# Residential Home Energy Surveys: What's the Impact…. Survey Says!

*Amy Buege, Molly Du and Jean Shelton, Itron Inc., Oakland, CA*
*Peter Franzese, CPUC, San Francisco, CA*

## ABSTRACT

The Home Energy Efficiency Survey (HEES) programs offered by the four California IOUs provide residential customers with customized recommendations regarding cost-effective energy efficiency changes for their homes. These recommendations span multiple end-uses, including measure and energy management practice changes, and provide information on available utility incentives to help offset the cost of implementation. Currently there is debate over the quantification of energy savings resulting from residential audit programs. During the 2010-12 program cycle, 40 million dollars were allocated statewide to the HEES programs, however only one IOU claimed savings from the program due to the difficulty developing accurate, defensible measurements of program savings. A recent evaluation of the California programs found statistically significant electricity savings for all IOUs resulting from implementation of HEES program measure and practice recommendations (outside of those implemented through other utility EE programs) which were not counted as part of any utility EE program claims. The successful implementation of the approach presented in this paper allows utilities to confidently claim independent savings resulting from residential audit programs.

This paper describes the research methods (including both quantitative analysis of participant survey self-reports and a billing regression analysis) and extensive data collection and manipulation used to estimate the net program effects from these residential audit programs. The billing analysis was unique from past efforts in that it isolated the HEES program savings through careful development of a non-participant sample (using PSM[1] to control for self-selection bias) while accounting for savings attributable to other EE program participation.

## Introduction

The HEES program offers residential customs a closer look at their household's energy usage and provides participants with individualize home energy savings recommendations based on energy surveys that can be completed via the mail, on-line, over the phone, or in person. The goal of the HEES program is to identify potential energy efficient (EE) measures and energy management practices that exist within a household, educate the customer on these EE opportunities, and promote the implementation of cost-effective energy efficiency projects by providing the participants with economic information they can use to make investment decisions. HEES is also a conduit for increasing participation in other IOU EE incentive programs, providing direct support for and coordination with these programs. The impact of energy surveys is tightly bound to both the content and the delivery of energy information and recommendations. In order to create energy impacts, the HEES Program must effectively communicate energy information and advice. Therefore, the unique characteristics of program design are an essential driver to the resulting energy survey savings. This program is unique from many residential audit programs offered in jurisdictions across the U.S. in that the recommendations are highly customized to the participants based on a detailed assessment of their homes.

The HEES Program offers tailored home energy surveys to residential IOU customers. These surveys start by collecting customer-specific home information, including an equipment inventory and usage history, and then use this data to make home-specific energy efficiency and conservation

[1] Propensity Score Matching.

recommendations which are presented to the customer in a formal report. This survey report outlines potential energy (kWh and Therms) and dollar savings resulting from the implementation of recommended measures (equipment) or practices (changes in behavior) and provides referrals to IOU EE incentive programs to assist with the implementation of these recommendations. The surveys are offered in various formats including online, telephone, mail, and in-home, with the majority of PG&E and SDG&E customers using the online tool, and the majority of SCE/SCG taking the mail survey.

## Recommendation Categories Studied

The recommendations provided through the HEES Program can be divided into a series of 23 measure recommendation categories and 11 practice recommendation categories. Measure recommendations include the purchase of energy-efficient items for one's home (such as a new high-efficiency washer or dryer), whereas practice recommendations include actions that one may take, on either a daily or semi-regular basis, to improve the energy efficiency of their home (such as using an insulated pool cover or washing clothes in cold water).

The recommendations provided through the HEES surveys differ by IOU. However, two of the most common HEES measure recommendations given by each of the utilities were to install CFLs and low-flow showerheads or faucet aerators. Energy management practice recommendations spanned a wide variety of end-uses such as raising the temperature settings of refrigerator and/or freezers, lowering heater thermostat settings, and sealing leaky ducts and around windows and doors.

The number of recommendations given to a customer also varied significantly by IOU due to variations in the recommendation algorithms constructed by each of the utilities and programmed into the software used to support each IOUs HEES program. PG&E provided the highest number of recommendations (measure and practice) per survey (an average of more than 28), while SCE/SCG averaged ten per survey and SDG&E averaged nine. The types of recommendations given to HEES participants also differed by utility with 45% of PG&E's recommendations being measure focused, compared with 30% of SCE/SCG and 39% of SDG&E recommendations being measure focused and the remainder being practices.

## Analytic Methods and Data Collection

The gross and net impact approach implemented for this evaluation measured a participant's response to the HEES survey in terms of the adoption of efficient measures and practices that lead to energy and demand savings. Impacts were evaluated using two primary methods. The first was a self-report method which utilized HEES participant telephone survey data to measure the frequency of measure and practice adoptions and self-reported influence of the HEES survey (attribution) on those EE adoption decisions for a sample of the participant population. The second method involved employing a billing regression model to quantitatively estimate net program impacts on a much larger sample of program participants. This was a complex undertaking as it required lining up HEES program tracking data with all other utility EE program tracking data. Table 1 below provides an overview of the data collected as part of this evaluation.

**Table 1.** Data Collection Activities

| Data Collection Type | Sample Frame | Sample Size | | | Timing |
|---|---|---|---|---|---|
| | | PG&E | SCE/SCG[2] | SDG&E | |
| Program Tracking Data | HEES Participants | 86,225 | SCE: 209,171 | 19,048 | January 2010 – mid-to-end 2012 |
| | EE Participants | 431,133 | 571,458 / 268,731 | 117,790 | Through Q4 2011 |
| Billing Data | HEES Sample and NP Matching Sample | PT: 61,943 NP: 773,727 | PT: 139,286 NP: 1,655,050 | PT: 7,277 NP: 88,135 | PG&E (08-12) SDG&E (08-12) SCE (08-11) |
| Weather Data | CA IOU Territory | All CA Weather Stations | | | 2008 - 2012 |
| CIS Data | HEES Sample and NP Matching Sample | PT: 61,951 NP: 775,089 | PT: 139,650 NP: 1,655,047 | PT: 7,282 NP: 89,760 | 2012 |
| CATI Phone Surveys | HEES Participants | Completes: 250 | Completes: 501 | Completes: 277 | May - July 2012 |

## Regression Based Impact Analysis

Ideally, a controlled experimental design would be used to determine the influence of a program on household behavior. Using a controlled experimental design, households would be randomly assigned to participant (treatment) and nonparticipant (control) groups. If an experimental design methodology had been used to determine participation in HEES program, the random assignment to control and participant groups would ensure that the pre-program average energy consumption and the monthly distribution of consumption of the control and participant households would be approximately equivalent. Given the similarity of consumption prior to program implementation, measurable differences in average energy consumption following program implementation would be reasonably attributable to the program.

Participation in the HEES program, however, is voluntary. Given that individuals self-select into the HEES program, the participant and nonparticipant groups are likely to differ due to the variables that influence self-selection. These variables could help explain the participation choice and associated usage of these households. Since HEES participants voluntarily participated in the program, the impacts of the program must be estimated using quasi-experimental matching methods.

**Propensity Score Matching.** To facilitate the estimation of the program impact, a propensity score matching method (PSM) was used to match the participant sample to a similar nonparticipant group. This matching methodology used observable characteristics of the participant and nonparticipant groups to develop samples that were similar in all observable characteristics. The observable characteristics within the matching methodology attempted to control for potential sample selection bias associated with the non-experimental nature of the design. The PSM method required one full year of pre-period billing data to ensure the differentiation of the response of a household to various weather conditions was captured. Including how a household responded to extreme weather conditions was

[2] The original HEES tracking data provided to the evaluation team from the SCE and SCG program implementers was nearly identical (95%+% match). Due to the difficulty distinguishing SCE HEES participants from SCG HEES participants in this file and the large overlap between SCE and SCG customers, SCE and SCG were treated as one utility for the CATI phone surveys. For the billing analysis, SCG participants were excluded since the billing analysis was an electrical billing model only.

especially important since it is during these extreme conditions that a household's disposition toward energy conservation becomes apparent. At least one full year of post-HEES period data was also required to examine the impacts of the HEES program.

After the sample of participants and feasible nonparticipant matches was constructed, a Logit model was built to construct the propensity scores. The regression used an indicator variable of being a participant as the dependent variable, with site specific characteristic variables as independent variables. These independent variables included monthly energy usage, standard deviation of monthly usage, covariance between usage and weather across pre-program months, CARE and FERA[3] status, household geographic location, previous energy efficiency program participation, and whether a gas account can be associated with the site. For each utility sub-sample,[4] a Logit model was run, and the propensity scores were calculated as the fitted probability of being a participant using the regression results from the Logit model.

Finally, the PSM method paired the participant and nonparticipant households with similar propensity scores in each sub-sample at each of the three utilities. Nearest neighbor matching (with replacement) was used in the matching process, and a radius of about one-quarter of the standard deviation of the propensity scores was imposed to ensure the quality of matching. If no nonparticipants fell within one-quarter of the standard deviation of a particular propensity score, the participant was dropped from the sample due to the lack of a valid match. For each sub-sample, upwards of 99% of the participant sample found a match from the nonparticipant sample.

**Billing Analysis Regression Model Development.** To estimate the monthly kWh savings attributable to participation in the HEES program, billing analyses were performed using the entire sample of matched data. For each site, various participation variables were created to determine the observable impact of HEES program participation on kWh usage. These variables are all indexed by site (i) and time (t). Some examples of some of these participation variables include:

- **PostHEES_1$_{it}$**: A 0/1 variable equal to 1 in all months following the first HEES survey.
- **PostHEES2_1$_{it}$**: A 0/1 variable equal to 1 in all months following the second HEES survey.
- **PostTel_1$_{it}$**: A 0/1 variable equal to 1 in all months following the first Telephone HEES survey.

In addition to the HEES program participation variables, the billing analysis model incorporated either monthly ex ante kWh savings estimates[5] or dummy variables to control for the savings resulting from other energy efficiency programs. The results of both of these approaches (ex ante savings variables or dummy variables) were completed for this evaluation. However, due to the similarity of results from these two methods and the issue of ex ante energy efficiency kWh savings estimates (which are often not very good estimations of individual participant savings) introducing more error into the model, the dummy variables model was used in this evaluation to estimate HEES program impacts. As such this paper focuses on the dummy variable model.[6]

The HEES regression model was designed to determine the independent influence of HEES participation on a participant's electricity consumption. The model selected was a site and time-fixed effect model. Robust standard errors were constructed to account for the panel data structure of the model and to correct for the time-series dependence and cross-sectional dependence of the residuals.

[3] SCE offers its customers two programs, CARE (California Alternate Rates for Energy) and FERA (Family Electric Rate Assistance), to provide income-qualified customers with bill relief (20% or more off their electricity bill).
[4] The sub-samples divided the participant population into five groups based on their quarter of HEES participation (quarters spanned 15 months).
[5] The ex ante energy efficiency kWh savings were found by merging each of the IOUs energy efficiency tracking databases with the matched billing analysis samples.
[6] Additional information on the Ex Ante Savings model can be found in the evaluation report which is not yet finalized.

The following equation shows the dummy regression models. As stated previously, the models were estimated using a sample of participants and the PSM matched nonparticipants.

### Dummy Variable Model

$$kWh_{i,t} = \alpha_i + \gamma_t + \beta_1 HDD_{i,t} + \beta_2 CDD_{i,t} + \beta_3 HDD_{i,t}^2 + \beta_4 CDD_{i,t}^2 + \beta_5 PostHEES\_1_{i,t} + \beta_6 PostHEES\_4_{i,t} + \beta_7 PostHEES\_7_{i,t} + \beta_8 PostHEES2\_1_{i,t} + \beta_9 PostHEES3\_1_{i,t} + \sum_{h=1}^{H} \beta_h^{D\_EE} \times Type\ h\ EE\ Dummy_{i,t} + \varepsilon_{i,t}$$

Where:

$kWh_{it}$ = kWh consumption at site i in month t.

$Type\ h\ EE\ Dummy_{i,t}$ = an indicator variable that equals to 1 for site i in month t where the estimated ex ante savings from other energy efficiency programs are non-zeros.

$\alpha_i$ = the site specific fixed effect.

$\gamma_t$ = the time fixed effect.

$\beta_1$ = monthly kWh change from a one-unit increase in heating degree days (HDD).[7]

$\beta_2$ = monthly kWh change from a one-unit increase in cooling degree days (CDD).

$\beta_3$ = monthly kWh change from of a one-unit increase in square term of HDD.

$\beta_4$ = monthly kWh change from of a one-unit increase in square term of CDD.

$\beta_5$ = average monthly treatment effect from HEES program in the first three months after HEES participation.[8]

$\beta_6$ = change in monthly treatment effect three months after taking the HEES survey.[9]

$\beta_7$ = change in the monthly treatment effect a half year after taking the HEES survey.[10]

$\beta_8$ = monthly kWh savings induced by taking the HEES survey a second time.

$\beta_9$ = monthly kWh savings induced by taking the HEES Survey a third time.

$\beta_h^{D\_EE}$ = monthly kWh savings observable in the billing data of the participants from type h of energy efficiency program.

## Results

### Self-Report Impacts

The self-report uptake and attribution analysis focused on gross and net estimates of the quantity of HEES recommendations (measure and practice) implemented post-HEES. Gross recommendations implemented exclude those incentivized through a utility EE program and those where standard efficiency equipment was installed. Net recommendations implemented were estimated by multiplying the gross installations by the self-reported program attribution score (derived from the influence level participants stated the program had in their decision to implement a HEES recommendation).

Table 2 below provides estimates of the net number of measures installed as a result of the HEES program. These estimates were derived by applying the self-reported recall[11], uptake and attribution

[7] The model specification estimated for this report includes heating and cooling degree days, and their squares, interacted with the three geographical locations. This specification was a better representation of the observation that the three districts had significantly different weather and resulting usage patterns. The models were also run excluding the square terms of HDD and CDD and the regression results were the same.

[8] This and the subsequent treatment effect (or savings variables) were designed in such a way that a negative coefficient indicates savings attributable to the HEES program.

[9] Previous evaluations of similar programs have found it often takes time for participants to install measures and adjust their behaviors. Therefore, there might be a delay for the impacts from the HEES program really take effect, and hence it is expected that $\beta_6$ is statistically significant with a negative sign indicating greater savings.

[10] The overall treatment effects from HEES after six months of participation should be the sum of $\beta_5$ through $\beta_7$.

rates to the number of recommendations given to participants in the 2010-12 HEES program.[12] As this table shows, across all IOUs approximately 129,000 recommended measures were implemented and attributed to HEES program participation (out of 1.8 million measure recommendations given through HEES). This yields an overall self-reported net implementation rate of 7%. Attribution of implemented measures to the HEES program was quite similar across IOUs, averaging 39% statewide. It is interesting to note that statewide, the highest net implementation rates across measure recommendations are for Lighting and Hot Water measures (19% and 5%, respectively). The lowest net implementation rates are for Building Envelope, Laundry and HVAC measure recommendation categories (each were less than 1.5%). The high level of Lighting and Hot Water measure implementation is likely due to the low cost and relative ease of installation associated with implementing these measure recommendations as compared to the Building Envelope, Laundry and HVAC measure categories that include significantly more expensive and time-intensive measure investments.[13]

**Table 2.** Self-Reported Measure Recommendation Recall, Uptake, and Attribution

| Utility | Measure End-use | Rec's Given | Recall Rate | Uptake Rate | Attribution Rate | Net Implement Rate | Net Rec's Implemented |
|---|---|---|---|---|---|---|---|
| State-wide | Lighting | 482,545 | 68% | 76% | 37% | 19% | 92,017 |
| | Hot Water | 506,098 | 51% | 21% | 47% | 5% | 25,272 |
| | Pool | 69,399 | 62% | 11% | 29% | 2% | 1,346 |
| | Kitchen | 146,090 | 47% | 9% | 39% | 2% | 2,526 |
| | Laundry | 113,302 | 32% | 13% | 29% | 1% | 1,378 |
| | HVAC | 401,994 | 29% | 8% | 61% | 1% | 5,597 |
| | Building Env | 93,697 | 47% | 4% | 46% | 1% | 866 |
| PG&E Total | | 1,110,764 | 46% | 32% | 40% | 6% | 65,049 |
| SCE/SCG Total | | 635,236 | 55% | 44% | 39% | 9% | 58,969 |
| SDG&E Total | | 67,124 | 54% | 37% | 36% | 7% | 4,984 |
| **Total Statewide** | | **1,813,124** | **49%** | **37%** | **39%** | **7%** | **129,003** |

Table 3 below provides similar estimates of the net number of energy management practice recommendations implemented as a result of the HEES program. As this table shows, across all IOUs, approximately 325,000 recommended practices were implemented and attributed to HEES program participation (out of three million practice recommendations given through HEES), resulting in a self-reported net statewide practice implementation rate of 11% (and at each of the IOUs). Uptake and attribution rates were also very closely aligned in each of the service territories. Statewide the highest net implementation rate across practice recommendations was Efficient Refrigerator and Freezer Practices (19%), followed by Efficient Water Heater Practices (18%). The lowest net implementation rates were for Efficient Cooling and Lighting Practices (both around 8%). It is somewhat surprising that lighting practices (such as replace halogen torchieres and use timers to switch lights on and off at preset times) had such low implementation rates considering lighting measures had the highest net implementation rates.

[11] Recall refers to whether or not the HEES participant remembered receiving a particular recommendation.
[12] Based on the final tracking data received by the evaluation team.
[13] Lighting measures were primarily CFLs and motion sensors on indoor/outdoor lighting and hot water measures, including insulating water heaters and installing faucet aerators and low flow showerheads, while Building Envelope, Laundry and HVAC included measures such as replacing a heating or AC system, installing a whole house fan, insulation or a new washer or dryer.

**Table 3.** Self-Reported Practice Recommendation Uptake and Attribution

| Utility | Practice End-use | Rec's Given | Recall Rate | Uptake Rate | Attribution Rate | Net Implement Rate | Net Rec's Implemented |
|---|---|---|---|---|---|---|---|
| State-wide | Fridge/Freezer | 262,612 | 87% | 29% | 77% | 19% | 50,786 |
| | Water Heater | 328,075 | 92% | 27.6% | 70% | 18% | 58,176 |
| | Building Env | 327,903 | 93% | 22.0% | 57% | 12% | 37,902 |
| | Other Practices | 98,605 | 86% | 32.3% | 41% | 12% | 11,400 |
| | Clothes Washing | 175,459 | 95% | 21.1% | 57% | 11% | 20,104 |
| | Home Heating | 514,444 | 90% | 15.6% | 66% | 9% | 48,018 |
| | Dishwashing | 144,476 | 96% | 16.1% | 57% | 9% | 12,838 |
| | Pool and Spa | 112,342 | 95% | 14.0% | 67% | 9% | 10,010 |
| | Clothes Drying | 305,020 | 93% | 15.7% | 59% | 9% | 26,565 |
| | Cooling Tips | 417,083 | 96% | 14.3% | 58% | 8% | 33,489 |
| | Lighting | 212,590 | 93% | 13.0% | 63% | 8% | 16,276 |
| PG&E Total | | 1,344,144 | 89% | 20% | 63% | 11% | 152,210 |
| SCE/SCG Total | | 1,448,005 | 96% | 19% | 63% | 11% | 162,003 |
| SDG&E Total | | 106,462 | 93% | 19% | 61% | 11% | 11,351 |
| **Total Statewide** | | **2,898,611** | **92%** | **19%** | **63%** | **11%** | **325,564** |

## Regression-Based Impact Analysis

Table 4 below summarizes the net HEES savings estimates resulting from the regression-based impact analysis assessment. These results are based on the model specification that incorporated dummy variables (as opposed to ex ante savings estimates) to control for the impacts resulting from other utility energy efficiency programs.[14] As this table shows, HEES online program participants in PG&E and SDG&E service territory decreased their usage in the first year post-HEES survey by an average of 316 kWh and 294 kWh (both 3%), respectively. For SCE, the on-site and telephone surveys had the highest influence, with participants decreasing their usage by 528 kWh (6%) and 720 kWh (7%), respectively. The reduction in energy use resulting from SCE's mail-in surveys was smaller at 210 kWh (2%) and the online surveys led to the smallest reduction in energy use (53 kWh, or 1%, for the long online survey and no significant savings resulting from the short online survey).

[14] Five dummy variables were included to represent the various measure types installed through other EE programs (HVAC, Lighting, Refrigerator, Water Heater, and Other).

**Table 4.** Regression-based Estimates of First-Year Net per Participant HEES Impacts

| Utility | Delivery Method | Average Monthly Usage | | First-Year Net HEES Impacts | |
|---|---|---|---|---|---|
| | | Pre-HEES | Post-HEES[15] | kWh | % Savings |
| **PG&E** | Online | 841 | 811 | 316 | 3% |
| **SDG&E** | Online | 782 | 749 | 294 | 3% |
| **SCE[16]** | On-site | 791 | 724 | 528 | 6% |
| | Telephone | 930 | 874 | 720 | 7% |
| | Mail-In | 838 | 800 | 210 | 2% |
| | Long Online | 628 | 613 | 53 | 1% |
| | Short Online | 486 | 474 | 0 | 0% |
| | Average | 742 | 714 | 152 | 2% |

As the table above shows, the regression-based first-year net HEES impact estimates varied significantly by delivery method (for SCE, the only utility that had substantial enough populations across the delivery methods other than online). The evaluation team believes the increased savings from the on-site, telephone, and mail surveys are attributable to two inter-related factors. The first factor is that those taking the survey had above-average pre-HEES average monthly usage. The table above also shows that SCE customers who took the HEES survey via telephone had pre-HEES usage that was 50% larger than those who took the long online survey. Similarly, on-site and mail-in survey participants had pre-HEES usage that was 25% and 33% larger than the average long online survey respondent's usage, respectively. The second factor is the targeting that was done to drive customers to the on-site, telephone and mail surveys. These survey delivery methods were typically delivered to customers who either complained of high bills (and thus may have more incentive to take action to reduce their monthly bills) or marketed to customers with higher than average bills who likely had higher levels of achievable savings.

The table above also shows that savings from the online surveys (long online for SCE) were quite similar for PG&E and SDG&E, but significantly lower for SCE. Again, the evaluation team believes much of this difference can be attributed to the marketing done by SCE that drives higher usage customers to the mail, telephone or on-site delivery options. By proactively marketing the other delivery options to these customers they have effectively removed the high usage (and likely high savings) customers from the population of customers taking the online survey.

The PG&E regression based first-year net savings estimates are substantially higher than those found for PG&E for the 2006-08 program cycle. The revised 2006-08 evaluation report[17] estimated net HEES per participant savings (across the mail and online delivery methods offered) to be 31 kWh. As Table 4 shows, PG&E's first-year net savings per participant in 2010-12 was more than ten times this (316 kWh). While both the recommendation algorithms and the average of number of recommendations given per survey remained fairly consistent between the two program cycles for PG&E, there were a number of differences between the program cycles and the evaluation methods used which may have resulted in the differences in the estimated net program impacts. The primary difference between the two program cycle evaluations is the significantly different methods used to determine baseline usage. The 2006–08 model was a participant-only billing analysis, whereas the 2010-2012 used a PSM

[15] The difference between Pre- and Post-HEES average monthly usage includes both the independent HEES impact and the impact of EE participation.

[16] For the billing analysis, SCG participants were excluded since the billing analysis was an electrical billing model only.

[17] *Addendum to the Process Evaluation of the 2006-08 HEES program: Estimating Energy Savings Associated with the HEES Program, Net of Savings Attributed to other PG&E Programs (REVISED APRIL 13, 2011),* ECONorthwest, December 15, 2010.

matched non-participant sample to control for changes (weather, economy, etc.) unrelated to the HEES program. The evaluation team believes the matched non-participant billing analysis presented in this paper and used for the current evaluation cycle does a better job at controlling for external factors (such as weather, the economy, etc.) and thus results in more accurate results.

The evaluation estimates of SCE's HEES program net savings were closely aligned with the ex ante net HEES savings estimates[18] used by SCE within the 2010-12 program cycle to assign program impacts.[19] As shown in Table 5, the savings estimates for SCE mail–in surveys, the largest survey type in the 2010-12 program cycle, were nearly identical (ex ante estimate of 212 kWh per survey versus evaluation estimate of 210 kWh per survey). The evaluation savings estimates for the other survey types were all larger than SCE's ex ante estimates. Applying the evaluation savings estimates to the population of 2010-12 SCE HEES participants yields an overall net savings estimate that is 7% higher than the savings based on the ex ante estimates.

**Table 5.** Comparison of SCE Ex Ante and Evaluation per Unit Net Savings Estimates

| Survey Type | 2010-12 Participants | Ex Ante (kWh) | 2010-12 Estimate (kWh) |
|---|---|---|---|
| **On-site** | 3,550 | 314.7 | 528 |
| **Telephone** | 1,140 | 281.8 | 720 |
| **Mail-In** | 122,442 | 211.8 | 210 |
| **Online Long** | 64,501 | 36.7 | 53 |
| **Online Short** | 17,538 | 0 | 0 |

Table 6 below shows the first year regression-based net HEES impacts based on the evaluation findings. The overall HEES impact is nearly 65,000 MWh, of which more than 50% is currently not being claimed by the utilities (27,000 MWh generated by PG&E's participants and 5,600 MWh generated by SDG&E's participants are unclaimed).

**Table 6.** Regression-based Estimates of Overall First Year Net HEES Impacts

| Utility | Delivery Method | 2010-2012 Participants | 1st Year Net HEES Impacts (kWh) | Total MWh Savings | % of Statewide Net 1st Year Impacts |
|---|---|---|---|---|---|
| **PG&E** | Online | 86,255 | 316 | 27,257 | 42% |
| **SDG&E** | Online | 19,048 | 294 | 5,600 | 9% |
| **SCE** | On-site | 3,550 | 528 | 1,874 | 3% |
| | Telephone | 1,140 | 720 | 821 | 1% |
| | Mail-In | 122,442 | 210 | 25,713 | 40% |
| | Long Online | 64,501 | 53 | 3,419 | 5% |
| | Short Online | 17,538 | 0 | 0 | 0% |
| | Average | 209,171 | 152 | 31,827 | 49% |
| **Statewide** | Total | 314,474 | 206 | 64,683 | 100% |

.

[18] SCE's ex ante HEES savings estimates are based on work completed by John Peterson of Athens Research and are documented in a Memo titled *Memo on HEES 2004-2005 savings analysis: dated September 7, 2007.*

[19] SCE was the only IOU to claim program savings during the 2010-12 program cycle.

## Conclusions

- **Residential Audit Programs Produce non-incentivized savings** – The billing analysis conducted for this evaluation found significant savings from all of the IOUs residential audit programs. The results show that it is possible to quantify and attribute savings from these types of programs. This approach allows energy efficiency program administrators to confidently claim independent savings resulting from their residential audit programs.
- **Delivery Mode Effects Program Impacts** – The results of this evaluation showed how program delivery mode impacts program savings as a result of the customers they reach. Within this evaluation mail surveys, while likely having a higher implementation cost (due to the costs associated targeted customer list selection, survey printing and postage), were found to be an effective means of reaching high usage customers[20] and customers who are unaware or reluctant to participate in online programs[21]. At the same time, online surveys can reach large audiences (although likely biased towards customers interested in saving money or energy[22]) and are more likely to result in a customer's engagement with an ongoing real-time energy management tool.[23]
- **Advancements in Modeling Efforts** – This evaluation employed innovative modeling techniques not used in previous California evaluations of residential audit programs. The modeling advancements and the benefits they provide include the following:
  - **Propensity Score Matching (PSM)** - The billing analysis conducted as part of this evaluation was unique from past California modeling efforts in that it isolated the HEES program savings through careful development of a non-participant sample using PSM to control for self-selection bias. PSM allows for a quasi-experimental design to be employed (in the absence of true experimental design) that uses observable characteristics of program participants to select an appropriate nonparticipant sample that serve as the baseline from which to compute program impacts.
  - **Controlling for Incentive Induced Impacts from other EE Programs –** The data used to conduct the billing analysis for this evaluation lined up not only multiple years of HEES program tracking data, billing data, and weather data, it also included tracking data from all other utility energy efficiency programs. While inclusion of all this data for participants (and a large sample of non-participants) was a very data intensive approach, the evaluation team believes it was a necessary step to control for energy savings generated by other utility EE programs to avoid double counting these savings.
- **Self-Report Conclusions** – While the self-report analysis did not quantitatively estimate kWh savings resulting from HEES program participation, it did result in some valuable findings.
  - **Support of Billing Analysis Results** - Surveyed customers self-reported a high level of HEES program attribution for efficiency upgrades, which supports the billing analysis findings.
  - **Limiting of Recommendations not Necessary** - Customer-appropriate recommendations is more important than the number of recommendations received. Providing numerous recommendations to participants (for example, one IOU provided 28 recommendations on average compared to only 9 from the other two utilities) did not result in a significant

[20] HEES mail, telephone, and on-site surveys were often targeted to high usage or hard-to-reach customers. This analysis found mail survey participants pre-HEES program usage was 25% higher than the non-participant average.
[21] Mail survey participants frequently reported being unaware of the online option (> 2/3rd) or indicated a barrier, such as lack of internet access, reluctance to share personal information online, which kept them from completing the survey online
[22] This evaluation found long online survey participants pre-HEES usage was 5% lower than the non-participant average.
[23] Online participants were three times more likely to sign up to use utility energy consumption management tools.

reduction in the net recommendation implementation rate (for measures or practices) as long as the recommendations were appropriate.

- **Customers More Likely to Take Low-Cost EE Actions** - Low-cost or no-cost practice recommendations were implemented at higher rates than measure recommendations which required substantially more out of pocket investment.
- **Customers Motivated by Saving Money** - Saving money and high energy bills were reported as the largest motivational factors for taking the HEES survey (53% statewide).
- **High Levels of Program Satisfaction** - Participants reported high levels of satisfaction with the energy savings recommendations they received through HEES and the energy savings generated as a result of implementing these recommendations. (Online survey satisfaction was notably higher in both categories.)
  - Dissatisfaction with the HEES program stemmed mainly from the lack of noticeable energy bill savings and a complaint that HEES recommendations were too generic and/or needed to include more detailed information, such as pay-back period.

- **Smart Grid Enabled Program Participation** – The audit programs presented here led to moderately high levels of Smart Grid enabled program participation. Overall 15% (greater than 20% for online survey participants) of HEES participants surveyed reported signing up to receive energy alerts/budget notifications to assist them in managing their household energy consumption. Two-thirds of those who signed up for energy alerts stated they did so after completing the HEES survey.
- **Ongoing Engagement** – Many participants voiced their desire for follow-up activities post program participation to assist them in implementing recommendations they received through the program. As the California IOUs fully transition their residential audit programs to the next generation of these programs (focused around the online Universal Audit Tool), recommendations such as this should be more easily addressed through automation.

## References

ECONorthwest. 2010. *Appendix: HEES Add-On Impact Analysis* to the *Process Evaluation of the PG&E 2006-2008 Home Energy Efficiency Survey (HEES Program), Study ID: PGE0297.02 prepared for Pacific Gas and Electric, San Francisco, CA*. December 15. *http://www.calmac.org/publications/PG%26E_HEES_Process_Evaluation_Appendix.pdf*

Peterson, John. 2007. *Memo on HEES 2004-2005 Savings Analysis.* Athens Research. September 7.

Quantum Consulting. 2004. *National Energy Efficiency Best Practices Study. Volume R7 – Residential Audit Programs Best Practices Report.* California Best Practices Project Advisory Committee. December.