

Process Evaluation of the PG&E 2006 – 2008 Home Energy Efficiency Survey (HEES Program)

Appendix: HEES Add-On
Impact Analysis

Study ID: PGE0297.02

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TO: Genrick Gofman, Beatrice Mayo, Pacific Gas & Electric
FROM: Steve Grover
**SUBJECT: 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)***

INTRODUCTION

This memorandum presents analysis ECONorthwest conducted to estimate energy savings attributable to the 2006-08 PG&E Home Energy Efficiency Survey (HEES) Program. The analysis described below is an extension to the 2006-08 HEES analysis presented in the report *Process Evaluation of the PG&E 2006-08 Home Energy Efficiency Survey (HEES) Program*, submitted to PG&E on April 21, 2010. The purpose of this additional analysis is to develop HEES program impact estimates that exclude savings that were achieved by participating in other PG&E programs, as savings from these actions are already being counted in these other programs' impact evaluations. Note that the impact estimates presented here should only be used for the HEES program, or possibly a similar program that provides the same type of in-depth audit. These savings estimates should not be used for more general energy education programs that do not involve an extensive audit component.

For the previous HEES evaluation report, ECONorthwest conducted a two-stage analysis that combined billing regression analysis with a statistical regression model to estimate the portion of energy savings attributable to the HEES program. Specifically, the analysis was conducted as follows:

Stage 1: Billing Regression Model. The Stage 1 Billing Regression model utilized monthly consumption data for participants in the 2006-08 HEES program, with separate models for gas and electricity. A fixed effects panel data model was used that included monthly consumption data, weather data, a trend term, and variables controlling for monthly energy use in the period after participating in the HEES program. The estimated change in energy consumption between these periods is used as an estimate of gross impacts associated with the HEES program.¹

¹ Additional detail on the Stage 1 and Stage 2 modeling is included in the report *Process Evaluation of the PG&E 2006-08 Home Energy Efficiency Survey (HEES) Program*, submitted to PG&E on April 21, 2010.

Stage 2: Attribution Model. The Attribution model is a separate regression model that estimates the portion of the gross savings from Stage 1 that can be directly attributable to the HEES program. Phone survey data from a subset of HEES participants from Stage 1 were used to determine the influence that the HEES had on the respondent following through with individual recommendations.

A summary of our finding from the April 2010 report is as follows:

- Based on the billing analysis, HEES program participants reduced their electricity usage on average by 2.3 percent after their participation, representing the gross savings associated with the HEES program.
- HEES participants directly attributed 20 percent of electricity savings to the HEES program (a conservative estimate of net program savings).
- Using coincident factors developed from several California-based analyses of household electricity use, we estimate that a reduction of 0.02 to 0.10 kW is directly attributable to the HEES program.
- HEES program participants reduced their natural gas usage on average by 2.2 percent after their participation. This result, however, is not statistically significantly different from zero at the 95 percent level of confidence. We cannot, therefore, conclude with statistical confidence that natural gas savings were achieved for the overall program. HEES participants directly attributed 32 percent of that to the HEES program.

A summary of the final impact estimates from the April 2010 report are presented in Appendix A of this memo for reference.

The previous HEES impact evaluation developed impact estimates for all customers that participated in the HEES program, but did not account for the fact that some of these customers may have gone on to participate in other PG&E programs. In these cases, the resulting energy savings is already captured in the impact claims of the rebate programs. The extension of the impact analysis described below re-estimates the impacts of the HEES program by removing the effects of cross-program participation, thereby avoiding double counting of energy savings.

HEES participants that also participated in another PG&E residential program are coded as “overlaps” in the model, as any savings observed in the Stage 1 billing regression model may have been already captured in the impact estimates for these other programs. The 2006-08 PG&E residential programs we considered in determining which customers were overlaps are as follows:

- Mass Markets Residential (PGE2000)
- Residential New Construction (PGE2009)
- Association of Bay Area Governments ABAG Energy Watch (PGE2015)
- Association of Monterey Bay Area Governments Energy Watch (PGE2016)
- Bakersfield and Kern County Energy Watch (PGE2017)
- East Bay Energy Watch (PGE2020)

- Fresno Energy Watch (PGE2021)
- Local Government Energy Action Resources LGEAR (PGE2023)
- Madera Energy Watch (PGE2024)
- Marin County Energy Watch (PGE2025)
- Merced/Atwater Energy Watch (PGE2026)
- Motherload Energy Watch (PGE2027)
- Redwood Coast Energy Watch (PGE2028)
- San Francisco Energy Watch (PGE2029)
- South San Joaquin Energy Watch (PGE2030)
- Santa Barbara County Energy Watch (PGE2031)
- Sonoma County Energy Watch (PGE2032)
- Stockton Energy Watch (PGE2033)
- Silicon Valley Energy Watch (PGE2034)
- Silicon Valley Leadership Group Energy Watch (PGE2035)
- Right Lights (PGE2051)
- California New Homes Multifamily (PGE2059)

REVISED HEES IMPACT MODELING APPROACH

The ultimate purpose of the HEES program is to provide recommendations to households on measures and behaviors that may lead to reduced energy consumption. For many of the measures recommended through the HEES program, PG&E offers other programs that provide the measure to its customers at reduced cost (through rebates or financing). For those households that participated in the HEES program and acted on a HEES recommendation by purchasing and installing an energy efficient measure through another PG&E program, any energy savings associated with the installation of that measure will be attributed to the PG&E program through which the measure was obtained. The focus of this revised HEES modeling approach is to isolate that portion of savings that can be attributed to HEES and not already included in the savings claims for the programs listed at the beginning of this memorandum.

Although multiple variations in the billing regression and attribution models were explored, we ultimately found that revising the attribution model (while leaving the Stage 1 billing regression model unchanged from the previous analysis) yielded the most reasonable results. To accomplish this, we controlled for customers in the attribution model that also received a PG&E rebate through another program. The attribution model from the analysis presented in the April 2010 report is as follows:

$$\ln(kWhSave_i) = \beta_1 Acted_i + \varepsilon_i$$

$$\ln(ThermSave_i) = \alpha_1 Acted_i + v_i$$

Where :

kWhSave = Percent kWh savings between baseline and post - HEES period

ThermSave = Percent therm savings between baseline and post - HEES period

Acted = Percent of HEES recommendations household acted upon

i = index for household ($i = 1, \dots, n$)

$[\beta \alpha]$ = Coefficient to be estimated

$[\varepsilon v]$ = Error term assumed normally distributed

To control for the effect on savings from overlap participants, an additional variable was created for the revised attribution model. The additional variable is an indicator variable that equals 1 if the HEES participant also participated in another PG&E program and otherwise equals zero (the “overlap” variable). The revised attribution models for electricity and natural gas are as follows:

$$\ln(kWhSave_i) = \beta_1 Acted_i + \beta_2 Overlap + \varepsilon_i$$

$$\ln(ThermSave_i) = \alpha_1 Acted_i + \alpha_2 Overlap + v_i$$

Where :

kWhSave = Percent kWh savings between baseline and post - HEES period

ThermSave = Percent therm savings between baseline and post - HEES period

Acted = Percent of HEES recommendations household acted upon

Overlap = HEES participant received an EE measure through another PG & E program

i = index for household ($i = 1, \dots, n$)

$[\beta \alpha]$ = Coefficient to be estimated

$[\varepsilon v]$ = Error term assumed normally distributed

As in the original HEES analysis, the value of the coefficient on the *Acted* variable represents an estimate of attribution of savings to the HEES program. The value of the coefficient for the *Overlap* variable (which was not included in the specification of the attribution model in the original analysis) represents a measure of attribution likely claimed by PG&E through another residential efficiency program.

RESULTS OF THE REVISED ATTRIBUTION ANALYSIS

This section describes the results of the revised impact analysis described above. As with the earlier HEES analysis, the development of estimates of electricity and natural gas savings required a two-stage modeling approach that combined standard billing regression analysis with a statistical regression model to estimate the portion of energy savings attributable to the HEES program. For the revised analysis, the results of the Stage 1 billing regression are the same as was estimated for the earlier analysis. As described above, the difference between the original

and revised analyses lies in the specification of the second-stage attribution model. For the revised analysis, the attribution model includes an indicator variable for the HEES participants that went on to participate in another PG&E residential efficiency program.

Error! Reference source not found. shows the original and revised estimates of the proportion of electricity savings attributable to the HEES program based on the revised attribution model. For the original analysis, we estimated that about 20 percent of kWh savings experienced by HEES participants was attributable to the HEES program alone. For the revised analysis that excludes the effect of participation in other PG&E programs, the portion of the HEES kWh savings drops to 12.7 percent.

Table 1: Attribution of Electricity Savings to the HEES Program

Attribution Model	Elasticity (Portion of Savings Attributable to HEES Program)	Standard Error	Lower Bound (95% CI)	Upper Bound (95% CI)
Percent of Savings Attributed to HEES (April 2010 Report)	0.198	0.032	0.134	0.262
Percent of Savings Attributed to HEES (Revised Analysis)	0.127	.043	0.041	0.213

Source: ECONorthwest Analysis of HEES program data and customer billing data

Error! Reference source not found. shows the same information for natural gas savings. In the original HEES analysis, we estimated that about 31 percent of natural gas savings experienced by HEES participants was attributable to the HEES program, with the 95 percent confidence interval for the actual level of attribution ranges from 22 percent up to 40 percent. In the revised analysis, this rate drops to 24 percent of therm savings.

Table 2: Attribution of Natural Gas Savings to the HEES Program

Billing Regression Model	Elasticity (Portion of Savings Attributable to HEES Program)	Standard Error	Lower Bound (95% CI)	Upper Bound (95% CI)
Percent of Savings Attributed to HEES (April 2010 Report)	0.312	0.046	0.220	0.404
Percent of Savings Attributed to HEES (Revised Analysis)	0.24	0.047	0.146	0.334

Source: ECONorthwest Analysis of HEES program data and participant survey data

The final impact estimate for the HEES program is a combination of the change in energy consumption estimated by the Stage 1 Billing Regression and the results of the Stage 2 HEES Add-on Impact Analysis

Attribution model. Estimates of gross impacts are obtained from the Stage 1 Billing Regression model, which estimates changes in energy usage before and after HEES participation while controlling for weather and other factors. Note that since we had limited information on other factors that could be affecting energy use, we were only able to control for a few factors in the model using weather data and a general time trend variable. As a consequence, the estimate of gross impacts from the Stage 1 model should be interpreted as an upper bound.

The Attribution model provided an estimate of that portion of gross impacts that could reasonably be attributable to the HEES program. As discussed above, this was accomplished by including information on how influential the HEES program was on the respondent acting on individual recommendations (through the *Acted* variable) while controlling for the effect of participation in other PG&E efficiency programs (through the addition of the *Overlap* variable).

A comparison of the original and revised impact estimates is shown in Table 3. The gross impact of the HEES is 241 kWh annually per participating household, which is about 2 percent of average annual energy use for HEES participants. In the original analysis presented in the April 2010 report, we estimated the average annual net savings for a HEES participant of 48 kWh and 5 therms. In the revised analysis, the average net energy savings for a HEES participant drops to 30 kWh and 3.9 therms—a 36 percent drop in kWh savings and 23 percent drop in gas savings, relative to the earlier analysis. Using the same 36 percent reduction factor, the demand savings attributable to the HEES also drops from 0.02 kW to 0.01 kW for HEES participants.

As discussed above, the impact estimates presented here should only be used for the HEES program, or possibly a similar program that provides the same type of in-depth audit. These savings estimates should not be used for more general energy education programs that do not involve an extensive audit component.

Table 3: Comparison of Original and Revised HEES Impact Estimates

	Gross Savings (Per HEES Participant) (+/- 95% Confidence Interval)		Net Savings (Per HEES Participant) (+/- 95% Confidence Interval)	
	April 2010 Analysis	REVISED Analysis December 2010	April 2010 Analysis	REVISED Analysis December 2010
Electricity	241 (+/-147) kWh	241 (+/-147) kWh	48 (+/-15) kWh	31 (+/- 20.7) kWh
Demand	0.10 (+/-0.06) kW	0.10 (+/-0.06) kW	0.02 (+/-0.006) kW	0.013 (+/- 009) kW
Gas	15 (+/-19) therms	15 (+/-19) therms	4.7 (+/-1.4) therms	3.6 (+/- 1.4) therms

Source: ECONorthwest Analysis of HEES program data, participant billing data, and participant survey data

APPENDIX A: SUMMARY OF RESULTS FROM APRIL 2010 REPORT

Table 4 presents the gross and net savings estimates from the prior April 2010 evaluation along with a confidence interval for each impact estimate. In this earlier analysis using the same model structure, we estimated gross electricity savings per participant of 241 kWh and total electricity savings of 1.1 million kWh. We estimated net savings per participant of 48 kWh and total net savings for the HEES program of 218,000 kWh.

For demand, we estimated gross savings per participant of 0.10 kW and total demand savings of 470 kW. We estimated net demand savings of 0.02 kW per participant and total net demand savings of 93 kW.

For natural gas we estimated gross savings per participant of 15 therms and total demand savings of 7,363 therms. As noted above, we cannot conclude with a suitable level of statistical confidence that gas savings were achieved for the overall program. Nevertheless, we estimate net gas savings of 5 therms per participant and total net gas savings of 2,297 therms that are statistically significant.

Table 4: 2006-2008 HEES Program Savings Estimates (April 2010 Report)

	Gross Savings Estimates (+/- 95% Confidence Interval)		Net Savings Estimates (+/- 95% Confidence Interval)	
	Per 2006-2008 Participant	Total 2006-2008	Per 2006-2008 Participant	Total 2006-2008
Electricity	241 (+/-147) kWh	1,103,480 (+/-674,598) kWh	48 (+/-15) kWh	218,489 (+/-35,744) kWh
Demand	0.10 (+/-0.06) kW	470 (+/-287) kW	0.02 (+/-0.006) kW	93 (+/-15) kW
Gas	15 (+/-19) therms	7,363 (+/-9,185) therms	5 (+/-1.4) therms	2,297 (+/-705) therms

Source: ECONorthwest Analysis of HEES program data, participant billing data, and participant survey data