E Gas	SCG Gas	PG&E Gas
Overall	2.6%	1.8%	1.5%
Low	2.4%	1.8%	1.2%
High	3.3%	1.5%	3.0%

Note: all savings except for SCG Gas High Engagement statistically significant at least at the 95% confidence level

To examine the kWh and therm reduction associated with these percentages, we look at energy reductions by engagement across both years and in 2015 for each IOU. The "both years" figure tracks average savings for a participant activated for all months of both years. The 2015 figures are illustrative of the annual reductions in kWh and therms possible during a single year, with all 2014 participants activated. In many cases the "both year" average savings results are more than double the level of the 2015 results. This is just an artifact of the increasing subset of opt-ins as the year progresses. The savings estimates of the early months of 2014 are based on a relatively small number of participants. This should not necessarily be construed as evidence that savings decrease over time. We report results on this aspect of savings in Section 3.4.7.

Figure 9 presents the results for electricity and Figure 10 presents the results for gas. It is clear the average electricity reductions per household are greater for high engagers relative to low engagers in both years. The 2015 reductions per household are in the order of about 90 kWh to 270 kWh for SDG&E, for low and high engagers respectively, while those for PG&E are about 70 kWh to 185 kWh per household. All these reflect statistically significant reductions. Additionally the difference in savings between high engagers and low engagers is statistically significant underscoring the finding that high engagement translates to higher savings.

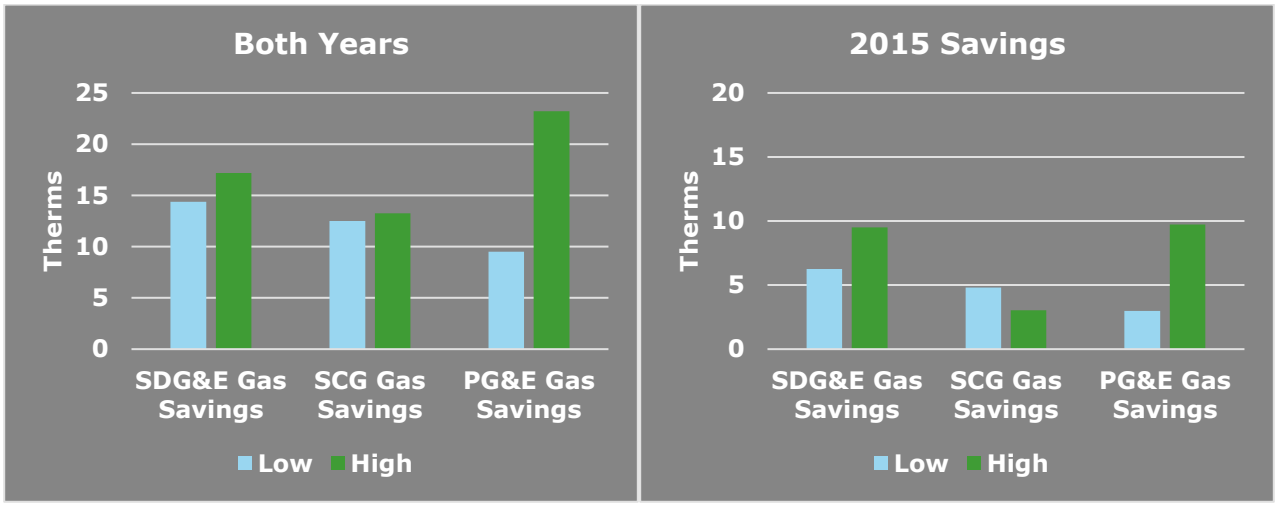
Figure 9: Residential total electric savings per household by engagement level and IOU



Like for electricity, there are notable reductions in gas use per household. The results indicate 2015 reductions of 6 to 10 therms for SDG&E, 3 to 5 therms for SCG, and 3 to 10 therms for PG&E. The reduction of 3 therms for high engagers of SCG is not statistically significant. However, SCG gas savings for high

engagers and low engagers are not statistically significantly different. The statistically significantly higher savings for SDG&E and PG&E high engagement gas customers relative to the savings for low engagement customers at these IOUs suggests that greater engagement with the tool leads to greater reduction in gas consumption.

Figure 10: Residential total gas savings per household by engagement level and IOU



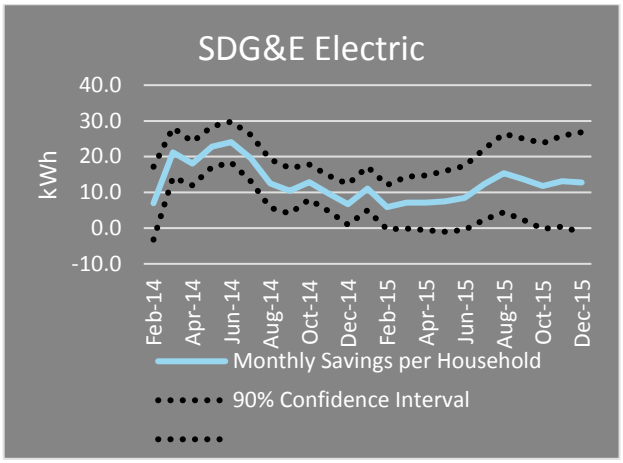
The findings above indicate that residential customers that used the tool with high level of intensity have reduced both their electric and gas consumption. When we examine the savings on per household level, it is clear those with a more significant level of engagement have reduced their consumption by at least as much, and in the case of electricity more, than those with a less intense engagement.

3.4.7 Impact of length of engagement

An important question for this analysis is whether savings persist over time. Due to the nature of UAT participation and the data we are using for this analysis, the results for this part of the analysis are only suggestive.

The monthly savings estimates provide some evidence of savings persistence. We present these estimates, along with their 90% confidence band, for each IOU.
Figure 11 provides the estimated savings for electricity and Figure 12 provides the same for gas for each utility. The 2014 monthly estimates represent savings for customers who have engaged prior to each given month. Only by January 2015 do the results reflect the savings estimates of the full group of 2014 customers.

Figure 11: Average monthly residential electric savings per household



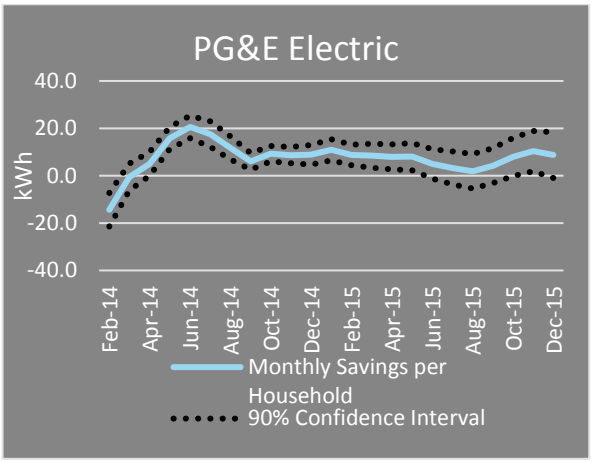
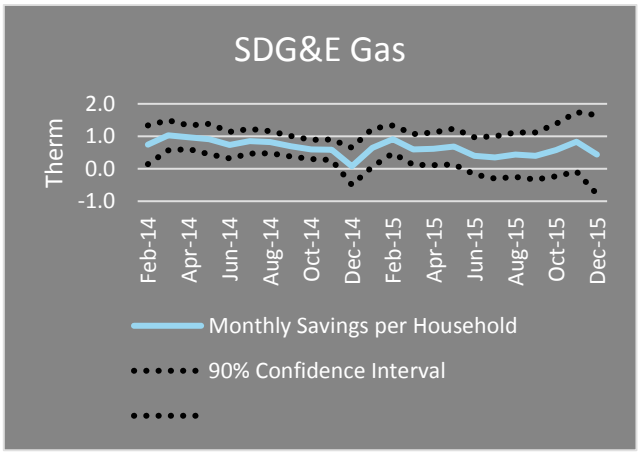
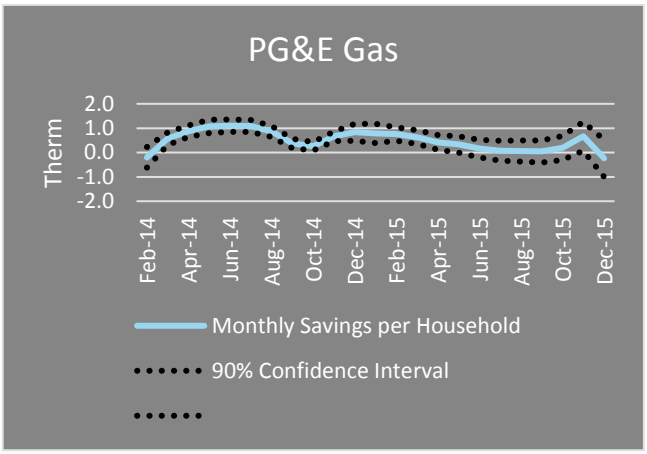
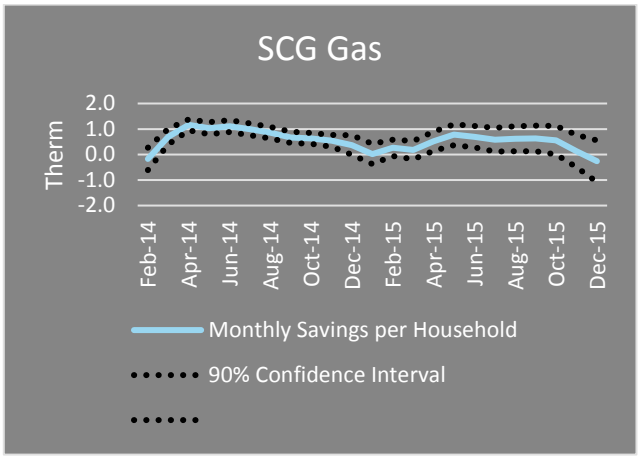


Figure 12: Average monthly residential gas savings per household







Both SDG&E and PG&E electric savings estimates show a clear increase of savings during the summer months of 2014. Both series moderate during the winter months. In summer 2015, SDG&E shows a smaller increase in savings, whereas PG&E shows a slight reduction in savings. The strong summer savings demonstrated by early 2014 engagers are not repeated for either IOU. This could reflect different summer conditions, the addition of a different cohort of consumers joining the program in late 2014 or the increasing distance from the first engagement with the program. Despite the apparent decrease in cooling savings,

savings do appear to maintain at a consistent level through the end of 2015. These findings suggest two things: that the program may effectively promote cooling savings opportunities when they are close at hand and that savings persist into a second year but appear to be less seasonally oriented.

The gas savings appear to be seasonal in an unexpected way. Both SDG&E and SCG savings estimates are reduced during heating season. In contrast, savings are more consistent during the rest of the year. Across the two years, there appears to be a slight reduction in savings. PG&E is less clearly seasonal but also exhibits a slight decline in 2015.

Additional data will make it possible to track savings over subsequent years. Additional data may also make it possible disentangle seasonal effects and the effect of time since engagement. It is clear from these plots that there is some seasonality to the savings and that those seasonal effects may be strongest early in the engagement cycle. It makes sense that attrition of savings would affect both seasonal and non-seasonal savings.

3.4.8 Downstream rebate joint savings

One possible effect of the UAT is to increase rebate activity in other IOU energy efficiency programs. To investigate this, we compared average savings from rebate measures installed by the treatment group with the savings from measures installed by the comparison group. An increase in opt-in group rebate program savings relative to the comparison group represents savings caused by the UAT engagement in conjunction with the rebate programs. While these joint savings are an added benefit of the UAT program, it is essential that they are only reported once.

We applied the following approach to roll up individual rebate savings and calculate overall joint savings:

- Used accepted deemed savings values (those used to claim savings for the rebate program)
- Started accumulating savings beginning from the installation date moving forward in time
- Assigned daily savings on a load-shape weighted basis (more savings when we expect the measure to be used more)
- Maintained the load-shape weighted savings over the life of the measure

This approach takes the deemed annual savings values and transforms them into realistic day-to-day savings. We determined the daily share of annual savings using hourly 2011 DEER load shapes for each IOU. These load shapes indicate when a measure is used during the year and, by proxy, when efficiency savings would occur.

Savings for each installed measure start to accrue at the time of installation (or removal for refrigerator recycling). We calculated average monthly household rebate program savings for the treatment and comparison groups and included zeroes for most households that do not take part in any rebate program. An increase in average per-household tracked program savings among the treatment group versus the comparison group indicates joint savings.

Our analysis does not provide any evidence of joint savings of either gas or electricity for any of the IOUs. Savings estimates from rebate measures of the opt-in group relative to the comparison group are not statistically significantly different. Thus, there is no evidence that UAT engagement has led to an increased savings for the opt-in group members that participate in other rebate programs relative to savings achieved by the comparison group from the same programs.

3.4.9 UAT HER Overlap

Just as the UAT and HER programs may motivate joint savings with other IOU rebate programs, there is a similar interaction between the UAT and Home Energy Report (HER) programs run by the IOUs. Receiving a report from the HER program could make a person more likely to opt into the UAT. For those additional people prompted to opt-in into the UAT by the HER program, their HER-motivated savings could be conflated with their UAT-motivated savings. As with downstream rebate joint savings, our primary concern is avoiding claiming jointly-motivated savings for both programs. Despite some overlap in participation in the two programs, we find no evidence of joint savings between the UAT and HER programs.

Table 23 and Table 24 show that members of the HER eligible population are more likely to be in the UAT opt-in group for PG&E and SDG&E, respectively.[15] That increase is evident, however, across both the HER treated and HER control groups. We surmise that the slight increase of HER eligible population in the UAT opt-in group is driven by something other than the HER reports.[16] The lack of evidence of an increase in HER treatment uplift into the UAT opt-in group due to receiving the report supports a conclusion of no joint savings between UAT and HER.

Table 23: PG&E HER Program Participants in PG&E's UAT Program

	HER Eligible Population	HER Treated	HER Control
UAT Comparison	58%	44%	14%
UAT Opt-in	61%	45%	16%

Table 24: SDG&E HER Program Participants in SDG&E's UAT Program

	HER Eligible Population	HER Treated	HER Control
UAT Comparison	8%	6%	2%
UAT Opt-in	13%	10%	3%

In addition to the double-counting challenge, the UAT interaction with HER programs may have further implications for understanding the overall effectiveness of the UAT program at delivering savings. The overlap in behavioral and conservation messaging and the fact that HER recipients are approximately equally present in the UAT opt-in and matched comparison groups, may mean that prior HER involvement depresses UAT savings[17]. If we assume that both HER and UAT motivate customer action, then the prior presence of the HER recipients in both UAT opt-in group and the UAT comparison group, would mean those savings are less available to the UAT program. The greater prevalence of prior HER involvement among PG&E UAT participants is a possible explanation for why PG&E UAT participants appear to save less than SDG&E.

[15] The PG&E table covers all PG&E HER program participants. The SDG&E table only covers recent waves of SDG&E participants. Earlier waves showed no increase of HER eligible or treated populations among the UAT opt-in group. Developing a table for SCG UAT participants' interaction with SCE's HER program required the assumption that electric HER reports would affect gas savings as well the additional step of matching SCG and SCE customers. Given no evidence of overlap for PG&E or SDG&E, we did not pursue this table.

[16] This increase could be driven by the geographic or consumption characteristics targeted for the HER eligible population.

[17] In order for there to be joint savings, the prevalence of HER treatment households needs to be greater among UAT's opt-in group than in the UAT matched comparison group. But our examination of the prevalence of HER in UAT confirms the equal presence of HER treatment and control households in both the UAT opt-in and matched comparison groups. As a result there is no joint savings.

4 PROCESS EVALUATION

The UAT is an opt-in program where only a subset of customers chooses to log on to the site and participate. Understanding the opt-in decision is critical to expanding the program and fully understanding the attributable savings. Additionally, the UAT leads participants through a range of processes with the goal of encouraging customer engagement. Participation may occur at a wide range of levels, from initial sign-in with no other activity beyond viewing energy usage data, to substantial engagement with goal-setting behavior and follow-up, thus leading to potentially variable savings.

While the impact evaluation quantifies potential savings attributable to the tool, we employed primary research using a survey of participants and non-participants to reveal customer choices and behaviors that lead to these potential savings. The survey helps in discovering what motivates people to participate and potentially explains variability in participant behavior.

4.1 Overall results

Key findings from the process evaluation are summarized below:

- While overall recall of tool use is low, high engagement users are more likely to recall tool use
- Perceived level of difficulty in finding information on the tool is low at 6%
- Around three-fourth indicate completing the survey on the tool, but only around one-third follow through and create an action plan
- Around half of all users claimed that the tool influenced their participation in at least one of the IOU programs they were eligible to participate in
- Around one-fourth report seeing lower bills since they began tool use

- Around one-fourth state that they would be likely to recommend the tool to someone they know
- Only 13% of all non-users[18] have heard of the tool. Of those who have not heard of tool, only 26% expressed that they were very or extremely interested in using the tool after hearing a description of the tool.

Results provide directional evidence that supports the findings from the impact evaluation and corroborate program theory. High engagement customers, who are shown to realize higher savings in the aggregate based on the impact evaluation, also report cross-program participation in higher proportions.

For any discussion related to tool use by IOU here and elsewhere in this report, we note that the differences observed may be due to confounded impacts of different tools (program implementers), customer base, marketing strategies, weather etc.

4.2 Survey Methodology

This section summarizes the survey mode and design, sample disposition, and sample characterization.

4.2.1 Survey mode and design

Given that the UAT is only accessible online and the fact that participant email addresses are known for program participants and a sizeable number of non-participants, we employed a web survey. This approach allows us to capture maximum information from a robust sample with minimal additional incremental cost per additional survey.

The survey sought to capture data providing insight into the behaviors, attitudes, and motivations of customers in relation to tool engagement and their energy use including:

- Tool recall
- Motivators of participation
- Source/channel where participant learned about the tool
- Frequency of use
- Completion of survey on tool, number of visits taken to complete survey
- Completion of energy management plan, frequency of updating plan
- Usefulness of features of UAT
- Satisfaction with UAT, likelihood to recommend UAT
- Adoption of energy saving behavior due to UAT influence
- Purchase of energy efficient equipment due to UAT influence
- Participation in other IOU programs due to UAT influence
- Perception on impact on bill
- General attitudes and behavior (climate change, conservation, price sensitivity etc.)
- Technology use
- Demographics

[18] Here we designate the UAT opt-in population as users and the matched comparison group as non-users.

4.2.2 Sample disposition

The online UAT survey was administered from January 2017 to February 2017. The sample frame for this survey was derived from the data used in the impact evaluation that included all tool users and a matched group of non-users. All customers in the matched data set (from the impact evaluation) who had available email contact information and who were not on the IOUs' do-not-contact list were included in the final survey sample frame and eligible to take the survey. While no incentives for completion were offered to those who were invited to take the survey, respondents were reminded via email and encouraged to complete the survey. The survey disposition is summarized below (Table 25).

Table 25: Survey disposition

	Total	PG&E	SDG&E	SCG
Total Frame	236,365	81,509	34,981	119,875
Bounces (Invalid addresses, spam etc.)	31,451	7,670	7,180	16,601
Total Eligible Frame	204,914	73,839	27,801	103,274
Completes	5,671	1,917	1,355	2,399
Response Rate	2.8%	2.6%	4.9%	2.3%

While the overall response rate for the study was low, it is comparable along relevant dimensions used in the stratification for the matching procedure such as consumption level[19] and climate zone (Table 26).

Table 26: Response rates by level of consumption and climate zone

Level of Consumption	Response Rate	Climate Zone	Response Rate
High	2.2%	Coastal/Mild	2.9%
Medium	2.4%	Desert	2.6%
Low	2.6%	Inland	2.1%

As expected, tool users respond to the survey in higher numbers than non-users (Table 27). Furthermore, response rates vary by users and non-users within IOU. For example: SDG&E users have a response rate of over 9% versus 2% for non-users. The corresponding response-rates for PG&E are around 4% and 2% and for SCG are 4% and 1% for users and non-users respectively.

Table 27: Response rates by users and non-users

Users	Response rate
Non-users	1.6%
Users	4.5%

4.2.2.1 Sample weights

The sample frame for this survey consists of all users and the matched sample of non-users based on consumption patterns. As discussed earlier in the report, the matching process identifiesfive non-users whose consumption patterns match most closely those of each user. Sample weights are used to balance the

[19] Consumption terciles are based on the sample frame used in the survey and vary by IOU.

survey data to reflect the distribution of this sample frame within IOU and treatment group and by climate zone and consumption. A detailed table summarizing the weights may be found in APPENDIX. G.

4.2.3 Sample characterization

We examined the sample on key demographic characteristics and compared against statewide statistics for California and within the sample among users and non-users. The UAT evaluation survey respondents had a higher proportion of those with annual household incomes greater than $75,000 and a college degree education or higher (Table 28).[20] They also had larger homes with an average of more than three bedrooms versus the California general population average of 2.6 bedrooms. A comparison of tool users versus non-users within the survey shows that they are similar along many key demographic lines, but a significantly higher proportion of non-users had incomes over $75,000 versus users at 64% to 57%, respectively. A significantly higher proportion of tool users lived in older homes built prior to 1980 relative to non-users at 58% to 55% respectively.

Table 28: Sample characterization

	CA	Total Survey (n=5,671)	Non-Users (n=2,797)	Users (n=2,874)
Income over $75,000	42%	61%*	64%	57%*
Education – Bachelor's degree or higher	31%	66%*	66%	66%
Number of members in the household	2.9[21]	2.7	2.7	2.6
Someone at home most or all of the day on a typical weekday		76%	77%	75%
Number of bedrooms in home	2.6[22]	3.1	3.1	3.1
Area of home (square feet)		1,860	1,886	1,834
Pre–1980 dwelling vintage		56%	55%	58%*
Never renovated dwelling		31%	31%	32%

Note: * Indicates statistically significant difference at the 95% confidence level between CA and and the evaluation survey sample and users and non-users.

4.3 Survey Findings

This section summarizes findings from the UAT evaluation survey.

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

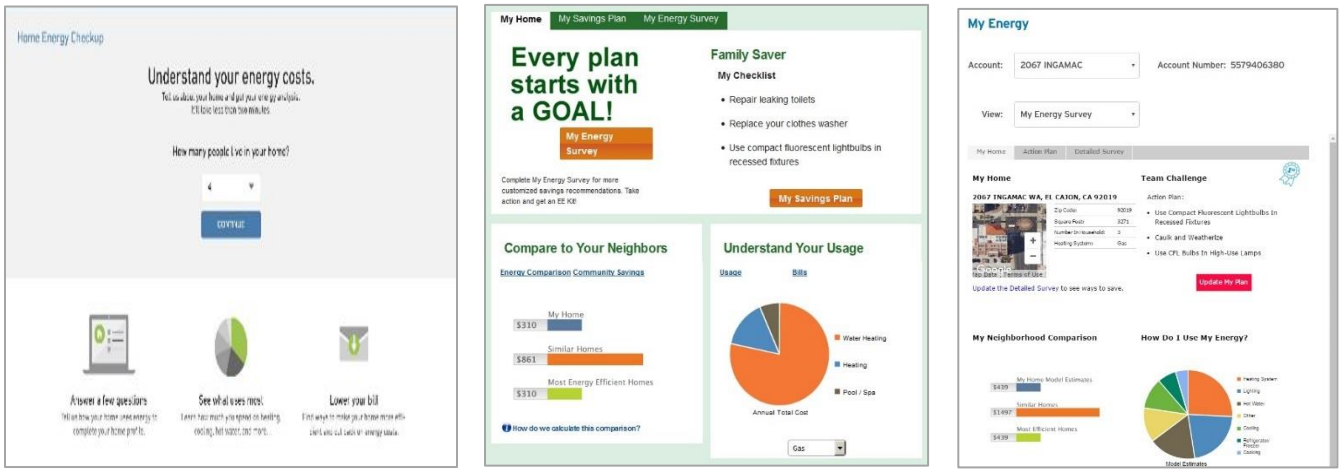
[21] http://www.census.gov/prod/cen2010/doc/dpsf.pdf

[22] Average estimated from distribution of number of bedrooms in occupied housing units in CA, Census

4.3.1 Tool recall

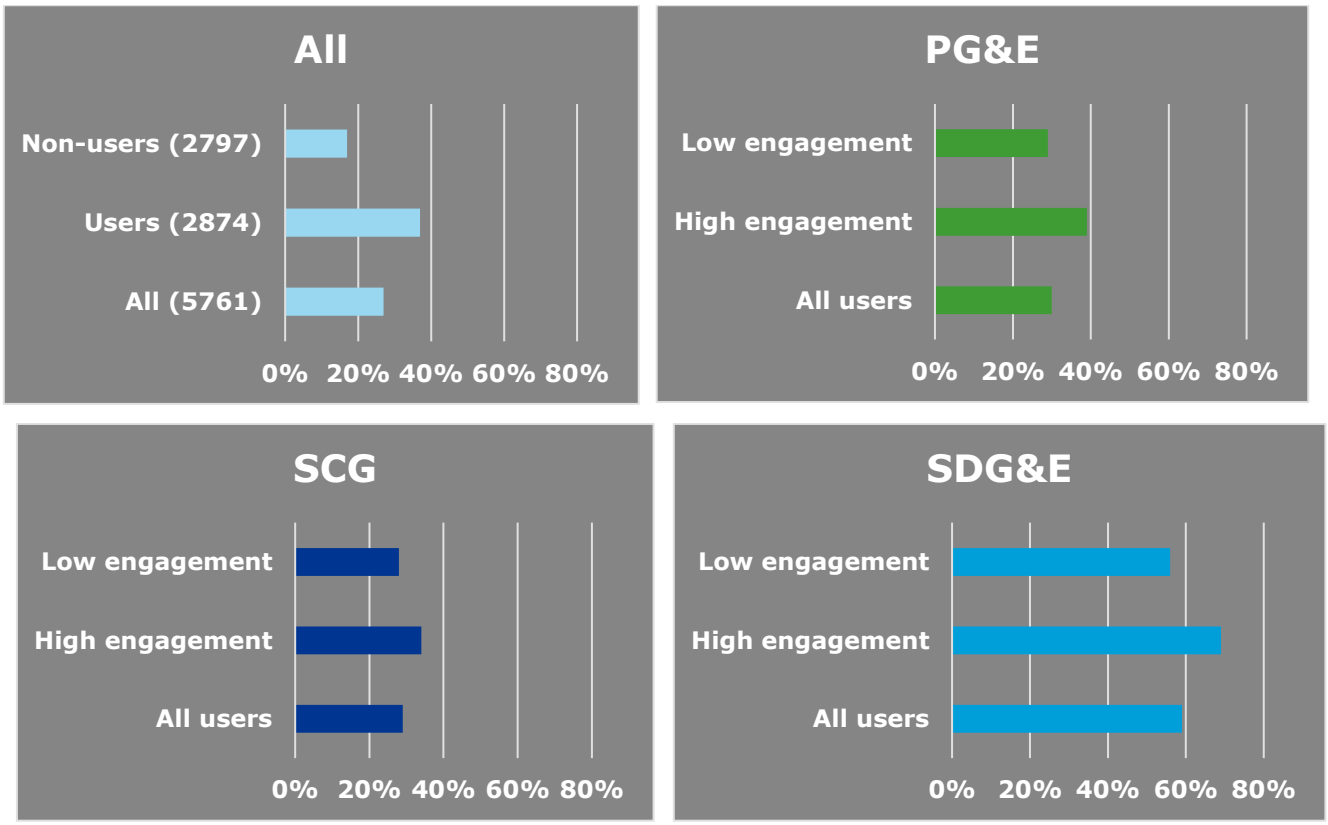
Respondents were shown a screenshot of the welcome screen of the online audit tool and asked if they recalled using the tool (Figure 13).

Figure 13: Tool welcome screen



Overall, 37% of all users stated that they recalled using the tool. We observe that recall is higher among high engagement customers versus low engagement customers for all IOUs (Figure 14).

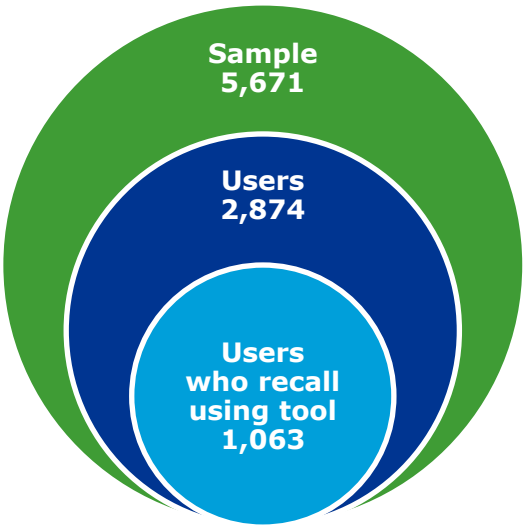
Figure 14: Tool recall by IOU



4.3.2 Users who recall using tool

The tracking data flagged 2,874 of the 5,671 survey respondents as users of the UAT. A substantially smaller subset of this set of users actually recall using the tool. All questions in the survey pertaining to tool use, engagement, tool influence, feedback, and verdict on the tool were posed to this subset of users who actually recalled using the tool, hereafter referred to as "users" in the findings presented (Figure 15).

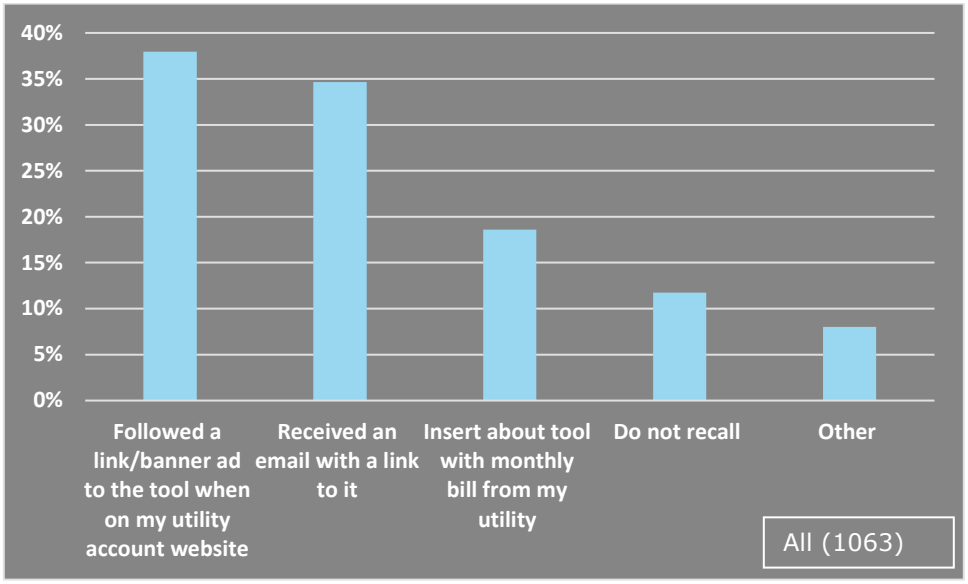
Figure 15: Tool recall



4.3.3 Channel through which users learned about the tool

Although review of IOU outreach methods indicates use of a mix of several other channels such as radio, TV, and social media among others, when asked how they learned about the tool, the majority of respondents indicated that they followed a banner advertisement to the tool (38%) or a link they received via email (35%). Fewer than 10% of all respondents indicated learning of the tool through channels other than email, banner ads, or bill inserts (Figure 16).

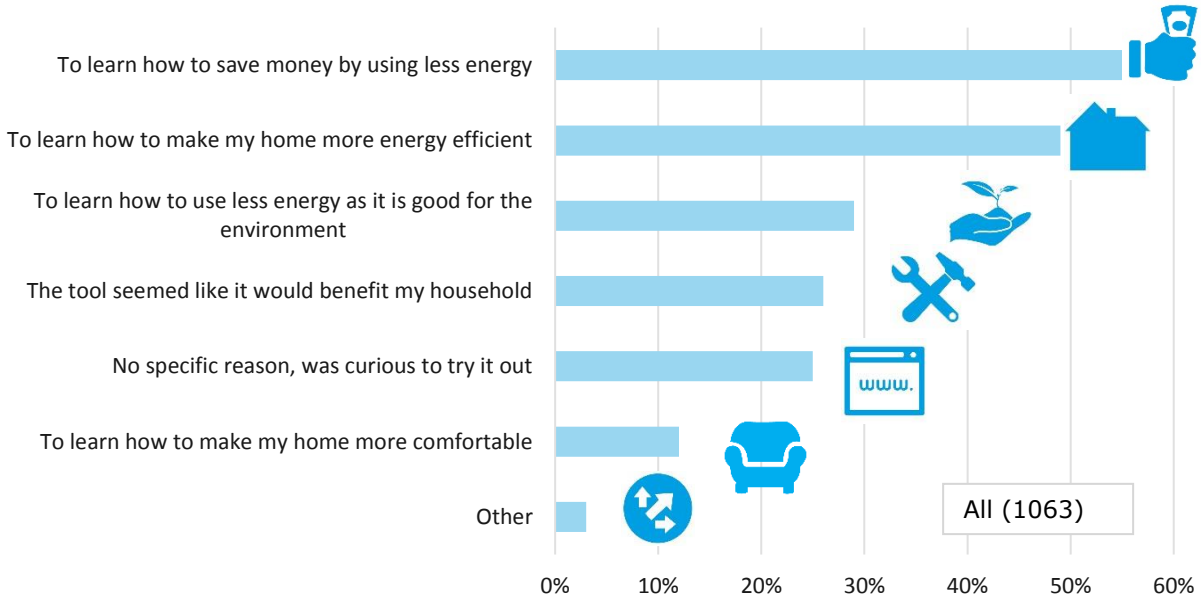
Figure 16: Channel through which users learned about the tool



4.3.4 Motivators of participation

Saving money emerges as the most mentioned from the list of potential motivators shown, followed closely by a desire to learn how to make their home more energy efficient (Figure 17). The environment and comfort are mentioned by notably fewer users as reasons why they used the tool.

Figure 17: Motivators of tool use



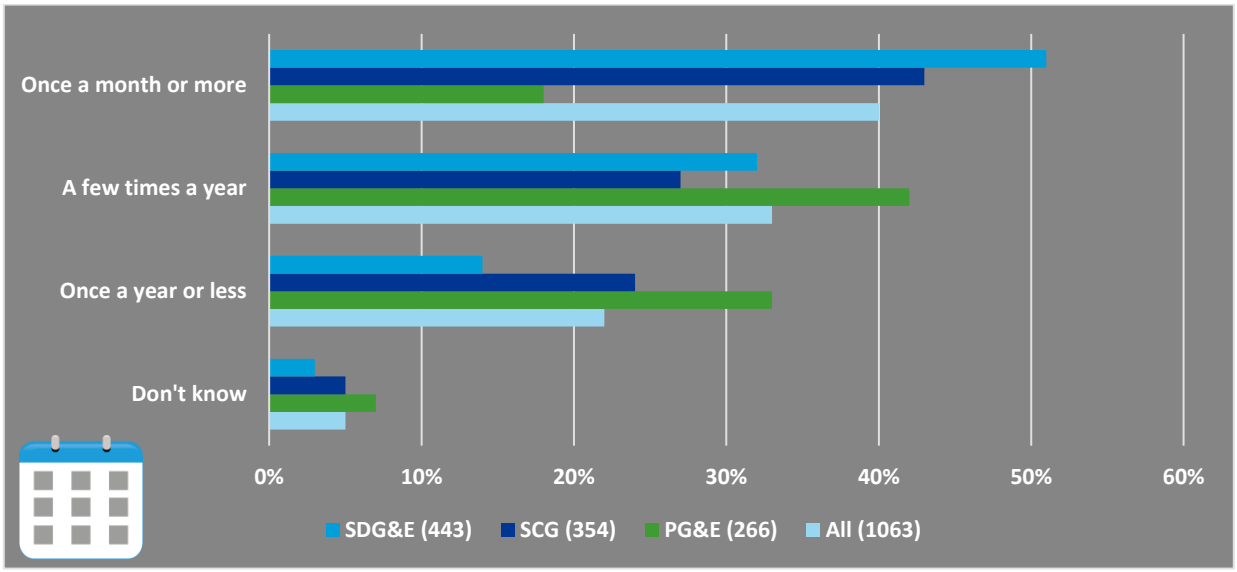
4.3.5 Depth of engagement

Engagement with the tool was measured using a series of questions posed to tool users who recalled using the tool. We queried the users on frequency of tool use, duration of the visit, number of visits taken to complete the survey on the tool, number of visits to create an action plan, and frequency of updating the action plan.

4.3.5.1 Frequency of tool use

Around 40% of all users indicated that they used the tool once a month or more often. While this high frequency of use was 51% and 43% for SDG&E and SCG respectively, it was significantly lower at 18% for PG&E users (Figure 18).

Figure 18: Frequency of use



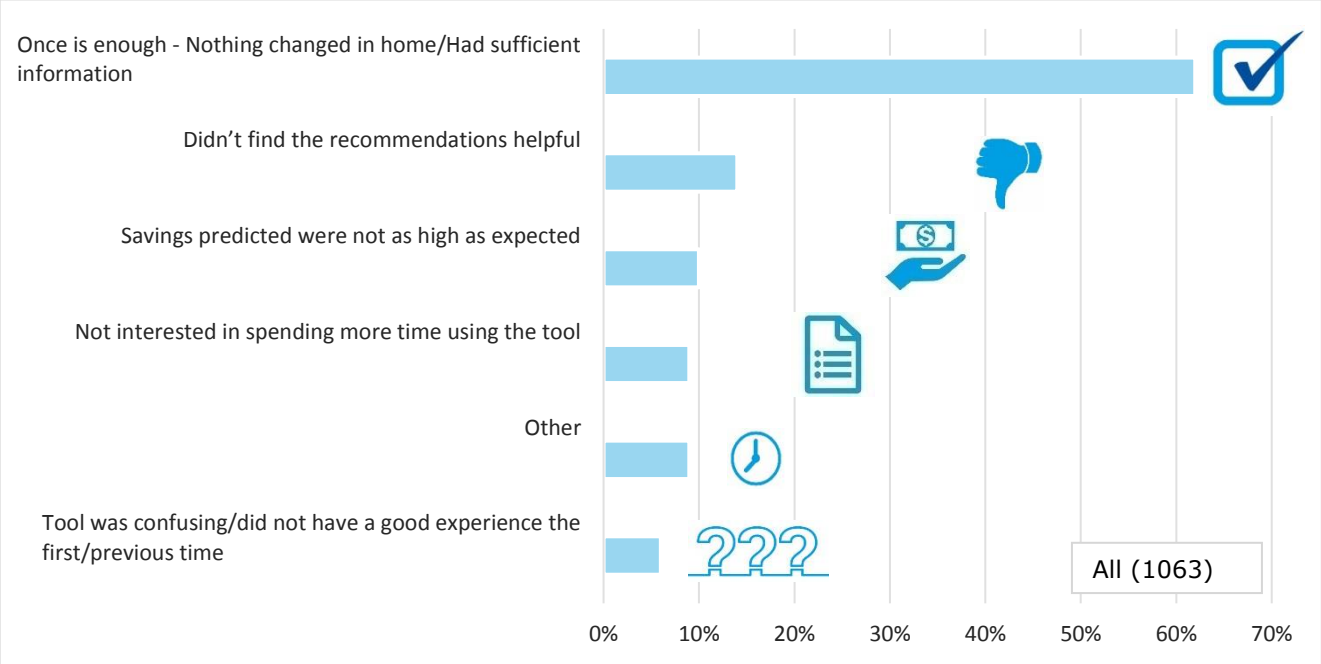
This aligns with the overall high recall of tool use among SDG&E customers relative to customers of other IOUs. Analyses of household level tracking data reveal the average number of visits per household as 5 for SDG&E, 4 for PG&E, and 3 for SCG. Aggregated monthly web metrics provided by the implementers of the UAT program for 2014 peg the return visit rate at 65% for SDG&E, 20% for PG&E, and 19% for SCG. Potential reasons could range from differences by implementer[23] and variable marketing or outreach strategies among others.

4.3.5.2 Barriers to more frequent use of UAT among users

Users were asked to indicate reasons why they did not use the tool more frequently. The majority of users (62%) felt one visit to the tool was enough when nothing in their home had changed and that they had sufficient information (Figure 19).

[23] SDG&E and SCG share the same implementer (Aclara) and PG&E has a different implementer (OPower) for the UAT

Figure 19: Reasons why tool was not used as often

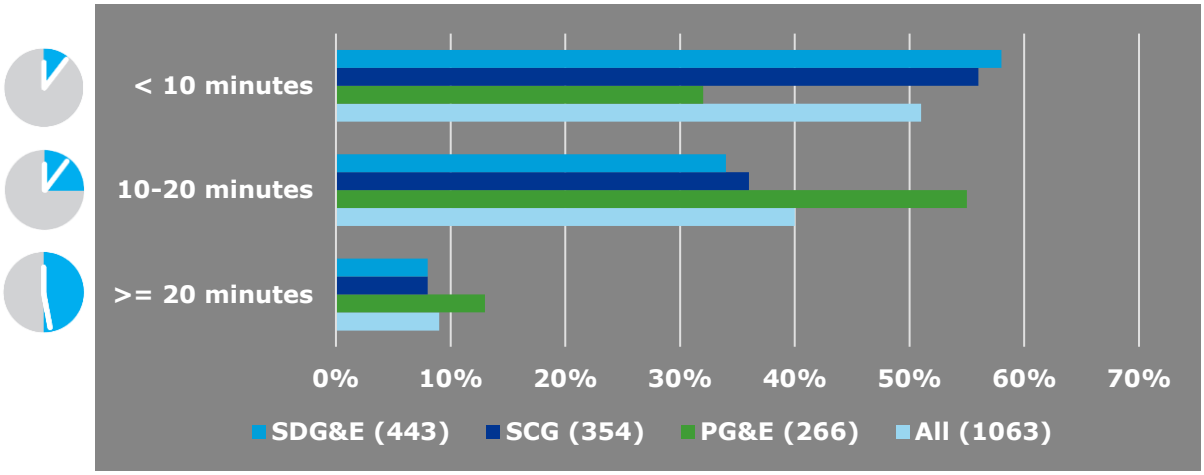


The above results on the reasons why users did not use the tool more frequently combined with the findings that over half the users state that they visited the tool a few times a year or less, make the case that the majority of users require more compelling reasons to make repeat visits. Using strategies such as gamification or incentives that introduce some extrinsic value associated immediately with the engagement may encourage repeat visits.

4.3.5.3 Duration of visit

On average, over half of all users spend less than 10 minutes on the tool (Figure 20). Over half of SCG and SDG&E tool users and around one-third of all PG&E tool users indicated that the average duration of their tool use was less than 10 minutes.[24]

Figure 20: Duration of visit

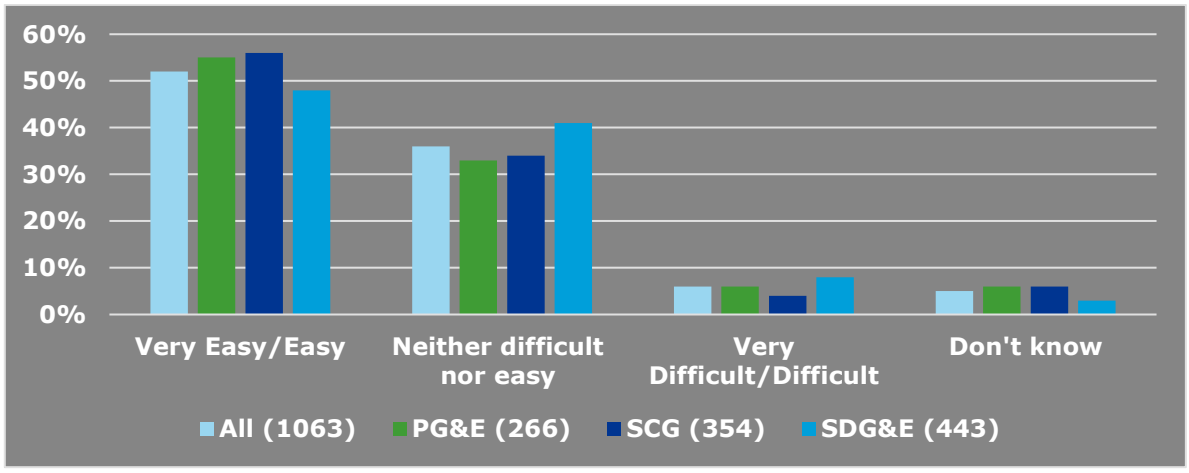


Aggregated monthly web metrics provided by the implementers of the UAT program peg average session time in minutes at 2.4, 4, and 3.4 for PG&E, SCG, and SDG&E respectively[25].

4.3.5.4 Ease of finding information

Over half of all respondents indicated some level of ease in finding the information they were looking for when using the tool (Figure 21). Only around 6% of respondents indicated any level of difficulty in finding information. There were no significant differences in customer perception of ease of finding information on the tool by IOU.

Figure 21: Ease of finding information



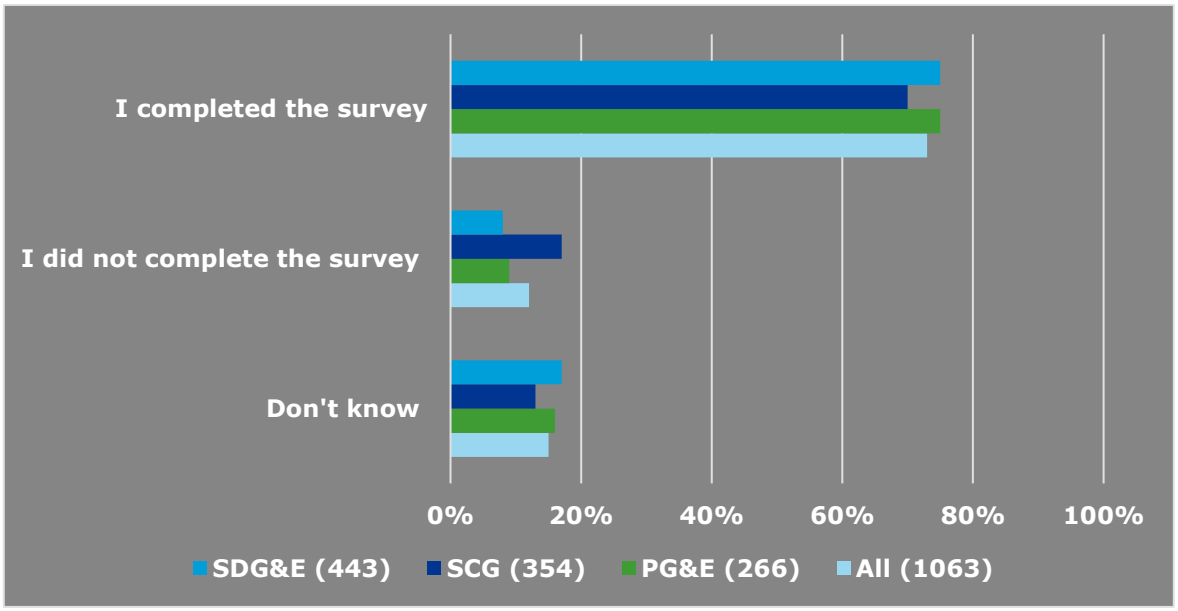
[24] Industry standards for average session duration for websites in general are around 2 minutes for direct traffic and 4 minutes referred traffic.

[25] While SCG and SDG&E's UAT program implementer, Aclara, provides average session length, PG&E's program implementer, Opower, provides length of time spent on 3 distinct pages of the tool. The average session length listed above for PG&E is computed as the sum of the time spent on the 3 distinct pages of the tool and hence may not be directly comparable to how session length is computed to SCG and SDG&E.

4.3.5.5 Completion of survey on the tool

Around three-fourth of all respondents completed the survey on the tool (Figure 22).[26] Only 12% of all respondents indicated that they did not complete the survey.

Figure 22: Survey completion on the tool



SCG respondents indicated they did not complete the survey in relatively higher proportions at 17%, which was twice as much as SDG&E and PG&E respondents. PG&E has deployed sophisticated multi-channel marketing that includes geo-targeted TV spots, email, social media, and banner ads to achieve tool survey completion rates as high as over 90% in 2015. SDG&E's marketing efforts have included email campaigns that include sweepstakes and they have seen success with these efforts with an all-time high completion rate for SDG&E of 40% in December 2016. While SCG's tool survey completion rates are lower at around 5% on average, lower marketing budgets have meant a more modest outreach campaign limited mainly to email[27].

Survey completion sets tool users on a path to higher engagement and results indicate that high engagement translates to higher savings. However, depth of engagement appears to be an important factor in explaining the variability in savings observed by IOU. The relatively higher savings observed for SDG&E and SCG relative to PG&E may be explained by higher frequency of tool use among the former versus the latter.

4.3.5.6 Action Plan – Creation and updates

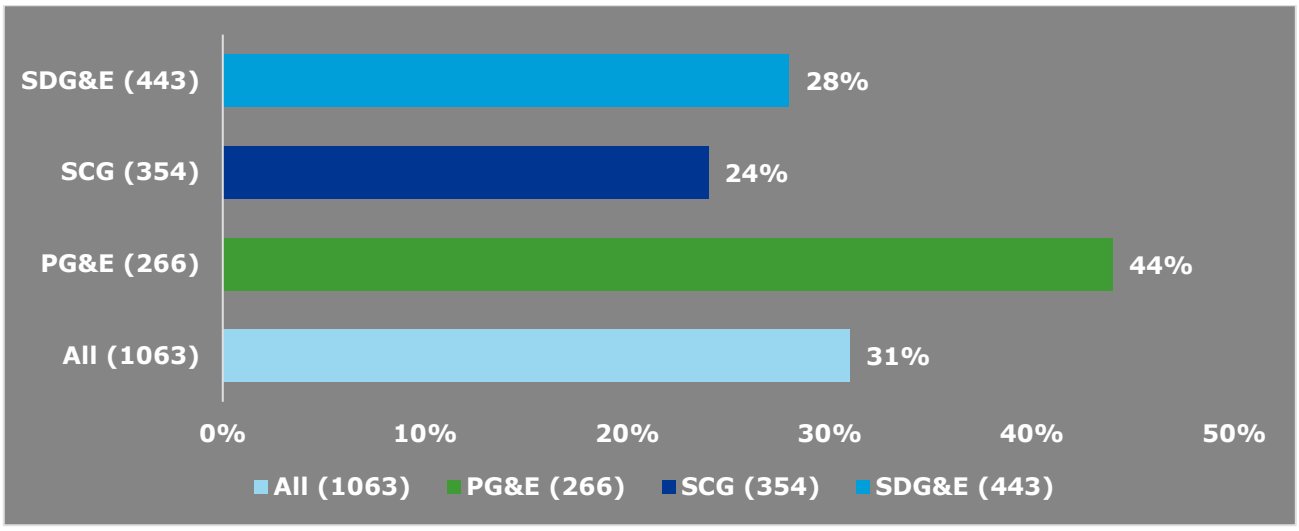
Overall, almost one-third of all respondents indicated that they had created an action plan for energy savings actions they intended to complete based on the recommendations they received from the tool (Figure 23). We note some differences by IOU with a significantly higher action plan creation rate for PG&E at 44% compared to SCG and SDG&E at 24% and 28% respectively. An analysis of tool user tracking data shows that action plan completion rates for PG&E, SCG, and SDG&E are 14%, 6%, and 18% respectively. In

[26] As of year end 2016, users of PG&E's, SDG&E's, and SCG's tool had tool survey completion rates of 19%, 13%, and 5% respectively. Survey completion rates for the study period in the year 2014 are 12%, 9%, and 3% for PG&E, SDG&E, and SCG respectively.

[27] Based on information received from IOU program staff via email, phone calls, monthly Energy Advisor reports, and regular PCG III meetings for UAT

general, PG&E and SDG&E users create action plans at higher rates than SCG. The results of this evaluation suggest that higher engagement with the tool corresponding to creation of action plans translates to higher savings.

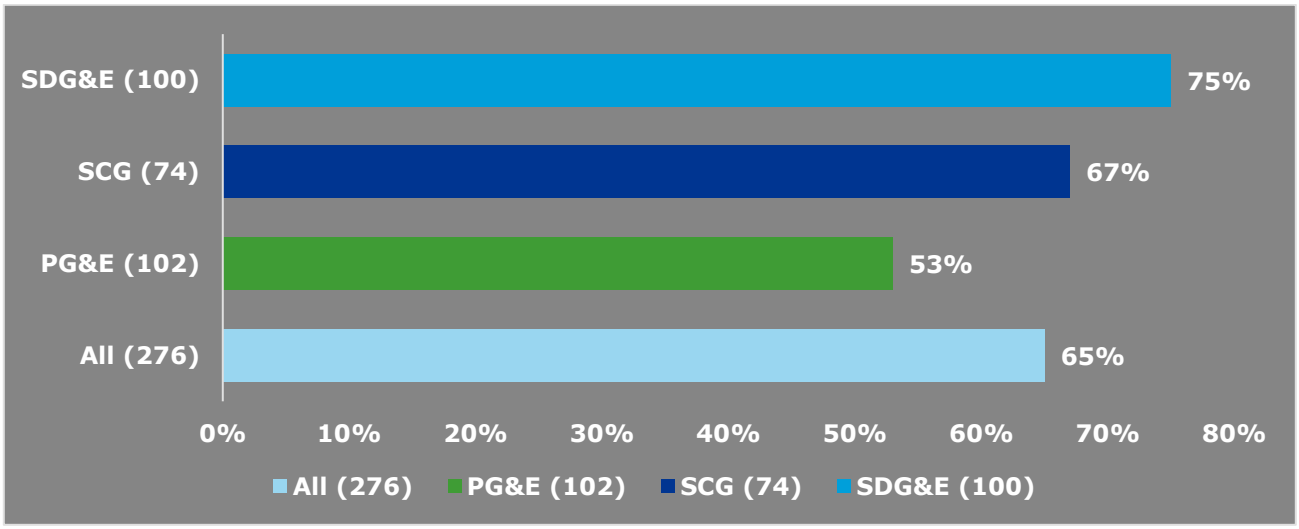
Figure 23: Action plan creation



However, the level of savings seems to be a function of ongoing engagement as measured by return visits and action plan updates (Figure 24). Around two-thirds of all respondents who created an action plan stated that they updated it. We observe some variation with SDG&E having the highest proportion of respondents stating they updated their action plan at 75% versus SCG at 66% and PG&E at 53%, respectively. Combined with higher return visits noted for SDG&E (

Table 2), this underscores how continued engagement with the tool could lead to greater savings.

Figure 24: Action plan updates



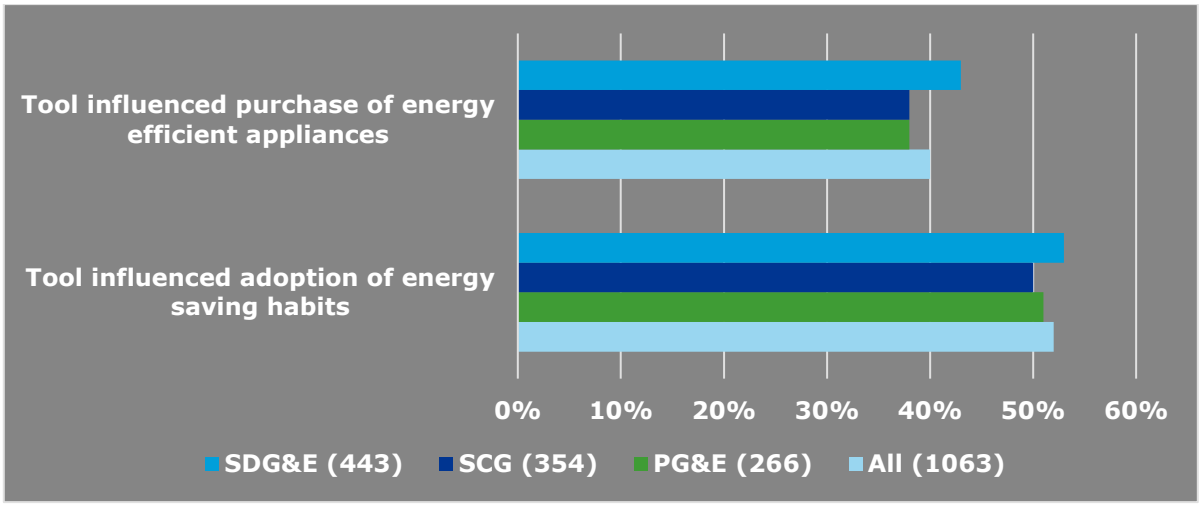
4.3.6 Tool influence

Tool influence was measured using a series of questions on adoption of energy saving behaviors, purchase of energy efficient appliances, participation in other IOU programs, and perceived impact on energy bill due to the tool.

4.3.6.1 Influence on energy use behavior

Around half of all users who recalled tool use stated that it influenced their adoption of energy saving habits and two-fifths stated that the tool influenced purchase of energy efficient appliances (Figure 25).

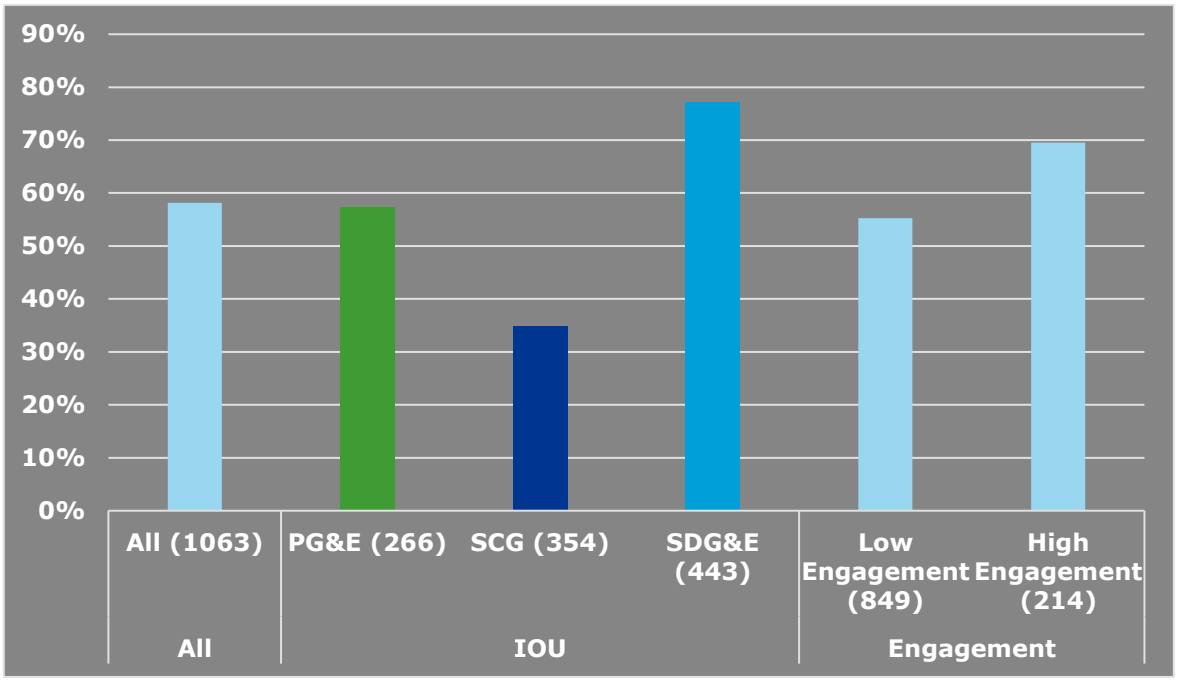
Figure 25: Tool influence on energy saving habits and energy efficient purchases



4.3.6.2 Cross-program participation

Tool users were presented with a list of utility programs they could have participated in and asked about whether use of the tool influenced their participation in any of them[28]. Overall, over half (52%) claimed that the tool influenced their participation in at least one of the IOU programs they were eligible to participate in (Figure 26). The more engaged the respondent the higher the likelihood that they claimed that the tool influenced their participation in other IOU programs. While acknowledging that an examination of cross program participation by IOU is not a one-to-one comparison, since the selection set of programs available to customers varies by IOU, we observed that SDG&E customers state the tool influenced participation at relatively higher levels than PG&E and SCG at 77% to 57% and 35%, respectively.

Figure 26: Tool influence on participation in other IOU programs

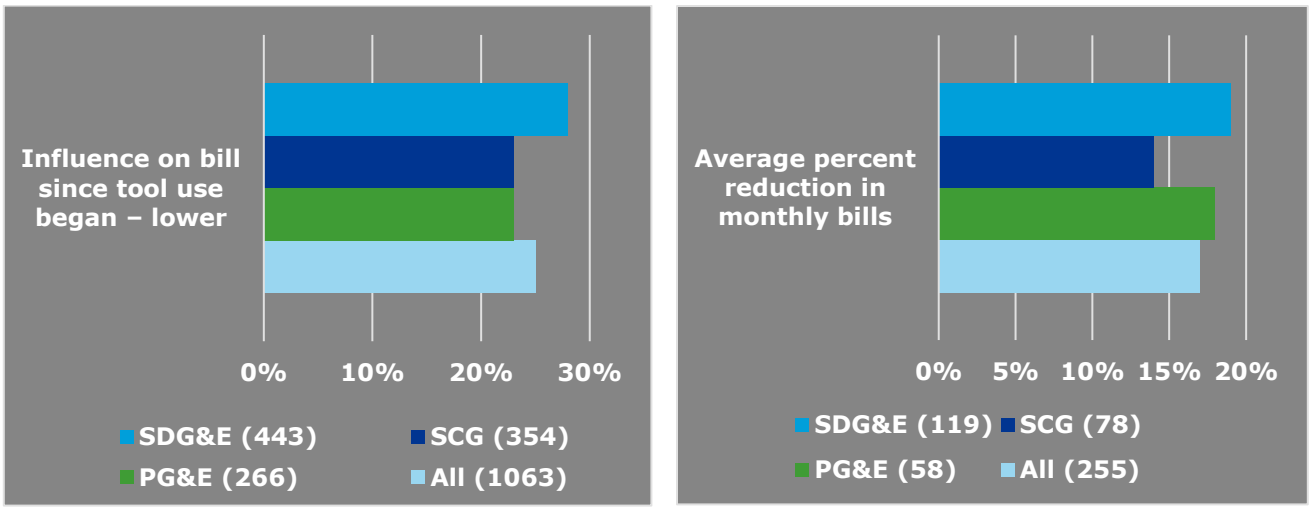


4.3.6.3 Influence on bill

Respondents were asked if they had noticed any changes on their bill since they began tool use and 25% said that their bill was lower. The average self-reported reduction in bills was 17% (Figure 27). There were no significant differences in self-reported reductions in bill since tool use began by IOU or level of engagement.

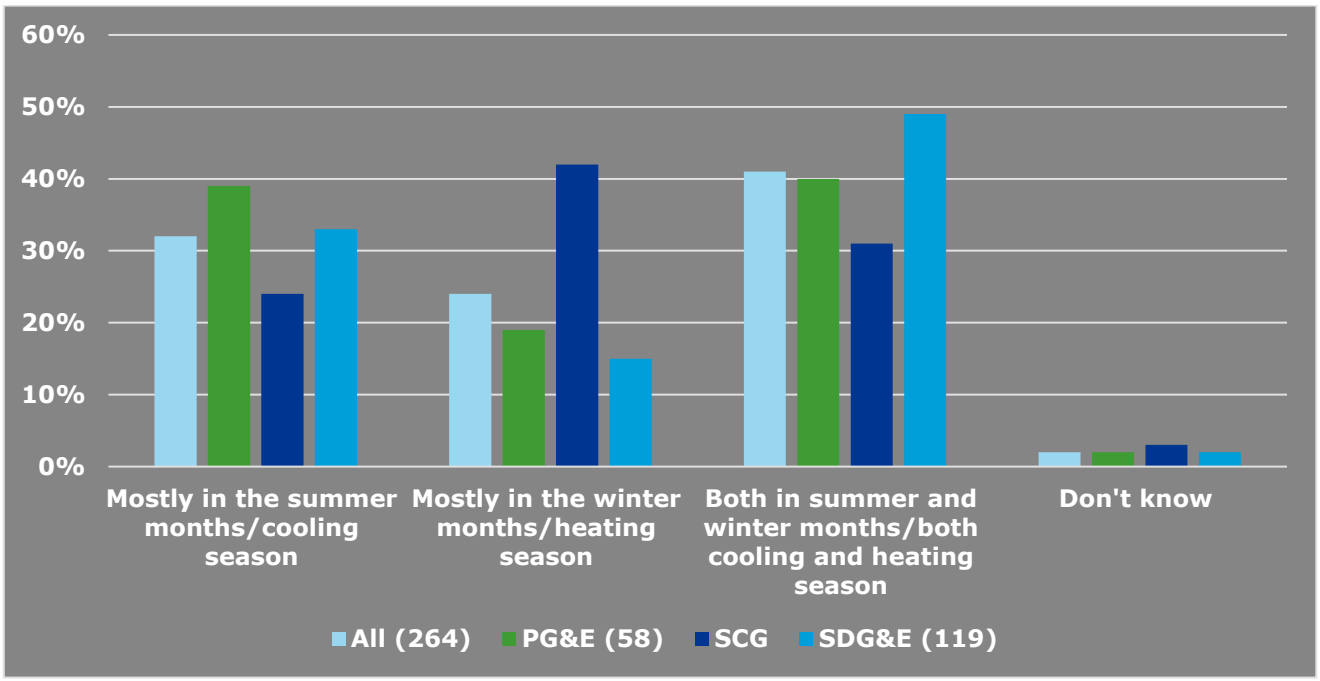
[28] The survey presented 9, 5, and 11 programs that residential customers of PG&E, SCG, and SDG&E respectively could have participated in.

Figure 27: Tool influence on bill



When asked whether they saw these changes in summer, winter, or both summer and winter, 41% of respondents stated that they saw changes in summer and winter months (Figure 28). Echoing SCG program staff observations regarding a spike in tool use in the winter when heating needs are greatest, we see SCG customers state that heating season was when they see changes on their bill due to tool use too.

Figure 28: Tool influence on seasonal bill reductions

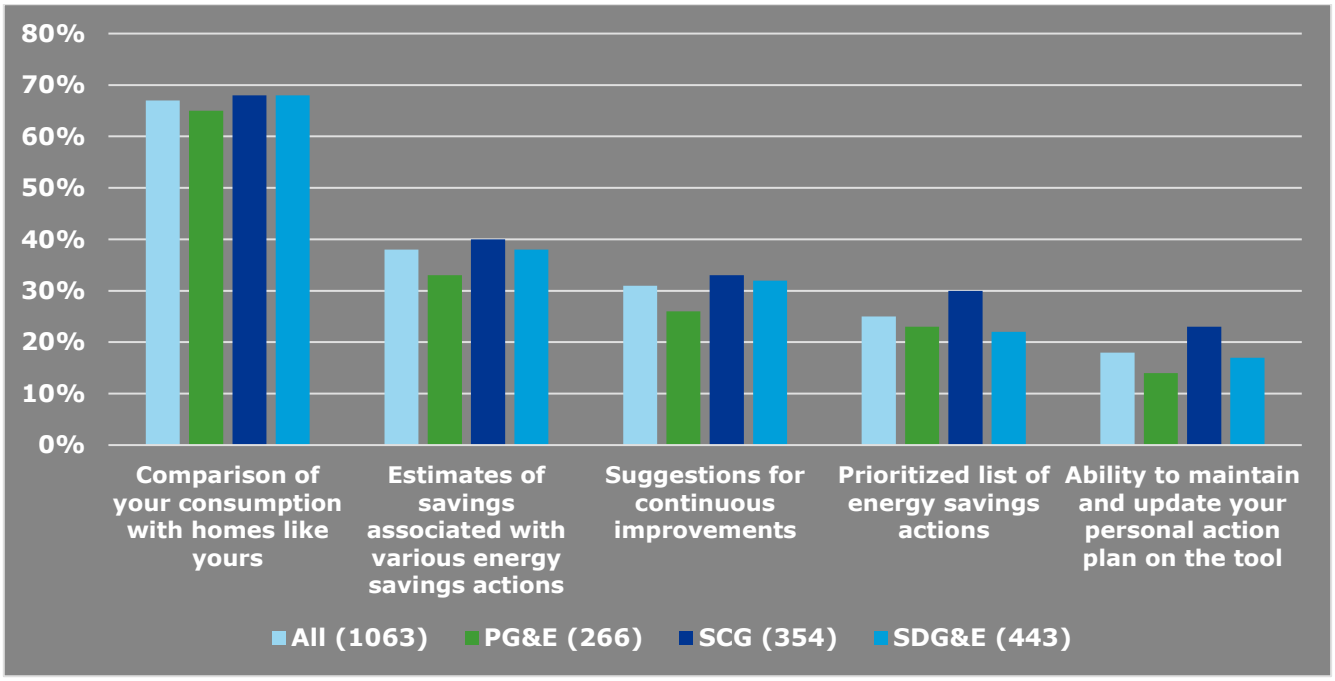


4.3.7 Tool – Rating

4.3.7.1 Usefulness of UAT features

Users were asked to indicate which features of the tool they valued. The most valued feature with over two-thirds responding was the comparison of their consumption with similar homes (Figure 29). Estimates of savings associated with various energy savings actions and suggestions for continuous improvements round out the top three features that users found useful. Around 12% indicated that they found all the features useful and an equal proportion indicated that they found none of the features useful. These findings underscore the importance of benchmarking/peer comparisons to customers and of its place as a core element of behavior programs for energy efficiency.

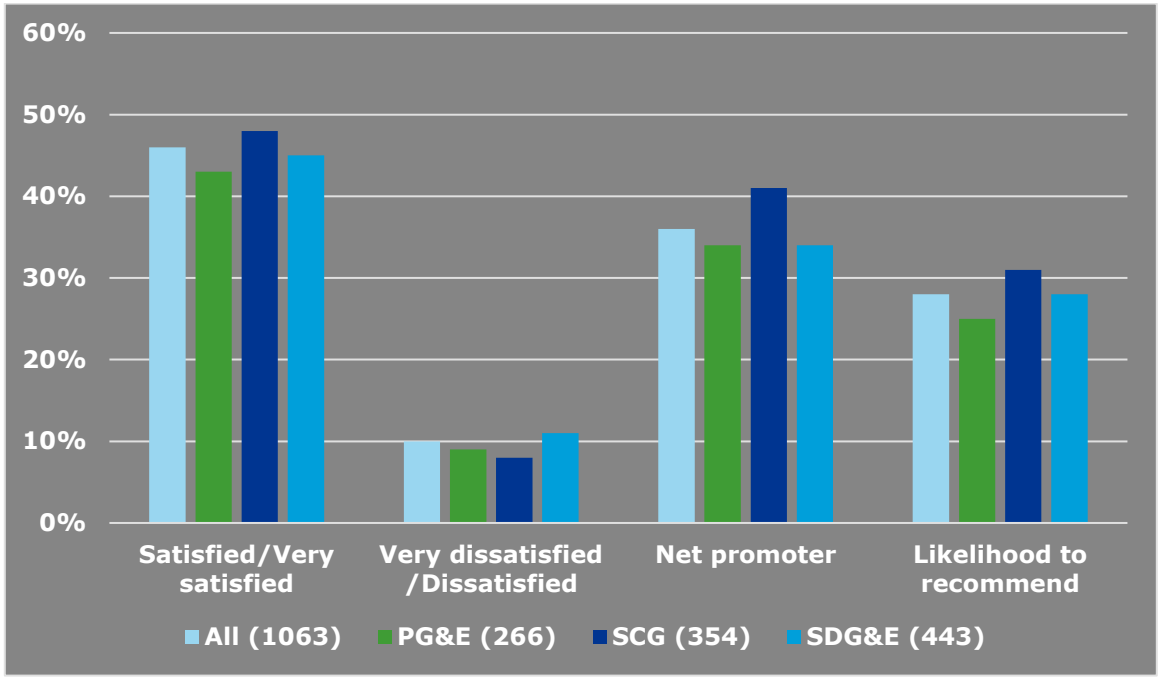
Figure 29: Usefulness of UAT features



4.3.7.2 Satisfaction with UAT and Likelihood to Recommend

When asked to indicate how satisfied they are with the UAT on a 5-point satisfaction scale, almost half of all users (46%) stated that they are satisfied or very satisfied and 10% expressed some level of dissatisfaction (Figure 30). The net promoter score, computed as the difference between the percent satisfied and dissatisfied, is approximately one-third of users. This is in line with the proportion of users (28%) who state that they would be highly likely to recommend the tool to someone they know.

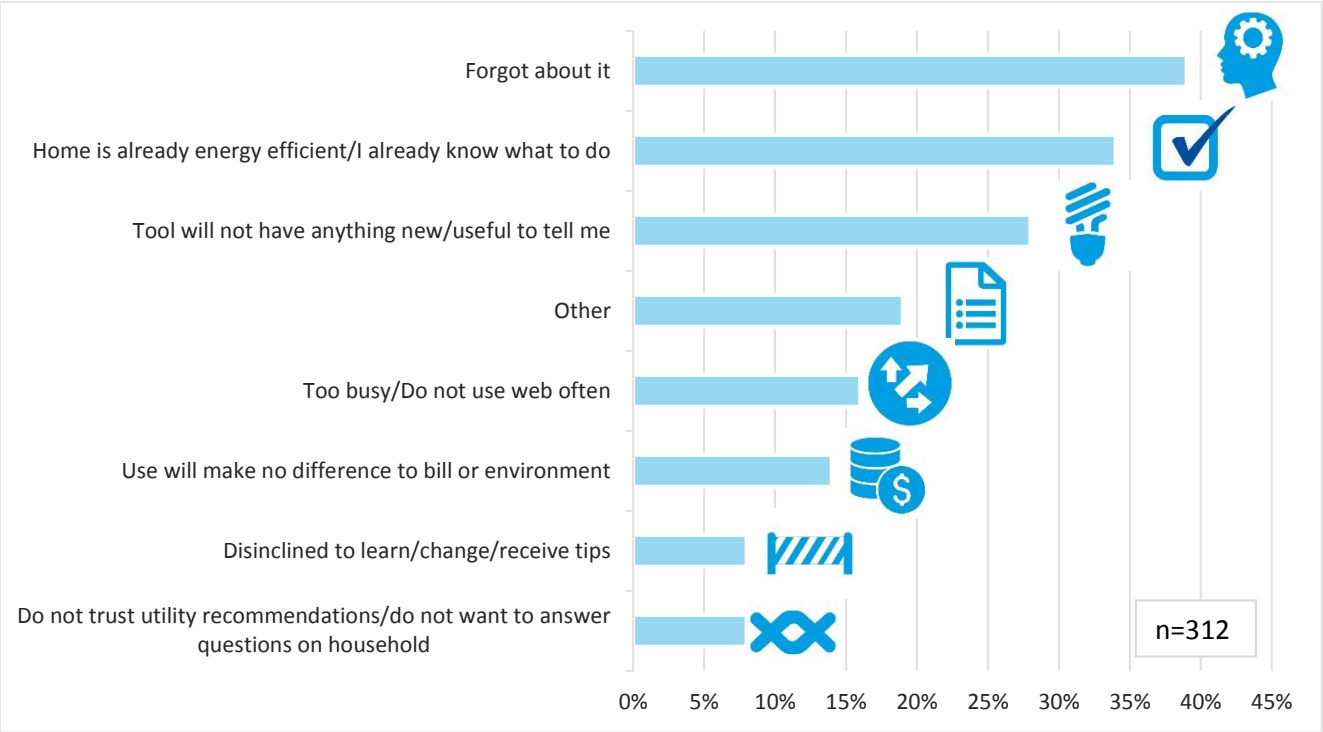
Figure 30: Satisfaction and likelihood to recommend UAT



4.3.8 Non-users of the tool

Only 13% of all non-users have heard of the tool. Of those who have not heard of tool, only 26% expressed that they were very or extremely interested in using the tool after hearing a description of the tool. Non-users who had heard of the tool were asked to indicate why they had not used the tool (Figure 31). Two of the top three reasons for not using the tool indicated by non-users are 1) a perception that they are already there with respect to their home's level of energy efficiency and their knowledge of what they need to do to save energy; and 2) a presumption that the tool will not have anything new or useful to tell them. Overcoming these customer perceptions will be the main barriers to expanding the reach of the tool.

Figure 31. Reasons why non-users who knew about the tool did not use it



4.3.9 Customer profile – by tool use and engagement level

A question of interest for this research was to examine how, if at all, tool users might differ from non-users in terms of their energy use behavior, technology adoption, and awareness of and attitudes towards the environment and energy efficiency. We conducted an analysis to explore differences by tool users and non-users along the following program exogenous characteristics:

- number of energy efficiency technologies/measures adopted in the home[29],
- changes to operating conditions of the home that reduce consumption[30],
- participation in other utility programs,
- number of electronic devices owned,
- the number of various types of apps used,
- awareness of a carbon footprint,
- price sensitivity, and
- attitudes towards the environment

We also examine whether users who engage at a higher level are different from users who engage at a lower level along the above lines, where we define high engagement users as those who completed an action plan and low engagement users as those who browsed the tool and completed the survey on the tool without creating an action plan.

[29] Respondents were asked to indicate whether they had any of the following four energy efficiency measures in their home: vent in the attic to keep the attic cooler, ceiling fans, programmable thermostats, and motion detectors for lights.

[30] Respondents were asked to indicate if they implemented any changes in their home that would increase energy consumption such as using more lighting, heating, cooling, using more hot water etc. They were also presented with changes that would decrease energy consumption such as using less lighting, heating, cooling etc. Respondents were presented with 16 actions that could increase consumption and 25 actions that could decrease consumption. Net change in operating conditions is the difference between total changes made that decrease consumption and total changes made that increase consumption.

Users of the tool are significantly higher on dimensions of energy use behavior compared to non-users (Table 29). Users made more net changes in operating conditions of their home that reduce consumption and they currently have more energy saving measures implemented in their home like attic vents, ceiling fans, and programmable thermostats. Users have the same or marginally higher levels of technology adoption or price sensitivity than non-users, but they are not significantly different from non-users along these dimensions. We note that while awareness and attitudes related to energy and the environment appear comparable, users are statistically significantly more aware of environmental issues, price sensitive, and motivated by savings.

High engagement users make significantly more net changes in operating conditions of their home that reduce consumption than low engagement users. Participation in other utility programs is the only behavior that is significantly different by level of engagement among users at 65% for high engagement tool users versus 55% for low engagement tool users.

Table 29: Customer profile - by tool use and engagement level

	All survey respondents		Tool users who recall using the tool	
	Non-users	Users	Low engagement	High engagement
n=	2,797	2,874	849	214
Energy-use behavior				
Changes in operating conditions of home to reduce consumption[31]	4.5	5.3*	5.8	6.8*
Energy-efficiency measures implemented (out of four presented)	1.9	2.1*	2.1	2.1
Participation in other utility programs due to influence of the tool			55%	70%*
Technology adoption				
Types of apps used (out of seven presented)	3.8	3.9	4.0	4.2
Electronic devices owned (out of six presented)	4.0	4.0	4.1	4.1
Awareness and Attitudes				
Heard of carbon footprint (% Yes)	80%	84%*	88%	90%
Price conscious – compare prices of a few brands[32]	86%	88%*	89%	90%
Don't feel responsible for conserving energy as personal contribution is very small[33]	10%	10%	10%	8%
One reason that would motivate saving energy – saving money (% mentioned)	59%	62%*	63%	64%
One reason that would motivate saving energy – maintaining health (% mentioned)	3%	3%	2%	3%
One reason that would motivate saving energy – protecting the environment/for the benefit of future generations (% mentioned)	32%	29%*	27%	27%
One reason that would motivate saving energy – reducing dependence on foreign oil/help California lead the way on saving energy (% mentioned)	7%	6%	7%	6%

Note: * Indicates statistically significant difference at the 95% confidence level between users and non-users and high engagement users and low engagement users

[31] See footnote 30

[32] Results displayed are % 4, 5 on a 5-pt scale of agreement where 1=Strongly disagree and 5=Strongly agree

[33] See footnote 32

The above findings suggest that the audience the tool is trying to reach is not that divergent in terms of their attitudes towards energy efficiency and the environment or in terms of how they use technology. Those that do use the tool well seem better tuned in to other benefits offered by utility programs and this manifests itself in the higher cross program participation and implementation of energy efficiency measures we observe.

5 CONCLUSIONS

This evaluation estimates electric savings of around 1.2% to 2.0% and gas savings of 1.7% to 2.9%. These savings are in the same magnitude as the established and much evaluated Home Energy Reports (HER) programs. HER programs are opt-out programs, whereas the UAT is an opt-in program. This would argue the case for expectations of higher savings from the opt-in UAT program with self-driven, motivated participants at the outset versus the opt-out HER program that could include relatively unmotivated customers in the treatment group.

On the other hand, while the opt-out HER program delivers a uniform "dose" of information with the same frequency to all those in the "treatment" group, the UAT program is driven entirely by the customer's interaction with the tool which is highly variable. The strength and frequency of the dose in the treatment group in the opt-in UAT program varies by each user's level of interaction with the tool. The net treatment effect of the tool is moderated by inactive or dormant customers resulting in savings estimates that are not as high. We see this effect reflected in the difference in savings estimates for high engagement customers that can be as much as 2x to 3x the savings estimates for low engagement customers.

Prioritize converting current users to a higher level of engagement. Survey and impact results in combination indicate increased savings from moving already acquired users up into higher levels of engagement is likely to be greater than the yield from new users with high acquisition costs.

While it is the case that the years 2015 and 2016 combined have had lower participation than the previous two full years combined, IOU program staff indicate a focus on improving the level of engagement among users. Completion ratios are the highest in 2015 and 2016 relative to previous years. The IOUs have employed various marketing methods to inform customers about the tool including banners on the utility website, email campaigns, television ads, direct mail, radio ads, and online newsletter ads. Variable

completion goals, customer base, tool implementers, marketing budgets, and strategies have meant that completion rates have varied over time and by IOU.

PG&E has deployed sophisticated multi-channel marketing that includes geo-targeted TV spots, email, social media, and banner ads to achieve completion rates over 90% in 2015. The highest completion rate achieved to date has been by PG&E in December 2015 when it deployed an all-electronic marketing mix of social media, email, digital banners, and search engine marketing (SEM) that yield a 92% completion rate. SDG&E's marketing efforts have included email campaigns that include sweepstakes and they have seen success with these efforts with an all-time high completion rate for SDG&E of 40% in December 2016. While SCG's completion rates are lower at around 5% on average, lower marketing budgets have meant a more modest outreach campaign limited mainly to email.

The majority of users indicated that they followed a link/banner ad to the tool when on their utility website or that they received an email with a link to the tool. As such, we recommend prioritize using electronic methods of promotion and outreach to help market the web-based tool.

Around half of all users indicated that they used the tool a few times a year or less. The majority of users (62%) felt one visit to the tool was enough since nothing in their home had changed or that they had sufficient information.

Message the value of repeat visits. Messaging, possibly derived through self-learning algorithms underlying the tool, that underscores the value of repeat visits/the next visit – such as continued, customized and valuable information that encourage the customers to continue to engage with the tool – will be more effective.

Users are different from non-users in terms of their energy use behavior but not in their attitudes towards the environment and technology adoption. High engaged users are not that different from low engaged users. The barriers to participation then reduce to the perceived value of the tool. As our results indicate, two of the top three reasons indicated by non-users relate to either a perception that they are already there with respect to their home's level of energy efficiency and their knowledge of what they need to do to save energy or to a presumption that the tool will not have anything new or useful to tell them.

Present customer testimonials of successful savings through engagement to low engaged customers. Match such testimonials to low engaged customers by baseline consumption, daily use pattern and other relevant dimensions to provide empirical evidence of tool efficacy that they can trust and that will spur them to action.

An objective of this research was to ascertain whether AMI data facilitates a more accurate matched comparison group. Results for the model-based matching generated using AMI data indicate well-balanced comparison and treatment matches. In addition, the quality of matches improved substantially for SDG&E electricity data while the conclusion on PG&E electricity data remains unchanged.

The exploratory work in model-based matching suggests there could be benefits from using AMI data in matching.

5.1 Areas for future research

This evaluation indicates that California's Universal Audit Tool program realizes significant savings. In order to improve program performance, understanding potential drivers of high performance leads to the following areas worthy of future research:

1. **Location.** It is possible that location is responsible for the noted engagement depths and savings differences. For instance, relatively high participation rates from SDG&E's inland users could contribute to the high savings observed. Future study would control for location to establish the causal links more directly.
2. **Marketing.** Marketing efforts in 2015 resulted in higher tool survey completion rates for PG&E and SDG&E. An interesting area of future research would be to examine how these impact depth of engagement with the tool and, in turn, savings.
3. **Consumption.** Several energy efficiency behavioral programs prioritize high energy consumption customers as targets to achieve greater savings. While this evaluation does not explore the relationship between savings and consumption, this is an area worth future study.

APPENDIX. A SCE UAT EVALUABILITY ASSESSMENT

The findings presented in the body of this report pertain to the Universal Audit Tool (UAT) for residential customers of PG&E, SCG, and SDG&E. SCE is not included in this evaluation due to the following reasons:

Low sample size.

At the time of this evaluation, SCE had not rolled out their tool widely like the other IOUs. SCE stated that they have been "waiting to add in the single sign-on functionality to the tool before they marketed it to their customers. Once this functionality is added, a full marketing campaign is expected to be launched. To conduct a quantifiable analysis, SCE is waiting for at least 60,000 customers to take the survey before any analysis is completed." Table 31 summarizes customer activity on the tool between October 2015 and September 2016. The other 3 IOUs had over 100,000 engaged customers on the tool, whereas SCE had around 40,000 engaged customers as of September 2016.

Table 30: Summary of SCE customers using Home Energy Advisor and Business Energy Advisor

Start Date Range	End Date Range	Residential Survey Visits	Residential Surveys Completed	SMB Audits Completed
10/30/2015	11/8/2015	700	437	16
11/9/2015	11/22/2015	1705	634	8
11/23/2015	12/6/2015	1413	487	15
12/7/2015	12/20/2015	1555	586	42
12/21/2015	1/3/2016	1229	498	33
1/4/2016	1/17/2016	1617	589	13
1/18/2016	1/31/2016	1619	605	11
2/1/2016	2/14/2016	1405	494	17
2/15/2016	2/28/2016	1266	436	16
2/29/2016	3/13/2016	1281	433	10
3/14/2016	3/27/2016	1136	363	9
3/28/2016	4/10/2016	1308	438	9
4/11/2016	4/24/2016	1305	415	6
4/25/2016	5/8/2016	1427	445	7
5/9/2016	5/22/2016	1733	620	10
5/23/2016	6/5/2016	1852	676	11
6/6/2016	6/19/2016	1780	595	11
6/20/2016	7/3/2016	2968	1070	8
7/4/2016	7/17/2016	1780	638	7
7/18/2016	7/31/2016	2408	861	4
8/1/2016	8/14/2016	2617	816	7
8/15/2016	8/28/2016	2345	793	11
8/29/2016	9/11/2016	2026	634	13
9/12/2016	9/25/2016	1675	520	8
9/26/2016	10/9/2016	1716	514	11
	Totals	41866	14597	313

Self-selection bias.

Despite the lack of wide marketing, the tool was discoverable on the SCE.com website as indicated by the number of customers accessing and completing the survey. This level of use may indicate that the self-selection bias among users of SCE's tool is stronger versus the other IOUs, due to the lack of outreach among their total customer base.

Lack of customer level data.

Finally, since customers could use the tool without signing in to their account their activity on the tool could not be tied to a customer account and their consumption data. SCE stated that "because the SCE UAT tools do not require or offer login until Oracle Single Sign-On (SSO) is implemented on October 20, 2016, Opower currently cannot map EEAT responses to customers in a reliable way. Therefore, we cannot provide customer account numbers and IDs or monthly web metrics on authenticated users." Table 31 summarizes unavailable SCE UAT data.

Table 31: Summary of unavailable SCE UAT data

Field Name	Section of CPUC Request	Explanation of why the Field is Unavailable
Service Account Number (e.g., SERV_ACCT_NUM)	Customer-level tracking data	This field is not available because access to the survey / audit does not currently require login; all responses are therefore unauthenticated and unverified, thus cannot be reliably tied to a customer account.
Customer Number (e.g., CUST_NUM)	Customer-level tracking data	This field is not available because access to the survey / audit does not currently require login; all responses are therefore unauthenticated and unverified, thus cannot be reliably tied to a customer account.
Premise ID (e.g., PREMISE_ID)	Customer-level tracking data	This field is not available because access to the survey / audit does not currently require login; all responses are therefore unauthenticated and unverified, thus cannot be reliably tied to a customer account.
Recommendations or other information supplied by the UAT to the user	Customer-level tracking data	This field is not currently recorded or able to be reported at the customer-level.
"Click to" links included in the UAT	Customer-level tracking data	This field is not currently recorded or able to be reported at the customer-level.
Web Metrics (e.g., traffic flow, typical google analytics output)	Customer-level tracking data	This field is not currently recorded or able to be reported at the customer-level.
Authenticated Users	Monthly web metrics	This field is not available because access to the survey / audit does not currently require login; all responses are therefore unauthenticated and unverified.
New Authenticated Users	Monthly web metrics	This field is not available because access to the survey / audit does not currently require login; all responses are therefore unauthenticated and unverified.

Field Name	Section of CPUC Request	Explanation of why the Field is Unavailable
Return Authenticated Users	Monthly web metrics	This field is not available because access to the survey / audit does not currently require login; all responses are therefore unauthenticated and unverified.
New Unauthenticated Users	Monthly web metrics	We can track snapshot metrics (e.g., total users) but not changes from month to month (e.g., new users since last month)
Return Unauthenticated Users	Monthly web metrics	We can track snapshot metrics (e.g., total users) but not changes from month to month (e.g., new users since last month)
New Action Plans	Monthly web metrics	This field is not available because it is not part of our UAT tools.
New Action Plan by New Users	Monthly web metrics	This field is not available because it is not part of our UAT tools.
New Action Plan by Return Users	Monthly web metrics	This field is not available because it is not part of our UAT tools.
New Actions	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Completed Actions	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Action Plans Created with 1-click	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Users Saving Home Panel	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Users Saving Appl Panel	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Users Saving Heat Panel	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Users Saving Light Panel	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Users Saving Insulation Panel	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Users Saving Water Panel	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Users Saving Other Panel	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Users Saving Solar Panel	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Users Saving Custom Panel	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Users Saving Vehicle Panel	Monthly web metrics	This field is not available because it is not part of our UAT tools.
Bounce Rate	Monthly web metrics	This field is not currently recorded or able to be reported at the customer-level.
Percent New Visits	Monthly web metrics	We can track snapshot metrics (e.g., total users) but not changes from month to month (e.g., new users since last month)

Evaluability Assessment

DNV GL's evaluation of the UAT used 2014 as the study period and relied on 12 months of consumption data from 2013 to establish pre-treatment consumption and 12 months of consumption data from 2015 to establish post-treatment consumption. SCE's tool will be evaluable with similar data available as for the other IOUs after October 2018.

APPENDIX. B RECOMMENDATIONS

Study ID	Study Type	Study Title/Program	Study Manager
CPUC ED Res 9	Impact	Universal Audit Tool - Impact Evaluation (Residential)	Gomathi Sadhasivan
Recommendations (Recipients - All IOUs)	**Summary of Findings**	**Additional Supporting Information**	**Best Practice / Recommendations**
1	Savings estimates for high engagement customers can be as much as 2x to 3x the savings estimates for low engagement customers.	Section 4.3.4	Prioritize converting current users to a higher level of engagement. Survey and impact results in combination indicate increased savings from moving already acquired users up into higher levels of engagement is likely to be greater than the yield from new users with high acquisition costs.
2	The majority of users indicated that they followed a link/banner ad to the tool when on their utility website or that they received an email with a link to the tool. The highest completion rate achieved to date has been by PG&E in December 2015 when it deployed an all-electronic marketing mix of social media, email, digital banners, and search engine marketing (SEM) that yield a 92% completion rate. SDG&E's marketing efforts have included email campaigns that include sweepstakes and they have seen success with these efforts with an all-time high completion rate for SDG&E of 40% in December 2016.	Sections 4.3.3 and 4.3.5.5	Prioritize using electronic methods of promotion and outreach to help market the web-based tool.
3	Around half of all users indicated that they used the tool a few times a year or less. The majority of users (62%) felt one visit to the tool was enough since nothing in their home had changed or that they had sufficient information	Sections 4.3.5.1 and 4.3.5.2	Message the value of repeat visits. Messaging, possibly derived through self-learning algorithms underlying the tool, that underscores the value of repeat visits/the next visit – such as continued, customized and valuable information that encourage the customers to continue to engage with the tool – will be more effective.

4	Two of the top three reasons indicated by non-users on the survey relate to either a perception that they are already there with respect to their home's level of energy efficiency and their knowledge of what they need to do to save energy or to a presumption that the tool will not have anything new or useful to tell them.	Section 4.3.8	Present customer testimonials of successful savings through engagement to low engaged customers. Match such testimonials to low engaged customers by baseline consumption, daily use pattern and other relevant dimensions to provide empirical evidence of tool efficacy that they can trust and that will spur them to action.
5	Results for the model-based matching generated using AMI data indicate well-balanced comparison and treatment matches. In addition, the quality of matches improved substantially for SDG&E electricity data while the conclusion on PG&E electricity data remains unchanged.	Section 3.4.4	The exploratory work in model-based matching suggests there could be benefits from using AMI data in matching.

APPENDIX. C MATCHING PROCESS

We provide additional details about the matching process in this appendix. Under the matched comparison approach the treatment effect is estimated by comparing the difference in outcomes before and after treatment of opt-in and comparison groups. In experimental studies, a randomized control trial (RCT) design ensures subjects are assigned to treatment or control groups randomly. Due to this random assignment, the only differentiating factor between the two groups is treatment. Thus, difference in outcome pre- and post-treatment can be attributed to treatment.

In observational studies, of the kind under consideration, subjects self-select into treatment. Since treatment assignment is not random and may be tied to the intrinsic characteristics of the subjects in this group, estimated treatment outcomes will reflect self-selection bias. Matching is a process that aims to circumvent such bias by identifying comparison subjects whose characteristics match those of the opt-in closely. Matching methods try to replicate RCT design to the extent possible with observable characteristics by selecting opt-in and comparison group subjects that are balanced in key characteristics. Balance is indicated by identical distributions of these characteristics of both groups.

In matched opt-in-comparison observational studies, we identify the effect of treatment assignment, $T = 1$, by evaluating average treatment effect on the opt-in (ATT) as follows:

$$ATT = E(Y_1|T = 1) - E(Y_0|T = 1)$$

Here, $E(Y_1|T = 1)$ is the expected outcome of treatment for the opt-in and $E(Y_0|T = 1)$ is the expected outcome of no treatment for opt-in individuals. The second term, however, is unobservable. If the expected outcome of comparison individuals is used in place of the second term, the average treatment effect on the opt-in (μATT) becomes:

$$\mu ATT = E(Y_1|T = 1) - E(Y_0|T = 0)$$

The difference between μATT and ATT captures the selection bias. For example, those who self-select into using UAT may already be motivated to save energy even in the absence of the tool for various reasons. Hence, the estimated treatment effect in this case reflects savings that occur, in part, because of such reasons. Matching based on these reasons or criteria, which affect treatment assignment, provides us a counterfactual that obviates selection bias.

Matching enables us to select opt-in and comparison groups that are highly similar along these key dimensions. Treatment outcomes (Y_1, Y_0), thus, become independent of treatment assignment conditional on or given these key characteristics:

$$(Y_1, Y_0) \perp \mathrm{T}|\mathrm{X}$$

Since treatment assignment becomes essentially random following matching, treatment outcomes no longer reflect selection-bias. Matched opt-in-comparison, therefore, is an effective tool that helps identify the effect of treatment and is the approach we use.

Matching procedure

There are various matching techniques that attempt to mimic the RCT design in observational studies. In this study, we used propensity score matching (PSM) to match opt-in and comparison subjects and reduce selection bias. As the name indicates, PSM is based on propensity scores, which are probabilities that subjects are assigned to the treatment group given certain characteristics they have. Subjects were matched based on these probability scores.

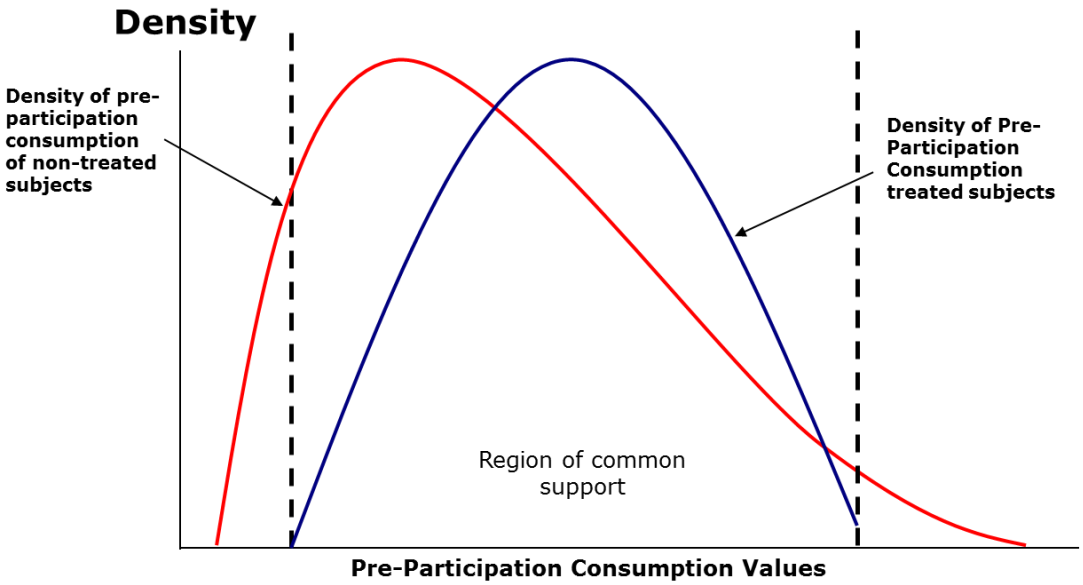
The PSM process involves the following general steps that we used in this evaluation:

1. Select subjects' characteristics that are related to treatment assignment.
2. Examine the empirical densities of these characteristics and exclude observations of the comparison group where these do not overlap as a first round of identifying common support for matching.
3. Fit a logistic regression model using these variables to estimate the probability that each subject gets assigned to the treatment group.
4. Conduct a second round of trimming or common support identification based on propensity scores.
5. Select a matching method, the number of comparisons in the many-to-one matching, and whether to match with or without replacement; match opt-in subjects' scores to comparison (comparison) subjects based on these selections.
6. Conduct diagnostic checks to see selected matches are well-balanced.

To avoid correlation between treatment selection and outcome, by construction, we needed to match with variables other than the dependent variable (consumption in the year prior to opting in, in our case). Such variables can include any characteristics such as household size, heating and cooling source, and rate groups that may affect treatment assignment. They can also include variables measured before participation, such as pre-evaluation period consumption data. We took the latter approach, as comprehensive data on household characteristics were not readily available. Specifically, we used monthly data from the year 2012 which pre-dates any consumption data that were used in the savings regressions. We also used climate zone information to stratify the data for matching. This involved implementing the matching procedure within three pre-defined climate zones for California - mild (coastal), inland, and desert.

Prior to estimating a propensity score model, we identified a first round of common support for matching by trimming the data based on the distribution of pre-participation consumption. Variable values of the comparison subjects that do not overlap with the values of the opt-in subjects were trimmed. In all the cases where we undertook matching, trimming pre-participation consumption values of the comparison subjects that are outside of the 1^{st} and 99^{th} percentiles resulted in the overlap of the distribution of these values with those of the opt-in. Figure 32 provides an example of how we established a region of common support.

Figure 32: Region of common support for matching



We fitted a logistic regression model using data that reflects common support and used the propensity scores from the regression to find matches for each opt-in subject based on $(k{:}\,1)$ matches. The model is given by:

$$ln\left(\frac{(p)}{(1-p)}\right) = \beta_0 + \sum_t \beta_t X_t + \varepsilon$$

Here, $p = p(T = 1|X)$ is the probability of receiving treatment (participation) and X is pre-participation monthly consumption. The estimated propensity scores from this model were then used to establish a second-round of common support by trimming values of the comparison group whose scores are above the maximum and below the minimum of those of the opt-in subjects.

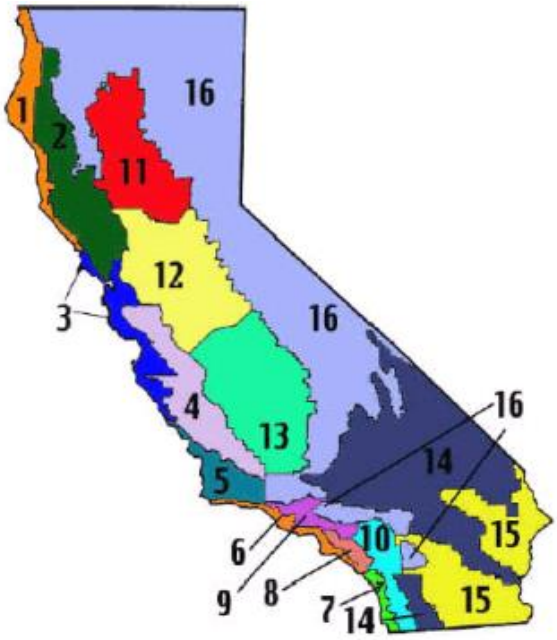
We used the nearest neighbor matching (NN) algorithm for this purpose. The approach produces matches for each opt-in subject, selected in random order, by searching for k propensity scores that are nearest to those of the opt-in subject. We selected matches without replacement. Thus, a comparison subject selected as a match for a given opt-in subject was not available for matching again. This sort of matching is called 'greedy' because matches are made by only looking at distances of scores of randomly selected opt-in vs. comparison subjects. Optimal matching, on the other hand, considers the overall distance between opt-in and comparison scores to select matches. The matches generated using either, however, are equally well-balanced.

Initially, we selected 5 best matches ($k = 5$) to identify an oversized matched comparison group for which to request AMI data. Within the 5:1 matched comparison group, we identified the optimal 1:1 matched comparison group for final models. As with the 5:1 matched comparison group selection, the 1:1 matched group was selected by identifying a comparison subject whose propensity score is closest to that of a opt-in subject selected randomly. Once selected, a comparison subject was not available for matching with any other opt-in household.

APPENDIX. D CLIMATE ZONES

The California Energy Commission partitions the state of California into 16 climate zones. Climate zones with the lower numbers 1-8 tend to be the coastal regions and represent cooler climates. Climate zones 9-16 tend to be inland and represent areas with a wide range of temperatures over the course of the year. A map of these climate zones is provided in Figure 33.

Figure 33: Building climate zones



Source: California Energy Commission

APPENDIX. E ENERGY CONSUMPTION MODEL

DNV GL uses an energy consumption model called PRISM that estimates a set of regression models of energy use as a function of weather for each premise in the study. The theoretical PRISM regression equation for a given premise is provided below:

$$E_t = \beta_0 + \beta_h H(\tau_h) + \beta_c C(\tau_c) + \varepsilon_t \qquad (1)$$

Where

E_t – Energy, measured in kWh, therms, or BTU, consumed at time-period t.

$H_t(\tau_h)$ – Calculated heating degree days using actual observed temperature at time period t and its deviation from reference temperature, τ_h.

$C_t(\tau_c)$ – Calculated cooling degree days using actual observed temperature at time period t and its deviation from reference temperature, τ_c.

$\beta_0, \beta_h, \beta_c$ – Regression coefficients measuring the marginal effect of base load, heating load, and cooling load, on a single site's energy consumption, respectively.

ε_t – Regression residual in time-period t.

A PRISM analysis uses cooling and heating degree-days to measure the variation in a site's energy consumption that can be attributed to variation in weather conditions. These cooling and heating variable constructs are calculated using the following equations:

$$C(\tau_c) = \begin{cases} 0, & x_t - \tau_c < 0 \\ x_t - \tau_c, & x_t - \tau_c \geq 0 \end{cases} \qquad \textbf{(2)}$$

$$H(\tau_h) = \begin{cases} \tau_h - x_t, & x_t - \tau_h < 0 \\ 0, & x_t - \tau_h \geq 0 \end{cases} \qquad \textbf{(3)}$$

In other words, if the observed temperature is above the cooling threshold τ_c, then that difference in degrees Fahrenheit is calculated as cooling degree days and vice versa for heating.

If the consumption data is utility billing data, the heating and cooling degree days for a particular billing period is traditionally given by calculating the heating or cooling degree days for each day within the billing period and aggregating across all days. The aggregation of degree days is then associated with time period t.

The parameter estimates from the PRISM model given in (1) along with an estimate of the model's goodness-of-it (such adjusted R-square) are used in the logistic regression used in PSM.

APPENDIX. F SURVEY SAMPLE WEIGHTS

Sample weights are used to balance the survey data to reflect the distribution of the sample frame within IOU and treatment group and by climate zone and consumption and are summarized below.

Fuel	IOU	Users/Non-users	Climate Zone	Consumption	IOU and treatment specific weights
Electric	PG&E	Non-users	Coastal	Low	0.94
Electric	PG&E	Non-users	Coastal	Medium	0.88
Electric	PG&E	Non-users	Coastal	High	1.04
Electric	PG&E	Non-users	Inland	Low	1.01
Electric	PG&E	Non-users	Inland	Medium	1.05
Electric	PG&E	Non-users	Inland	High	1.13
Electric	PG&E	Users	Coastal	Low	0.86
Electric	PG&E	Users	Coastal	Medium	0.87
Electric	PG&E	Users	Coastal	High	0.93
Electric	PG&E	Users	Inland	Low	1.07
Electric	PG&E	Users	Inland	Medium	1.08
Electric	PG&E	Users	Inland	High	1.39

Fuel	IOU	Users/Non-users	Climate Zone	Consumption	IOU and treatment specific weights
Electric	SDG&E	Non-users	Coastal	Low	0.94
Electric	SDG&E	Non-users	Coastal	Medium	0.98
Electric	SDG&E	Non-users	Coastal	High	1.13
Electric	SDG&E	Non-users	Inland	Low	0.91
Electric	SDG&E	Non-users	Inland	Medium	1.02
Electric	SDG&E	Non-users	Inland	High	1.01
Electric	SDG&E	Users	Coastal	Low	0.71
Electric	SDG&E	Users	Coastal	Medium	1.03
Electric	SDG&E	Users	Coastal	High	1.26
Electric	SDG&E	Users	Inland	Low	0.81
Electric	SDG&E	Users	Inland, Desert*	Medium	1.13
Electric	SDG&E	Users	Inland	High	1.69

* We combine/collapse these cells by climate zone in this case due to sparse sample size (n=1) for SDG&E users with medium consumption in a desert climate zone.

Fuel	IOU	Users/Non-users	Climate Zone	Consumption	IOU and treatment specific weights
Gas	SCG	Non-users	Coastal	Low	0.85
Gas	SCG	Non-users	Coastal	Medium	0.81
Gas	SCG	Non-users	Coastal	High	0.81
Gas	SCG	Non-users	Inland	Low	0.97
Gas	SCG	Non-users	Inland	Medium	1.07
Gas	SCG	Non-users	Inland	High	1.10
Gas	SCG	Non-users	Desert	Low	0.81
Gas	SCG	Non-users	Desert	Medium	1.08
Gas	SCG	Non-users	Desert	High	0.86
Gas	SCG	Users	Coastal	Low	0.84
Gas	SCG	Users	Coastal	Medium	0.93
Gas	SCG	Users	Coastal	High	1.19
Gas	SCG	Users	Inland	Low	1.00
Gas	SCG	Users	Inland	Medium	1.05
Gas	SCG	Users	Inland	High	1.02
Gas	SCG	Users	Desert	Low	0.69
Gas	SCG	Users	Desert	Medium	1.04
Gas	SCG	Users	Desert	High	0.56

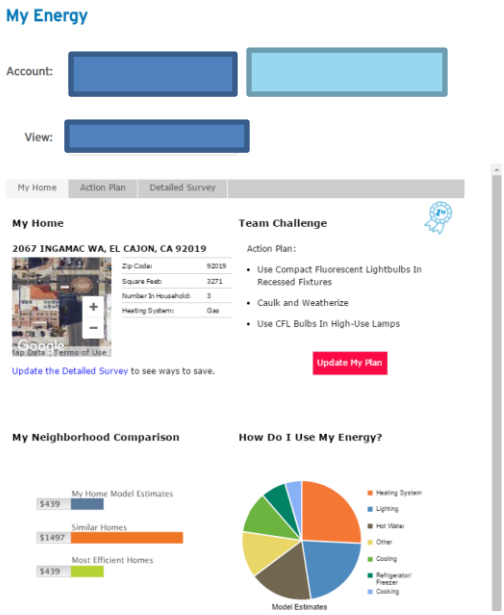
APPENDIX. G SURVEYS

E.1 INTRODUCTION

(SDG&E Introduction)
This survey is being conducted by an independent research organization on behalf of the California Public Utilities Commission (CPUC) and San Diego Gas & Electric (SDG&E) with households on free web-based services provided by SDG&E to receive tips and information on actions they could take to make their home more energy efficient and realize bill savings.
The CPUC and SDG&E will use this information to help plan programs to benefit homeowners and save energy. Responses to this survey will be kept strictly confidential and reported only in the aggregate.

Please contact Peter Franzese at the California Public Utilities Commission, at Peter.Franzese@cpuc.ca.gov if you have any questions or concerns regarding this survey.
Thank you for taking the time to participate in this survey

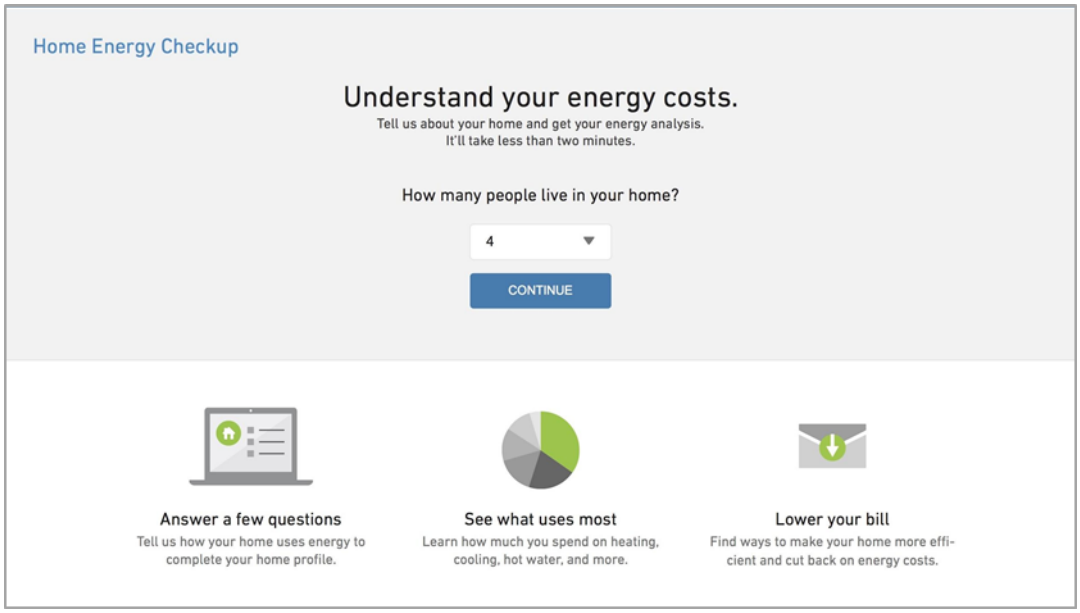
My Energy Survey is a free web-based service or **tool** provided by SDG&E that gathers basic information from customers like you about your homes and habits to provide you with an online energy "audit" that includes personalized recommendations for energy saving actions.
You receive energy saving tips tailored to your home and energy using appliances and can set up an energy savings action plan on the tool. You can also update the tool with your progress, monitor changes, and continue to engage with the tool and receive tips for ongoing energy savings.



(PG&E Introduction)
This survey is being conducted by an independent research organization on behalf of the California Public Utilities Commission (CPUC) and Pacific Gas & Electric (PG&E) with households on free web-based services provided by PG&E to receive tips and information on actions they could take to make their home more energy efficient and realize bill savings.
The CPUC and PG&E will use this information to help plan programs to benefit homeowners and save energy. Responses to this survey will be kept strictly confidential and reported only in the aggregate.

Please contact Peter Franzese at the California Public Utilities Commission, at Peter.Franzese@cpuc.ca.gov if you have any questions or concerns regarding this survey. Thank you for taking the time to participate in this survey.

Home Energy Checkup is a free web-based service or **tool** provided by PG&E that gathers basic information from customers like you about your homes and habits to provide you with an online energy "audit" that includes personalized recommendations for energy saving actions.
You receive energy saving tips tailored to your home and energy using appliances and can set up an energy savings action plan on the tool. You can also update the tool with your progress, monitor changes, and continue to engage with the tool and receive tips for ongoing energy savings.



(SCG Introduction)
This survey is being conducted by an independent research organization on behalf of the California Public Utilities Commission (CPUC) and SoCalGas (SCG) with households on free web-based services provided by SCG to receive tips and information on actions they could take to make their home more energy efficient and realize bill savings.
The CPUC and SCG will use this information to help plan programs to benefit homeowners and save energy. Responses to this survey will be kept strictly confidential and reported only in the aggregate.

Please contact Peter Franzese at the California Public Utilities Commission, at Peter.Franzese@cpuc.ca.gov if you have any questions or concerns regarding this survey. Thank you for taking the time to participate in this

Ways to Save is a free web-based service or **tool** provided by SCG that gathers basic information from customers like you about your homes and habits to provide you with an online energy "audit" that includes personalized recommendations for energy saving actions.
You receive energy saving tips tailored to your home and energy using appliances and can set up an energy savings action plan on the tool. You can also update the tool with your progress, monitor changes, and continue to engage with the tool and receive tips for ongoing energy savings.

E.2 TOOL – RECALL, CHANNEL, MOTIVATION

As mentioned earlier, the (My Energy Survey, Home Energy Checkup, Ways to Save) tool is a free web-based service provided by (SDG&E, PG&E, SCG) that gathers basic information from customers like you about your homes and habits to provide you with an online energy "audit" that includes personalized recommendations for energy saving actions.

R1. Do you recall using this tool?

1. Yes
2. No ➔ **GO TO R4**
98. Don't know ➔ **GO TO R4**

R2. How did you learn about the tool? [CHECK ALL THAT APPLY]

1. Received an email with a link to it
2. Followed a link/banner ad to the tool when on my utility account website
3. Utility phone center customer service representative
4. Insert about tool with monthly bill from my utility
5. Postcard from utility about tool
6. Friends/colleagues/neighbors/family
7. Other (specify)
8. Do not recall

R3. What motivated you to use the tool? [CHECK ALL THAT APPLY]

1. The tool seemed like it would benefit my household
2. To learn how to make my home **more comfortable**
3. To learn how to make my home **more energy efficient**
4. To learn how to **save money** by using less energy
5. To learn how to use less energy as it is **good for the environment**
6. People I knew encouraged me to use it
7. No specific reason, was curious to try it out
8. Other (specify)

98. Don't know

R4. Do you know about/Have you heard of this tool?

1. Yes
2. No ➔ **GO TO R6**

98. Don't know ➔ **GO TO R6**

R5. Why have you not used the tool? **[RANDOMIZE, CHECK ALL THAT APPLY]**

1. I was interested, but forgot about the tool
2. I'm not interested in learning how to reduce my energy use using an online tool
3. I'm too busy
4. I don't use the web that often
5. I don't think reducing my energy consumption will significantly **reduce my monthly bill**
6. I don't think reducing my energy consumption will significantly **benefit the environment**
7. I don't want to answer questions about myself/my household.
8. I don't believe the tool will give me useful recommendations
9. I don't believe the tool will tell me something I don't already know
10. I already know what to do to save energy
11. I'm not interested in changing the way I use energy at home
12. My home is already efficient enough
13. The savings predicted were not as high as expected
14. I'm not that interested in money-saving tips
15. I don't trust the information or guidance **(SDG&E, PG&E, SCG)** would provide
16. Other (specify) _____

98. Don't know

R6. If a free tool/web-based service as described above was available to you, how interested would you be in using it?

1. Not at all interested
2. Slightly interested
3. Moderately interested
4. Very interested
5. Extremely interested

98. Don't know

E.3 TOOL – USE

U1. On average, how often did you visit the site/use the tool? [CHOOSE THE OPTION THAT BEST DESCRIBES YOUR TOOL USE]

1. A few times a week
2. Once a week
3. Once a month/when I receive my bill
4. A few times a year
5. Once a year
6. Less than once a year

98. Don't know

U2. What were the reasons, if any, why you didn't use the tool more frequently? [RANDOMIZE, CHECK ALL THAT APPLY]

1. Felt the information provided was enough to act on and make changes – no need to revisit tool
2. I didn't see the benefit of doing it more than once when nothing had changed in my home.
3. Not interested in spending more time using the tool
4. The savings predicted were not as high as expected
5. I didn't find the recommendations helpful
6. I didn't have a good experience the first/previous time
7. I found it confusing
8. I didn't think reducing my energy consumption will make a difference
9. Other (specify) _____

98. Don't know

U3. On average, what was the duration of your visit/tool use?

1. Less than 10 minutes
2. 10-20 minutes
3. 20-30 minutes
4. 30 minutes – 1 hour
5. More than 1 hour

U4. On average, about how many web pages/different screens on the tool would you click through to get the information you were looking for when you logged in? Your best estimate is fine.

1. 1-5 screens
2. 6-10 screens
3. 11-25 screens
4. 25-50 screens
5. Over 50 screens

98. Don't know

U5. How difficult or easy was it to find the information you were looking for when using the tool?

1. Very difficult
2. Difficult
3. Neither difficult nor easy

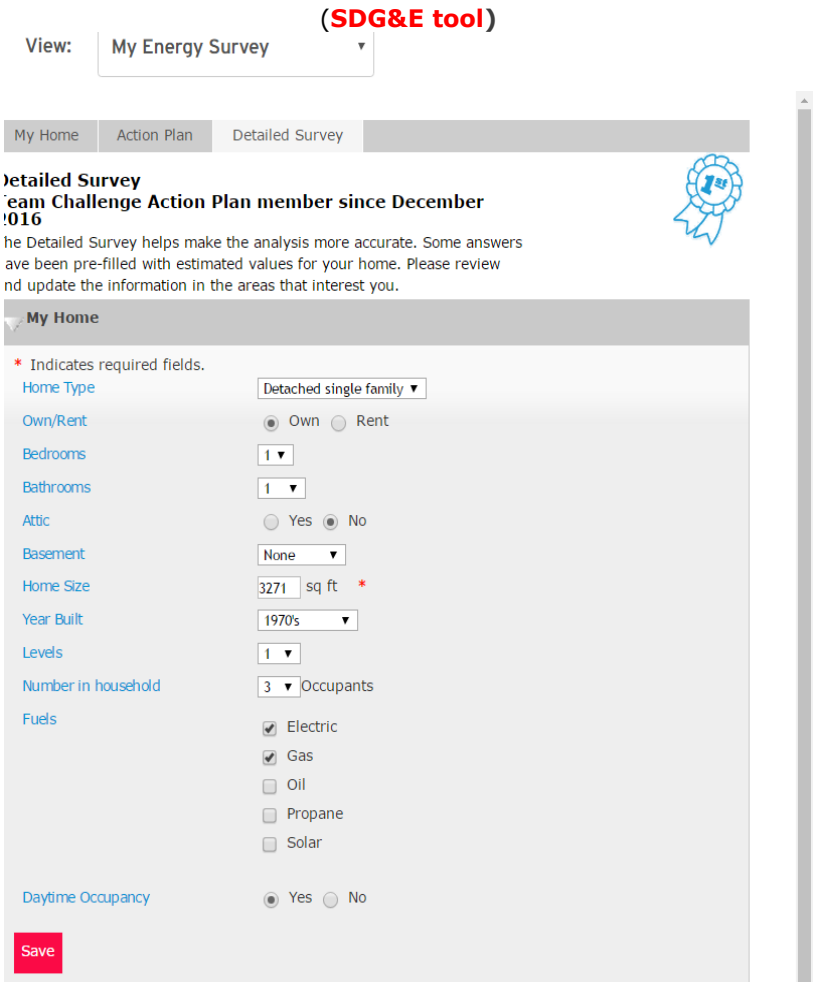
4. Easy
5. Very easy
98. Don’t know

E.4 TOOL – ENGAGEMENT

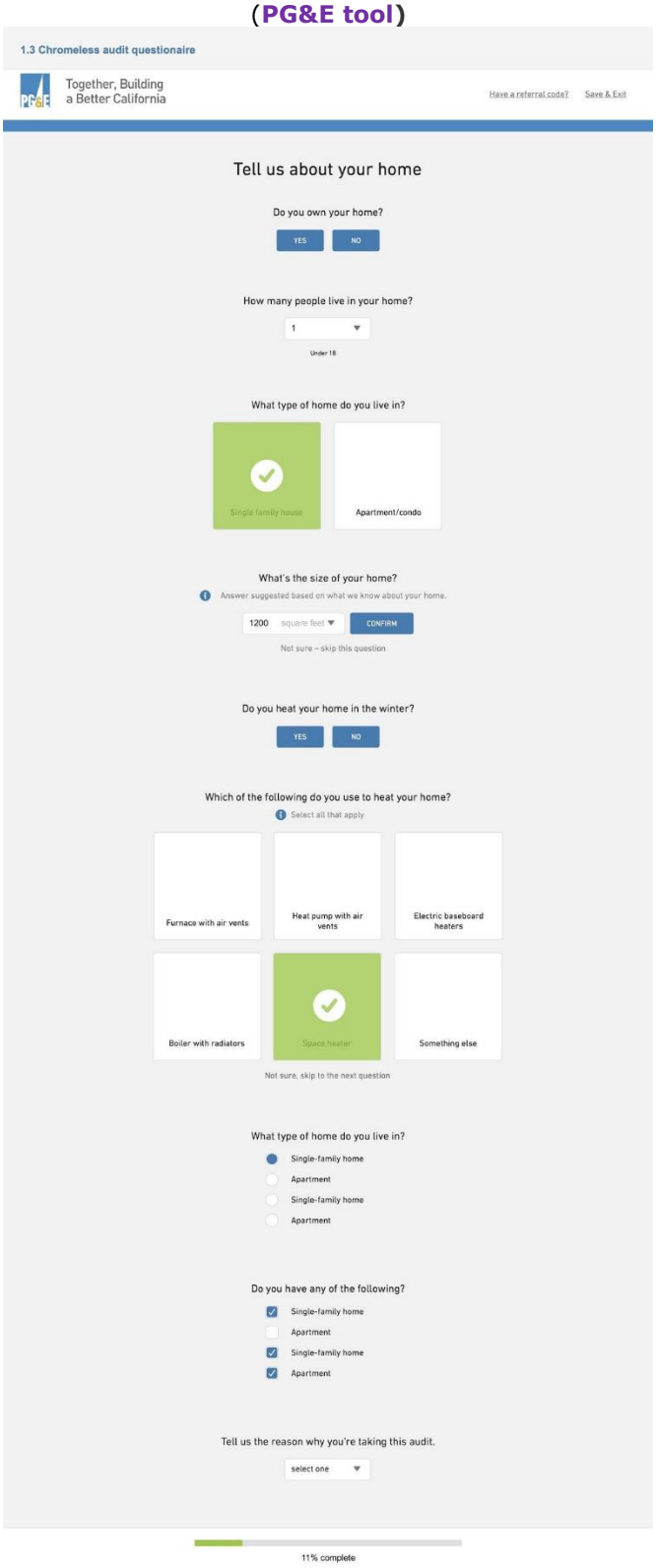
E1. How many visits to the tool did you make before completing the survey?

1. (started and finished it in one shot)
2. 2 to 4
3. 5 or more
4. I did not complete the survey → **GO TO E3**
98. Don't know → **GO TO E3**

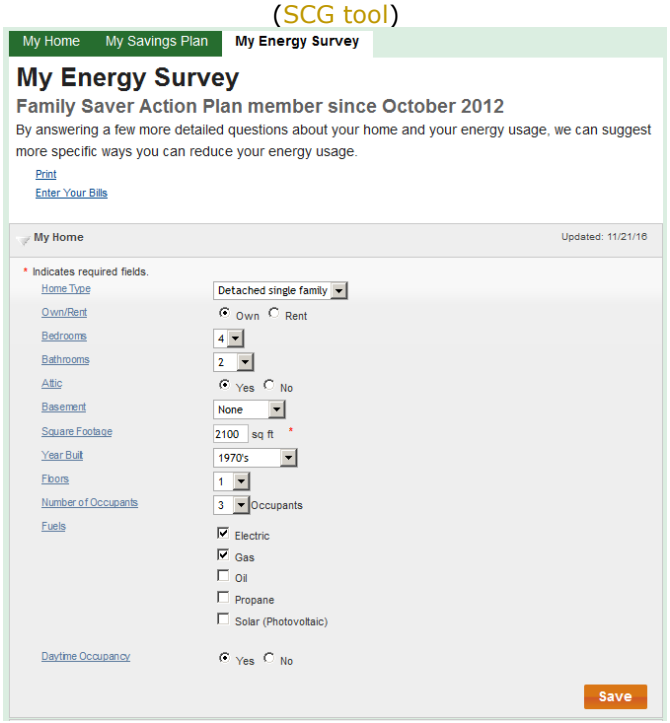
(SDG&E tool)



(PG&E tool)


1.3 Chromeless audit questionaire
Together, Building a Better California
Have a referral code?
Save & Exit
Tell us about your home
Do you own your home?
YES
NO
How many people live in your home?
1
Under 18
What type of home do you live in?
Single family house
Apartment/condo
What's the size of your home?
Answer suggested based on what we know about your home.
1200
square feet
CONFIRM
Not sure – skip this question
Do you heat your home in the winter?
YES
NO
Which of the following do you use to heat your home?
Select all that apply
Furnace with air vents
Heat pump with air vents
Electric baseboard heaters
Boiler with radiators
Space heater
Something else
Not sure, skip to the next question
What type of home do you live in?
Single-family home
Apartment
Single-family home
Apartment
Do you have any of the following?
Single-family home
Apartment
Single-family home
Apartment
Tell us the reason why you're taking this audit.
select one
11% complete

(SCG tool)



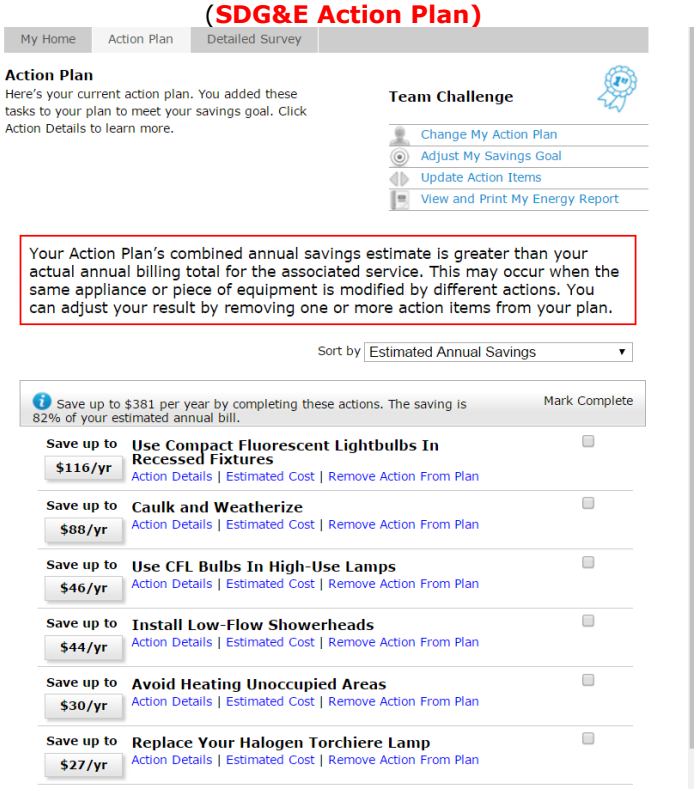
E2. When did you complete the survey on the tool?

RECORD RESPONSE: _____ (month Jan - Dec) _____ (year 2012 – 2016)

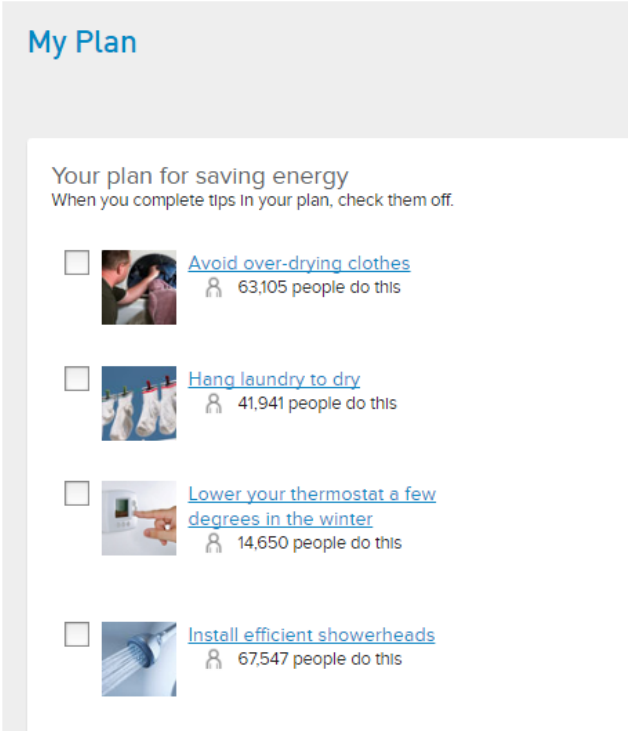
E3. Did you create an ("Action Plan", "Action Plan", "Savings Plan") for energy savings actions you intended to do based on the recommendations you received?

1. Yes
2. No **GO TO I1**
98. Don't know **GO TO I1**

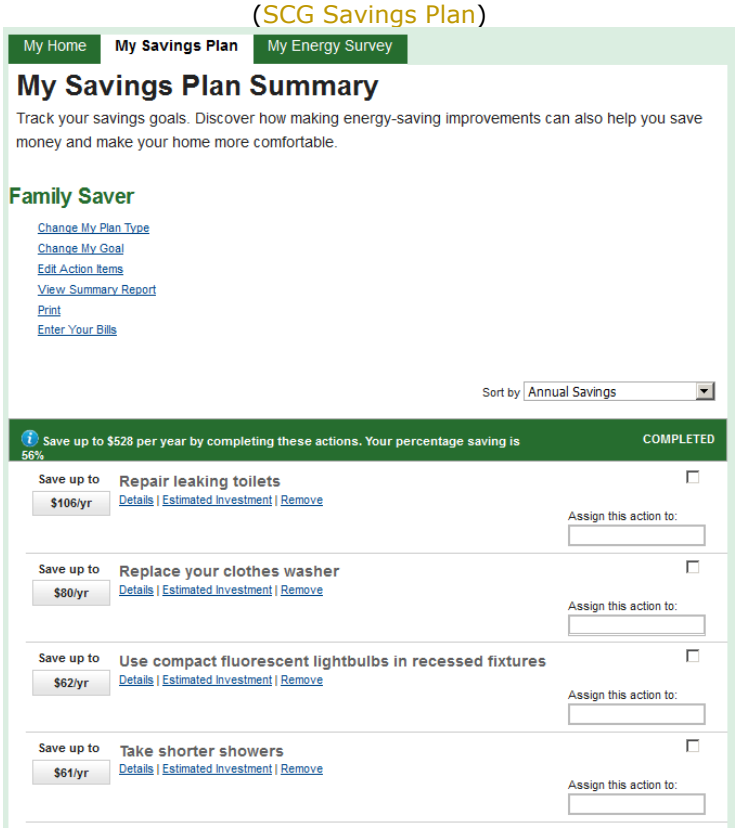
(SDG&E Action Plan)



(PG&E Action Plan)



(SCG Savings Plan)



E4. How many visits to the tool did you make before completing the (Action Plan, Action Plan, Savings Plan)?

1. 1 (started and finished it in one shot)
2. 2 to 4
3. 5 or more
4. I started but have not completed my (Action Plan, Action Plan, Savings Plan) **➔GO TO I1**
5. I did not develop an (Action Plan, Action Plan, Savings Plan) **➔GO TO I1**

98. Don't know

E5. How often did you update the (Action Plan, Action Plan, Savings Plan)? [CHOOSE THE OPTION THAT BEST DESCRIBES YOUR TOOL USE]

1. Daily
2. A few times weekly
3. A few times monthly
4. Monthly/When you got your utility bill
5. A few times a year
6. Once a year
7. Less than once a year
8. I did not update the (Action Plan, Action Plan, Savings Plan)
9. Other (Specify)

98. Don't know

E.5 TOOL – INFLUENCE

I1. Did you adopt any new energy saving habits because of the tool?

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

I2. Did the tool influence your purchases of household appliances and devices?

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

I3. Which of the following utility programs and services would you say you have participated in/availed of because of the tool? [RANDOMIZE, CHECK ALL THAT APPLY, CODE =1 if checked, =0 otherwise]

(SDG&E Answers)

1. **Refrigerator recycling:** SDG&E offers free pick-up for refrigerators, freezers, and room air conditioners
2. **Whole House Retrofit program/Energy Upgrade California/Home Upgrade Program:** SDG&E offers rebates through Energy Upgrade California for homeowners who complete energy efficient upgrades
3. **Water Heater rebate:** SDG&E offers rebates on qualifying energy efficient water heaters
4. **Time-of-Use rate:** Be aware of your electric rates pricing plan
5. **Solar calculator:** If you are thinking about solar, use our Solar Calculator to evaluate the right size for your home
6. **A/C quality Care program:** Receive an incentive when you get an air conditioner tune-up from a qualifying contractor
7. **Reduce Your Use program:** Earn a bill credit when you participate in reduce your use days between the hours of 11am-6pm
8. **Clothes Washer rebate:** SDG&E offers rebates on qualifying clothes washers
9. **Insulation rebate:** SDG&E offers rebates on insulation through the home energy efficiency rebate program
10. **Variable speed pool pump and motor:** SDG&E offers rebates on qualifying variable speed poll pumps and motors
11. **Discounted lighting:** SDG&E offers discounts at certain retail locations for certain energy efficient lighting products
12. The tool **did not influence my participation in any of the above utility programs and services** [EXCLUSIVE]
98. Don't know

(**PG&E Answers**)

1. **Energy Upgrade California:** PG&E offers rebates through Energy Upgrade California for homeowners who complete energy efficient upgrades
2. **Water Heater rebate:** PG&E offers rebates on qualifying energy efficient water heaters
3. **Rate Options:** Be aware of your electric rates and learn about Time-of-use pricing
4. **Solar Estimator:** If you are thinking about solar, use our Solar Calculator to evaluate the right size for your home
5. **SmartRate:** An optional rate that reduces your summer rate except on SmartDays when temperatures are high and an event day is called.
6. **A/C Quality Care program:** Receive an incentive when you get an air conditioner tune-up from a qualifying contractor
7. **Clothes Washer rebate:** PG&E offers rebates on qualifying clothes washers
8. **Pool pump and motor:** PG&E offers rebates on qualifying variable speed poll pumps and motors

9. **Discounted lighting:** PG&E offers discounts at certain retail locations for certain energy efficient lighting products
10. The tool **did not influence my participation in any of the above utility programs and services**

98. Don't know

(**SCG Answers**)

1. **Energy Upgrade California/Home Upgrade Program:** SoCalGas offers rebates through Energy Upgrade California for homeowners who complete energy efficient upgrades
2. **Water Heater rebate:** SoCalGas offers rebates on qualifying ENERGY STAR-certified water heaters
3. **Natural gas furnace rebate:** SoCalGas offers rebates on qualifying ENERGY STAR-certified furnaces
4. **Clothes Washer rebate:** SoCalGas offers rebates on qualifying ENERGY STAR-certified clothes washers
5. **Insulation rebate:** SoCalGas offers rebate on attic and wall insulation through the home energy efficiency rebate program
6. The tool **did not influence my participation in any of the above utility programs and services**

I4. Since you began using the tool, have you noticed any changes in your monthly bill?

1. Yes, they are lower
2. Yes, they are higher
3. No, there has been no real change ➔ **GO TO V1**
4. I do not check my bill regularly ➔ **GO TO V1**

98. Don't know ➔ **GO TO V1**

I5. On average, about what percent has your monthly bill changed by? Your best estimate is fine.

Average percent <reduction *if I4=1*>/<increase *if I4=2*> in bill ____ **%**

I6. Would you say you bill changed…?

1. Mostly in the summer months/cooling season
2. Mostly in the winter months/heating season
3. Both in summer and winter months/both cooling and heating season

98. Don't know

E.6 TOOL – VERDICT

V1. Which of the following features of the tool, if any, did you find useful [CHECK ALL THAT APPLY]

1. Comparison of your consumption with homes like yours
2. Prioritized list of energy savings actions
3. Estimates of savings associated with various energy savings actions
4. Ability to maintain and update your personal action plan on the tool
5. Suggestions for continuous improvements
6. All of the above [EXCLUSIVE]
7. None of the above [EXCLUSIVE]
8. Other (specify)

98. Don't know

V2. How satisfied were you with the tool?

1. Very Dissatisfied
2. Dissatisfied
3. Neutral
4. Satisfied
5. Very Satisfied

98. Don't know

V3. How likely are you to recommend the tool to someone you know?

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

98. Don't know

E.7 HOUSEHOLD CHANGES

CH1. Which of the following changes, if any, have happened or have you made in your home since 2013? [CHECK ALL THAT APPLY]

Lighting	Using **more lighting**	Using **less lighting**	
	Purchased and installed energy efficient bulbs such as LED bulbs		
Programmable Thermostat	Installed a learning/smart thermostat (e.g. Nest or Ecobee)		
Cooling	Cooling **additional areas** in your home	Cooling **fewer areas** in your home	
	Using **more cooling** in your home (i.e. turn down thermostat set-point in summer)	Using **less cooling** in your home (i.e. turn up thermostat set-point in summer)	
Heating	Heating **additional areas** in your home	Heating **fewer areas** in your home	
	Using **more heating** in your home (i.e turn up thermostat set-point in winter)	Using **less heating** in your home (i.e. turn down thermostat set-point in winter)	
HVAC system change	Replaced old HVAC system with new system	Had quality maintenance performed on existing HVAC system	
Refrigerator	Bought new **and kept running the old one** (in garage/basement)	Bought a new refrigerator and **got rid of old one**	**Got rid of an extra one** that had been in use
New Appliances	Bought/installed new energy efficient/energy star appliances (ex: dishwasher, clothes washer, clothes dryer)		
Water Use	Using **more** hot water (added a bathroom, upgraded to a spa bathroom to have multiple shower heads/water jets, doing more laundry etc.)	Using **less** hot water (washing in cold water, using low-flow showerheads, using faucet aerators, upgrading washing machine, upgrading water heater etc.)	
Water Heater	Bought/installed new water heater		
	Turned down the temperature on the water heater		
Laundry	Washing laundry in cold water		
	Line drying laundry		
Pool Use	Added a pool	Eliminated/stopped using your pool	
	Heat pool more	Heat pool less	
Pool pump	Schedule pool pump to run more	Schedule pool pump to run less	
Spa	Added a spa	Eliminated/stopped using your spa	
	Heat spa more	Heat spa less	
Occupancy	Occupied your home for **more days in the year** compared to previous years	Occupied your home for **fewer days in the year** compared to previous years	
	More people living in the home	**Fewer people** living in the home	
Living space	**Increased living area/square footage** of your home (finished basement to add media room or bedroom, for example)	**Decreased living area/square footage** of your home (converted a bedroom to a store room, for example)	
Energy Management	Installed a home automation system or home energy management system (e.g. Amazon's Echo/Alexa or Apple's Home Kit)		
No changes made since first using the tool since 2013 [EXCLUSIVE]			

E.8 SEGMENTATION ITEMS

HH1. Which of the following do you have in your home? [CHECK ALL THAT APPLY]

1. Programmable thermostats
2. Motion detectors for yours lights
3. Vent in your attic area to keep the attic cooler
4. Ceiling fans
5. None of the above

HH2. Have you heard of a carbon footprint? ***A carbon footprint is a measure of the energy you use, either directly or indirectly. This includes but is not limited to the energy consumption from your home, your transportation, your diet, and your purchases.***

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

HH3. Please indicate your level of agreement with the following statements:

a. I compare prices of at least a few brands

b. I do not feel responsible for conserving energy because my personal contribution is very small

(record response, slider)

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

HH4. Which of the following is the ONE reason that would motivate you to save energy? [CHECK ONE]

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

E.9 TECHNOLOGY USE

T1. Which of the following electronic devices do you own? [CHECK ALL THAT APPLY, RANDOMIZE 01-06]

1. Cell phone
2. Tablet
3. Smartphone
4. Laptop computer
5. Desktop computer
6. eBook Reader
7. All of the above [EXCLUSIVE]
8. None of the above [EXCLUSIVE]

T2. Which of the following types of applications (apps) do you use? [CHECK ALL THAT APPLY, RANDOMIZE 01-07]

1. Transportation (For example: Uber, Lyft, Via, etc.)
2. Navigation (For example: Waze, Google Maps, Apple Maps, etc.)
3. Social Media (For example: Facebook, Instagram, Snapchat, etc.)
4. Restaurant Reviews (For example: Yelp, Foursquare, Urbanspoon, etc.)
5. Banking and Finances (For example: Venmo, PayPal, Wells Fargo Mobile, etc.)
6. Location Sharing (For example: Swarm, Find My Friends, etc.)
7. Video Streaming (For example: Youtube, Netflix, Hulu, HBOGo, etc.)
8. None of the above [EXCLUSIVE]
9. I do not use any apps [EXCLUSIVE]

E.10 RESPONDENT AND HOUSEHOLD CHARACTERISTICS

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

HH1. What year was your home built?

[SINGLE RESPONSE]

1. Before the 1970s
2. 1970s
3. 1980s
4. 1990-1994
5. 1994-1999
6. 2000s
7. Don't know

HH2. To the best of your knowledge, when was the last time this home was remodeled?

1. Never
2. Before the 1970s
3. 1970s
4. 1980s
5. 1990-1994
6. 1994-1999
7. 2000s
8. Don't know

HH3. How many bedrooms are there in your home?

[SINGLE RESPONSE]

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

HH4. Roughly, how large is your home (in square feet)? _____

HH5. Which of the following best describes your education?

[SINGLE RESPONSE]

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

98. Don't know

HH6. How many people, including yourself, live in your household?

[SINGLE RESPONSE]

1. 1
2. 2
3. 3
4. 4
5. 5
6. 6 or more
7. Don't know

HH7. On a typical weekday is someone at home most or all of the day?

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

HH8. Which of the following categories best describe your family's total household income in 2015 before taxes?

[SINGLE RESPONSE]

1. Under $25,000
2. $25,000 to under $50,000
3. $50,000 to under $75,000
4. $75,000 to under $100,000
5. $100,000 to under $150,000
6. $150,000 to under $200,000
7. $200,000 or more
98. Don't know

E.11 WRAP-UP

T&T (Used when respondent completes the survey)

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

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

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

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.

Response to Public Comments Matrix			
Commenter	**Page Number (as shown in Word document footer)**	**Comment**	**DNV GL Response**
Carol Yin	N/A	Would it be possible for the evaluation team to include an appendix with recommendations presented using the table from the CPUC Energy Division Impact Evaluation Standard Reporting Guidelines? Thank you!	Report has been updated.
Steve Schmidt	31	From page 31: "...the quality of matches improved substantially for SDG&E electricity data while the conclusion on PG&E electricity data remains unchanged. Therefore, this exploratory work in model-based matching suggests there are benefits from using AMI data in matching." The results in table 14 on that same page shows the significant improvement in SDG&E results but also shows a nearly identical decrease for PG&E results. This surprising variance is not explained. A possible explanation for this variance could be the quality of the AMI data analysis performed. For example, mention is made of weather normalization using AMI data with CDD and HDD data, but there is no discussion of the method used for selection of balance point temperatures. If this was not done on a home-by-home basis results will be inaccurate, given the huge variation between (for example) HDD58 and HDD65 in many California locations.	1) The report has been updated to reflect that while using certain elements of AMI data led to a stronger match for SDG&E than for PG&E, this is not definitive evidence that AMI data improves matches in all cases. 2) Our site level energy consumption model does in fact estimate not only weather (HDD CDD) effects but also cooling- and heating- degree basis for each household.
Steve Schmidt	N/A	This same issue applies to the quality of the UAT's audit results on individual homes. There appears to have been no effort to evaluate the accuracy of the UAT's results against ground truth data. Inaccurate energy audit results would obviously impact the effectiveness of recommendations, and this issue does not appear to have been evaluated in any way.	Accuracy of savings predictions cannot be determined - it is contingent upon the customer undertaking the recommended energy saving actions. Savings lower or higher does not necessarily mean an inaccurate prediction as it is confounded with respondent usage behavior.

Response to Public Comments Matrix			
Commenter	**Page Number (as shown in Word document footer)**	**Comment**	**DNV GL Response**
SCG & SDG&E	21	Thank you for the detailed explanation on the sample matching process. We especially appreciate the following: (1) Use of the aggregated AMI data, (2) First round of matching to narrow down to the 5 best possible candidates, then narrow the matching to the best possible 1:1 matching. This is such an important step, we really appreciate the extra efforts and the attention to detail.	Thank you!
SCG & SDG&E	39	"Despite some overlap in participation in the two programs, we find no evidence of joint savings between the UAT and HER programs." Are you saying this because you are using a matched comparison quasi experimental approach for this analysis (i.e., the HER participants are also in the matched comparison group, thus the impact is a netted result)? Please confirm.	Yes. This is correct.
SCG & SDG&E	39	"The greater prevalence of prior HER involvement among PG&E UAT participants is a possible explanation for why PG&E UAT participants appear to save less than SDG&E." This is actually suggesting joint savings between UAT and HER (i.e., less available for PG&E's UAT), but the analytical methodology helped isolate the UAT savings. Can you make this section clear? We are all sensitive to the potential double counting.	Report has been updated to clarify with the following footnote: In order for there to be joint savings, the prevalence of HER treatment households needs to be greater among UAT's opt-in group than in the UAT matched comparison group. But our examination of the prevalence of HER in UAT confirms the equal presence of HER treatment and control households in both the UAT opt-in and matched comparison groups. As a result there is no joint savings.

Response to Public Comments Matrix			
Commenter	**Page Number (as shown in Word document footer)**	**Comment**	**DNV GL Response**
SCG & SDG&E	57	The scale for top of Table-29 (i.e., for Energy Usage Behavior and Technology Adoption sections) is not clear. Can you make this clear in the report?	Report has been updated.
PG&E	Overarching	The report does not include any ex-ante values for the program, nor does it include GRR, NRR, or the IESR tables as should be standard across impact evaluations. These are basic requirements of any impact evaluation and should be included.	This is the first impact evaluation for this program. While there are energy savings claims for Energy Advisor (HERs, mail audits, etc.) overall; there is no work paper associated with the UAT nor claimed savings assigned to this program. As such, we cannot produce realization rates. If this information was available then it should have been included in the tracking database the IOUs provided to support the evaluation.
PG&E	Overarching	The dates and focus of this study are not clear. Was this an evaluation for 2014 or 2015? Across the report, figures specify 2015 savings as the focus, but elsewhere the report indicates that 2014 is the period of analysis. This should be clarified in the title and executive summary and kept consistent across the body of the report.	Report has been updated (introduction only). Sections 3.4.1 and 3.4.2 go into detail regarding selection of study period.
PG&E	Overarching	Further, data requests to PG&E included requests for both Residential and Business UAT program data. The rationale behind requesting both res and non-res data was that the Business Energy Check-up tool would be evaluated as well, although this report is specifically residential and does not point to an upcoming Business/Nonres evaluation. PG&E would like the evaluators to verify that only residential data was used in the analysis for this report and to draw conclusions about the Residential UAT.	This is already noted in the introductory paragraph in the Executive Summary (report pertains to residential evaluation alone). A separate report will be published from the evaluation of the non-residential tool.

Response to Public Comments Matrix			
Commenter	**Page Number (as shown in Word document footer)**	**Comment**	**DNV GL Response**
PG&E	Overarching	Throughout the report, the operational definitions for key terms (example: "high" versus "low" engagement, "engaged" versus "completed") are left out of the text and the terms are not used consistently in descriptions of the sample or analysis. It's also unclear how these groups overlap (example: are all customers categorized as "high" engagement also categorized as "completed"?). Is there overlap in these categories and if so, where? It also appears that the research focus of the study is around engaged vs. completed, but that does not explain the inclusion of high vs. low engagement. If the research questions are centered around the comparison of engaged vs. completed, where does high vs. low play into this and how does it address those questions?	A glossary has been included to clarify these terms
PG&E	Overarching	Although the report appropriately caveats the possibility of self-selection bias on the survey response and in the appendix, the report does not thoroughly address the self-selection bias inherent to tool usage in the main text. Potential for self-selection in the opt-in model needs to be caveated in the Executive Summary and throughout the report. PG&E requests that this also be addressed explicitly in the methods section, along with other evaluation limitations, as part of an additional section on Limitations/Weaknesses in the study.	Methods section 3.3.1 discusses this, as does the Appendix in greater detail as noted.
PG&E	Overarching	Various tables throughout the report are broken across multiple pages. For ease of consumption and data comparison, PG&E requests that pages be reformatted so all tables and graphics, when possible, are on a single page.	Report has been updated.

Response to Public Comments Matrix			
Commenter	**Page Number (as shown in Word document footer)**	**Comment**	**DNV GL Response**
PG&E	Section 1.1, pg. 6 / 2.2.1, pg. 13	Description in the tool as Home/Business Energy Check Up (Section 1.1) does not match the description of the tool in Section 2.2.1, which excludes the Business portion of the title. For PG&E, the tool is branded as Home Energy Checkup for Res customers and Business Energy Check-up for Non-res customers. Section 1.1 should be updated to the correct branding name for res for PG&E.	The mention of "Business" has been dropped from the introductory paragraph in the executive summary.
PG&E	Section 1.3, pg. 7 - 8	Language in the report indicates that IOU program staff were interviewed to support this evaluation. However, PG&E is not aware of any interviews that took place with PG&E program staff. Which program staff at PG&E were contacted for inclusion and which were interviewed? If none, please adjust the text of the report accordingly.	Report has been updated. Footnote added - Information from IOU program staff gathered via email, phone calls, monthly Energy Advisor reports, and regular monthly PCG III meetings for this UAT evaluation.
PG&E	Section 1.4, Figure 1, pg. 8	What does "length of association with the tool" ("Length of engagement") mean? How is this related to other engagement (low vs high) metrics and was any additional analysis done around this metric?	See response above regarding addition of a glossary.
PG&E	Section 1.4, Figure 1, pg. 8	PG&E would like to clarify the "Tool Use" description in Figure 1. The information provided in the figure speaks more to frequency of usage, and we recommend the language be updated in the following way:- Current language: "The majority of users (62%) felt one visit to the tool was enough since nothing in their home had changed or that they had sufficient information." - Suggested language (to describe "Tool Use Frequency" rather than general "Tool Use"): "The majority of users (62%) did not feel it necessary to use the tool more than once because nothing in their home had changed or because they got sufficient information after the first use."	Report has been updated.

Response to Public Comments Matrix			
Commenter	**Page Number (as shown in Word document footer)**	**Comment**	**DNV GL Response**
PG&E	Section 1.4, Figure 1, pg. 9	The Customer Profile key findings are unclear. Can there be additional language added to clarify how "attitudes towards the environment" and "technology adoption" were operationalized for purposes of comparison?	Report has been updated.
PG&E	Section 1.4.1, Table 2, pg.9 - 10	Text in Section 1.4.1 discusses results by level of engagement, and Table 2 breaks users into “low” and “high” without operationalizing "low" and "high" and providing criteria for user placement into either category. We request clarification in the text as to how "low" and "high" are defined, and that this definition be consistent throughout the report where "low" and "high" appear.	See response above regarding addition of a glossary.
PG&E	Table 2, pg. 9 - 10	How were electric/gas savings per household calculated? Our interpretation is that it should be total electric savings divided by number of users, which is inconsistent with the number in the table. Can there be multiple users per household? Please include the formula used for this calculation with the tables where it appears.	Cross reference to section that details savings computations is now included in the report. Total electric/gas savings are a weighted sum of savings which takes into account the varying number of users in the post opt-in period (2014-2015). As noted in the table, the per household savings estimates are for 2015. These are the reasons why one cannot compute savings per household as total savings divided by number of users given in the table.

Response to Public Comments Matrix			
Commenter	**Page Number (as shown in Word document footer)**	**Comment**	**DNV GL Response**
PG&E	Table 4, pg. 13 - 14	The 2016 Engagement and Completion numbers for PG&E listed in this table are incorrect: • Engaged should be 241,865 • Completions should be 97,612 Per DNV GL request, PG&E program staff member Kimberly Conley provided these numbers to Gomathi Sadhasivan on 3/20/2017. These numbers should be reflected in the report.	Report has been updated.
PG&E	Table 4, pg. 13 - 14	There is a discrepancy in how terms are used in this table vs. elsewhere in the report. Here, "engaged" means anyone who visited the UAT site, and "completed" seems to refer to those who completed a survey, but later (3.4.3) "completed" is used to indicate specifically those who completed an action plan. Please clarify.	3.4.3 defines Low versus High engagement as users who **did not** and **did** create an Action Plan on the tool. Complete versus Engaged is those who **complete** the online survey versus everyone else (as you note here). The IOUs track users by the latter classification. This evaluation seeks to assess the impact of depth of engagement and uses creation of an action plan to denote a deeper level of engagement with the tool. This distinction and description is maintained and consistent throughout the report.
PG&E	Section 3, pg. 15	The introduction to Section 3 includes mention of a "first tier" and "second tier" of engagement. How does this map to "high" and "low" engagement? How does that map to "engaged" and "completed"?	The report has been updated and a glossary has been included to clarify these terms.
PG&E	Table 9, pg. 20 / Table 20, pg. 33	Tables 9 and 20 include "engagement rates", defined as creation of an action plan. How does this map to criteria used to define "high" and "low" engagement"? How does that map between earlier definitions of "engaged" and "completed"?	Report has been updated and a glossary has been included to clarify these terms.

Response to Public Comments Matrix			
Commenter	**Page Number (as shown in Word document footer)**	**Comment**	**DNV GL Response**
PG&E	Table 10, pg. 26	What does "w/ billing data" mean? In the context of this table, what does "engaged" and "completed" mean? Table 10 does not appear to line up with numbers in Table 4; the numbers have the same label but are widely varied. Numbers need consistency/alignment across the report. Can the authors please clarify the terminology and the disparity between Table 4 and 10 numbers?	1) w/ = with. Report has been updated. 2) Engaged and Completed are consistently used throughout this report to mean those who used the tool and the subset of those who used the tool that actually completed the audit/survey on the tool respectively. 3) Table 4 uses IOU provided summaries. Table 10 is the subset that we have complete billing data for (those who are eligible for the evaluation) in the study period from 2013-2015.
PG&E	Table 10, pg. 26	Why is there missing data for PG&E's 2012 engaged/completed and 2016 completed participant counts? This data was sent to DNV GL through a data request in early phases of the evaluation, and was re-sent to DNV GL on 3/20/17 (see Comment 14 above). In addition, the 2016 Completed number should not vary from Table 4 to 10, so it should not be blank. If there is a reason for variation, please explain in the text.	See response above regarding Table 10. Table 10 is a subset of Table 4.
PG&E	Figure 7, pg. 29 / Figure 8, pg. 30	What is the P mentioned in the X-axes? Percentiles? How can anyone fall in 0%? Could you please label the axes clearly and provide additional explanatory text around how this is broken out? Similarly, the conclusions for these figures need more elaboration, with conclusions demonstrated and linked to the visual evidence.	Section 3.4.4 notes that these are percentiles. Figures 7 and 8 summarize the cumulative distribution of electiricity and gas consumption for the opt-in users and matched comparison group. The plots summarize consumption at various percentiles. P0, P1, P5...through P100 are percentile points to show matched consumption. P0 is the minimum and P100 is the maximum value of consumption. Report now includes a footnote further describing what is plotted.

Response to Public Comments Matrix			
Commenter	**Page Number (as shown in Word document footer)**	**Comment**	**DNV GL Response**
PG&E	Table 21, pg.34	The PG&E %s in Table 21 do not match the surrounding text.	Report has been updated.
PG&E	Table 26, pg. 42	Throughout the report, "consumption" can mean either gas or electric (ex: on page 21, "consumption" is used multiple times but in the first section of 3.3.1 is clarified as "energy consumption".) How is "consumption" being operationalized in this and other tables/figures/text throughout the report? Should be a clear definition in Executive Summary, with footnotes throughout where the term is used variably. Likewise, "high", "medium", and "low" consumption are not defined for this table. What were the criteria for each category?	1) Consumption or energy consumption is used when referring to both electricity and gas throughout the report. In cases where the reference is to a particular fuel, it is called out as electricity or gas accordingly. 2) High, medium, and low consumption referenced in Table 26 are consumption terciles based on the sample frame used in the survey and vary by IOU.
PG&E	Figure 11, pg. 36 / Figure 12, pg. 37	Would the authors please clarify and label the y-axis variable?	Report has been updated.