# The Impact of Home Electricity Reports

## Final Report

**Prepared for the Sacramento Municipal Utility District**

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# Executive Summary

This report presents evaluation findings on the impact of Home Electricity Reports on saving electricity for residential customers in the Sacramento Municipal Utility District (SMUD). The evaluation study was conducted by ADM Associates, Inc., as a quasi-experiment using a pre-test / post-test control group design spanning a 24-month period of observation. A treatment group of approximately 35,000 SMUD households received Home Electricity Reports that provided feedback on electricity consumption in the home compared to similar neighbors. The reports also provided tips on how each household could save electricity. A control group of approximately 49,000 households did not receive the Home Electricity Reports.

ADM used multiple, linear regressions in a billing analysis to estimate the overall savings in kilowatt hours (kWh) attributable to the Home Electricity Reports. The billing analysis also examined how kWh savings varied depending on the season and selected housing characteristics. We found that the Home Electricity Reports had an overall net impact of 1.9 percent kWh per day per household. This converted to an annual mean savings of approximately 213 kWh per household. Other key findings on the overall net impact of the Home Electricity Reports are displayed below. These findings list the percent savings for Home Electricity Report recipients, compared to the controls, relative to the base year and are ranked according to kWh saving. KWh savings are based on the estimated effects of the Home Electricity Reports and are annualized except for the estimates of seasonal impacts which pertain to the quarters in question (summer and winter).

- Homes with pools: 2.4% savings (363 kWh)
- Newer homes built between 1993 and 2001: 2.4% savings (294 kWh)
- Older homes built before 1978: 1.9% savings (196 kWh)
- Smaller homes with 1600 square feet or less: 2.0% savings (195 kWh)
- Gas homes: 1.8% savings (188 kWh)
- Larger homes with more than 1600 square feet: 1.4% (183 kWh)
- Electric homes: 1.2% savings (159 kWh)
- Summer quarter: 2.0% savings (63 kWh)
- Winter quarter: 2.1% savings (62 kWh)

ADM Associates, Inc., subsequently analyzed SMUD's Energy Use Survey to identify the energy efficiency changes made by Home Electricity Report recipients that were responsible for producing the observed energy savings. In addition, we also conducted our own telephone survey with Home Electricity Report recipients who had been documented to be substantial energy savers during the pilot program year. We found that the energy efficiency changes implemented by report users that had an impact on energy savings were primarily behavioral as opposed to

equipment changes. The most common kinds of behavioral changes cited by the high energy savers included the following:

- Turning off lights in unoccupied rooms;
- Setting thermostats to save energy;
- Using alternatives to electrical power like washing dishes by hand or not using electrical power when there were alternatives, like sleeping without air conditioning or turning off the AC when away from home or turning off the outside lights after going to bed;
- Reducing air conditioning costs by using fans;
- Keeping out the sun's heat; and
- Unplugging stereos and other small electronic appliances (including personal computers) when not in use.

The energy efficiency changes identified from the telephone survey are summarized in Table ES-1 on the next page. We found that *the majority of changes -- approximately 57 percent – were behavioral in nature*. Major investments in energy saving products and services (e.g., purchasing Energy Star-rated major appliances) accounted for a little over 29 percent of the changes made by report users. Low-cost investments in energy efficient products (e.g., purchasing CFLs) accounted for only about 12 percent of the energy saving changes reported by users and approximately two percent of the changes involved both behavioral responses and investments of money.

Recycling old refrigerators and freezers was found to have a large potential impact on saving energy. However, it was practiced by only about 11 percent of the Home Electricity Report users.

The final question addressed by the evaluation was whether dual participation in other SMUD energy conservation programs contributed to the observed kWh savings attributable to the Home Electricity Reports. We found that *about one quarter of the savings attributed to the Home Electricity Reports can be accounted for by the financial support provided by SMUD's rebate and financing programs designed to help residential customers purchase energy efficient products and services.* We also found that a greater proportion of Home Electricity Report recipients (4.9% vs. 4.4%) became involved in the SMUD rebate and financing program compared to control households, perhaps as a way to support the implementation of energy efficiency changes that may have been prompted by the information contained in the Home Electricity Reports. The latter interpretation, however, is an area where further research is needed. Thus, exposure to the Home Electricity Reports appears to have had a positive influence on participation in the SMUD rebate and financing program, but further research is needed to

clarify this finding.

*Table ES-1. Energy Saving Changes Made by Users of the Home Electricity Reports*

| Home Energy Efficiency Change | Category | N | % |
|---|---|---|---|
| Turn off lights in unoccupied rooms | Behavioral | 23 | 12.43 |
| Set your thermostat for comfort and savings | Behavioral | 19 | 10.27 |
| Switch to compact fluorescent light bulbs (CFLs) | Low Cost | 17 | 9.19 |
| Other changes | Behavioral | 14 | 7.57 |
| Reduce air conditioning costs by using fans | Behavioral | 12 | 6.49 |
| Buy ENERGY STAR | Investment | 11 | 5.95 |
| Keep out the sun's heat | Behavioral | 7 | 3.78 |
| Choose an efficient refrigerator | Investment | 7 | 3.78 |
| Install a ceiling fan | Investment | 6 | 3.24 |
| Choose an efficient dishwasher | Investment | 6 | 3.24 |
| Unplug stereos and other devices when not in use | Behavioral | 4 | 2.16 |
| Choose efficient windows | Investment | 4 | 2.16 |
| Reduce pool pump run time | Behavioral | 4 | 2.16 |
| Be smart about clothes washing | Behavioral | 4 | 2.16 |
| Choose an efficient clothes washer | Investment | 4 | 2.16 |
| Improve shading for windows | Behavioral | 3 | 1.62 |
| Upgrade your central air conditioner | Investment | 3 | 1.62 |
| Choose a laptop computer instead of a desktop computer | Investment | 3 | 1.62 |
| Use and switch off power strips | Both | 3 | 1.62 |
| Use clothes dryer efficiently | Behavioral | 3 | 1.62 |
| Stay cool and save with a whole house fan | Investment | 3 | 1.62 |
| Shade coverings and awnings | Behavioral | 3 | 1.62 |
| Hang laundry to dry | Low Cost | 2 | 1.08 |
| Recycle your second refrigerator | Behavioral | 2 | 1.08 |
| Weather strip windows and doors | Low Cost | 2 | 1.08 |
| Reduce water heater temperature | Behavioral | 2 | 1.08 |
| Install sun screens | Investment | 2 | 1.08 |
| Improve insulation | Investment | 1 | 0.54 |
| Seal leaky ducts | Investment | 1 | 0.54 |
| Maintain your air conditioner | Investment | 1 | 0.54 |
| Use indoor light timers and sensors | Investment | 1 | 0.54 |
| Be smart about dishwashing | Behavioral | 1 | 0.54 |
| Choose an efficient television | Investment | 1 | 0.54 |
| Use solar power | Investment | 1 | 0.54 |
| Install efficient showerheads | Low Cost | 1 | 0.54 |
| Set refrigerator temperature wisely | Behavioral | 1 | 0.54 |
| Make sure refrigerator seals are tight | Both | 1 | 0.54 |
| Use solar outdoor lights | Investment | 1 | 0.54 |
| Seal air leaks | Investment | 1 | 0.54 |

ADM made two recommendations for program improvement. The first program improvement recommendation was to promote refrigerator recycling which is a high-impact energy efficiency activity that may be under-utilized. The second program improvement recommendation was to focus on education and energy efficiency promotions of various kinds – free home energy efficiency audits and activities to promote behavioral changes and low-cost energy efficiency

solutions – targeted to senior citizens, low energy users, busy and cost-conscious families, and renters.

Following a critique of certain aspects of the Home Energy Program Evaluation, ADM made the following recommendations for improving future SMUD evaluations of energy conservation programs:

- Where the population kWh distribution is skewed, select a stratified random sample based on applications of the Dalenius-Hodges method or a similar technique.
- Implement the evaluation concurrently with the program so that the evaluation contractor can collaborate with program planners in a timely fashion, particularly in the interest of collecting longitudinal data.
- Always collect unique ID codes from respondents at each point of data collection to enable the linking of data collection forms.
- Use detailed instructions that are appropriately differentiated for different study groups so that respondents provide data specific to SMUD's monitoring and evaluation interests.
- Write survey items with adequate detail that clearly describe the phenomena of interest.
- Develop longer surveys that adequately measure all domains of interest. Use survey blueprints to design and evaluate the item structure of a proposed survey.
- Consider the use of a telephone interview procedure as an alternative to a mail survey as a way of reducing selection bias when interest in the topic is likely to influence the decision to complete and return a mail questionnaire, as well as when education and age levels are also likely to influence self-selection into the survey sample.
- Consider the use of incentives and follow-up procedures for increasing survey response rates.

ADM suggested some directions for further research that would attempt to tie up some loose ends from the present study in terms of identifying additional factors that account for more of the observed savings and that would expand the scope of the present study by being able to discriminate between energy savers and non-savers, and identify factors that predict persistence in energy conservation.

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# Chapter 1: Introduction

## Background

The Sacramento Municipal Utility District (SMUD) implemented the Home Electricity Report pilot program from April, 2008, through March, 2009, to help residential customers reduce their electricity consumption. Participating customers received "Home Electricity Reports" on a monthly or quarterly basis over the course of the pilot year. The reports were designed to motivate and educate recipients to take actions to improve their home energy efficiency. These reports were designed with three key components:

- The home's electricity use (measured in kWh) for the previous month (or quarter) was compared to a group of "neighbors" in 100 nearby homes that were similar in square footage. Comparisons were also made with the 20 most efficient neighbors from that group. A report narrative interpreted the data for the customer in normative terms.

- Similar comparisons were made of the home's electricity use for the current reporting period relative to the same time the prior year. Customers were awarded green stars when their current level of usage was less than last year's level of electricity use. These annual comparisons were tracked by month – and green stars displayed, or not, for each month -- over the course of the pilot program year.

- Three action steps, or tips, for saving energy were provided in each report. The energy saving tips involved a combination of suggestions for behavior change as well as energy efficiency purchases that could be made to reduce electricity consumption.

Appendix A contains a sample Home Electricity Report.

### *The Evaluation Design*

SMUD contracted with ADM Associates, Inc., to provide an independent, third-party evaluation of the Home Electricity Report pilot, specifically to determine kWh savings attributable to the program. The study was conducted as a quasi-experiment using a pre-test / post-test control group design spanning a 24-month period of observation. The year before the pilot program – April 2007 through March 2008 – constituted the pre-test period and the year of the pilot program – April 2008 through March 2009 – constituted the post-test period of observation.

### *Selection of Treatment and Control Groups*

The Home Electricity Report pilot program was set up by SMUD and its implementation contractor – Positive Energy – with treatment and control groups to enable a scientifically valid impact evaluation to be carried out. Positive Energy (PE) assigned households from SMUD's customer database to treatment and control groups using the following methodology.

- PE selected 85 census tracts from the SMUD service territory that were geo-codable and had a high density of single-family homes with addresses that could be verified with the county assessor's office.

- Additional criteria were applied to households in these census tracts for a house to be eligible for inclusion in the study as either a test or control site. This resulted in the identification of approximately 84,000 residential homes as a consequence of applying the following criteria:

    1. A household must be on one of the primary meter read cycles for that census tract.

    2. A household must have a current, active account with SMUD.

    3. A household must be residential and not an apartment building.

    4. A household must have a square footage value between 250 and 99,998.

    5. A household's first bill date must be at last 12 months prior to the start of the pilot program.

Groups of contiguous census blocks (groups of 50-200 homes) were then randomly assigned to either the treatment or control group. The process was to first randomly assign a census "block batch" of five contiguous census blocks to the treatment group and then randomly assign a contiguous census "block batch" to the control group. This process continued until approximately 35,000 residential homes had been assigned to the treatment group and 35,000 homes had been assigned to the control group. The remaining census blocks and 14,000 homes were then also assigned to the control group.

The logic for using the contiguous "block batch" method of random assignment was PE's "network effects" hypothesis. This untested hypothesis asserts that "energy savings could be higher if an entire community is engaged rather than individual households."[1] That is, PE believed that a synergy effect would increase energy savings because of increased communication among people in the same community who received Home Electricity Reports.

***The Question of Sample Selection Bias***

The block batch method of group assignment actually produced a quasi-experiment rather than a truly randomized experiment, because the method of assigning groups to treatment and control conditions was not strictly random. This design limitation heightens the importance of statistical control through covariate analysis. However, with samples as large as those in the present study,[2]

[1] Personal communication with, and documents supplied by, Tyler Curtis of Positive Energy on April 30, 2009.

[2] ADM used a panel analysis approach in which each of the approximately 84,000 households was observed across 24 months. This data file contained an excess of 1.8 million observations.

even very small between-group differences can be statistically significant. The important question, however, is whether any initial between-group differences are of substantive significance. As shown in Table 1-1, all of the observed between-group differences in the year prior to the program are very small and although statistically significant, none appear to have any substantive ramifications. The initial between-group differences in energy consumption was on the order of 0.4 kWh per day (i.e., 0.37 to be exact) which is a trivial difference and amounts to control group households leaving a 100-Watt light bulb on for about four hours longer than treatment group households over the course of 12 months.

*Table 1-1. Treatment and Control Group Differences in Household Characteristics During the Year Prior to the Home Electricity Report Pilot*

| **Household Characteristic** | **Treatment Group Mean** | **Control Group Mean** | **T-C Difference** |
|---|---|---|---|
| Age in Years | 36.72 | 37.99 | -1.27 |
| Square Feet | 1723.67 | 1737.14 | -13.47 |
| % Electric Accounts | 26.05 | 24.53 | 1.52 |
| kWh per Day | 30.65 | 31.02 | -0.37 |

While the differences shown in Table 1-1 suggest that the study data were slightly biased in favor of the treatment group on three of the four measured characteristics, all of these differences appear to be rather trivial and lacking in substantive significance. However, we will return to this issue at the end of the report in drawing conclusions about the impact of the Home Electricity Reports.

## General Approach

The research questions addressed by ADM Associates, Inc., in the evaluation of the Home Electricity Report pilot program were as follows:

1. What is the overall kWh savings attributable to the Home Electricity Report program?

2. How do kWh savings vary depending on season and selected housing characteristics?

3. What kinds of energy efficiency changes made by customers are responsible for producing the observed energy savings?

4. What percentage of the home energy efficiency changes made by Home Electricity Report recipients are behavioral versus physical equipment changes?

5. Does participation in other SMUD energy conservation programs contribute to the observed kWh savings?

ADM Associates, Inc.'s, general approach was to use a billing analysis to answer research questions 1 and 2. We approached research questions 3 and 4 through an analysis of SMUD's Energy Use Survey and by conducting a telephone survey follow-up with treatment group customers who were found to have been significant energy savers during the pilot year. Finally, we answered research question 5 through additional billing analyses involving households that had participated in SMUD's rebate and financing program and by analyzing their participation in this program over the study's 24-month period of observation. Thumbnail sketches of each of these four research methods are summarized below.

***Billing Analysis***

Billing records for the Home Electricity Report recipients were compared with those of similar customers who did not receive the reports – before and after the pilot program period -- to estimate energy savings attributable to having received the Home Electricity Reports. This billing analysis was carried out for treatment and control group customers[3] over a 24-month period -- 12 months prior to the program and during the 12 months of the pilot program – using multiple regression analysis in a General Linear Model (GLM) framework. The GLM analysis spanned the 24 months from April 2007 to March 2009. Analyses were subset by the two methods of distributing Home Electricity Reports: monthly or quarterly.[4] The analysis statistically controlled for selected housing characteristics, billing time period, and weather conditions over time.

The influence of selected housing characteristics on home energy consumption – home size, the "vintage" of a home, its primary heating source (gas or electricity), and the presence of a pool – were examined in subset analyses as were seasonal differences on residential kWh consumption.

***Analysis of SMUD's Mail Survey***

Following the billing analysis, ADM analyzed data from SMUD's Energy Use Survey. This survey was distributed by mail and made available online to 5,000 Home Electricity Report recipients and 5,000 control group members. Based on responses to 16 items in question 5 of the survey, we attempted to identify energy saving changes made by treatment and control group members. The 16 survey items are listed below in a checklist response format:

[3] Approximately 35,000 SMUD customers were assigned to the Home Electricity Report treatment group and over 49,000 SMUD customers were assigned to a control group for this study.

[4] Positive Energy assigned treatment group homes to monthly or quarterly report distribution based on their average daily kWh usage in the year prior the program. Lower energy use homes – those below 21.86 kWh per day – were assigned to the quarterly group. Approximately 25,000 pilot program participants received the Home Electricity Report monthly and approximately 10,000 received it quarterly. The decision on the number of homes to assign to monthly or quarterly reports was based on cost considerations related to maximizing report distribution given budget constraints. Thus, *Home Electricity Report distribution frequency was confounded with prior energy use levels.*

❑ 1 Adjusted my thermostat to save energy and costs
❑ 2 Added or improved insulation in attic, walls, pipes, or water heater
❑ 3 Added weather-stripping to doors or windows
❑ 4 Replaced old windows with more energy efficient windows
❑ 5 Replaced caulking on windows
❑ 6 Replaced standard incandescent light bulbs with CFLs (compact fluorescent light bulbs)
❑ 7 Installed a low-flow shower head
❑ 8 Planted a tree to shade my home
❑ 9 Had my heater and/or air conditioner serviced
❑ 10 Replaced my heater or air conditioner
❑ 11 Replaced an appliance with an Energy Star ® appliance
❑ 12 Removed or unplugged a secondary refrigerator or freezer (such as one in the garage)
❑ 13 Installed shade screens
❑ 14 Installed a whole-house fan
❑ 15 Unplugged small appliances when not in use
❑ 16 Turned off computer or other electronics when not in use

We hoped that the SMUD survey would allow us to expand our billing analysis to help explain energy use outcomes in terms of changes in customer behavior attributable to receipt of Home Electricity Reports versus normal replacement of equipment.

***Telephone Survey***

We drew a random sample of 300 treatment group households that were determined to be in the third quartile of savings during the pilot program year.[5] From this sampling frame, we contacted 278 homes in order to achieve our target of 75 completed interviews (we actually completed 78 interviews). The purpose of these telephone interviews was to find out (a) the extent to which customers remembered receiving the Home Electricity Reports, (b) whether they made energy saving changes in response to the information contained in the reports; and if so, what kinds of changes they made; and (c) if not, why not.

***The Influence of SMUD's Rebate and Financing Program***

ADM received a data set from SMUD that documented the participation of treatment and control group customers in the SMUD rebate and financing programs. We merged this data set into the panel dataset we had developed for the billing analyses. Our analysis objective was to determine the contribution that participation in the SMUD rebate and financing programs had on energy savings attributed to the Home Electricity Report program. This was accomplished by running the GLM regression model with and without households that participated in the rebate and

[5] Home Electricity Report recipient households in the 75$^{th}$ to 95$^{th}$ percentile of savings in the post-test period were estimated to have saved between 12 to 36 kWh per day on average.

financing programs, and then determining whether participation rates for the rebate and financing programs had changed differentially over time for the treatment and control groups.

If participation in SMUD's rebate and financing program contributed to the impact of the Home Electricity Reports, then we should see the savings estimate drop when the regression is run without the SMUD Rebate and Finance Program participants.

If the Home Electricity Reports were driving customers into the rebate and financing program as a means of subsidizing energy saving changes that customers might have decided to implement because of information contained in the Home Electricity Reports, then we would expect to see an increase in the rate of participation in the SMUD Rebate and Finance program over time among treatment group households, relative to control group households.

# Chapter 2: The Billing Analysis

*(What is the amount of overall savings that are attributable to the Home Electricity Reports? How do kWh savings vary depending on seasonal and selected housing characteristics?)*

SMUD's monthly billing records over a 24-month period[6] provided customer data on household energy consumption in kWh. This data was analyzed in order to answer the two, above-mentioned evaluation questions.

We first cleaned the database as necessary and created new variables needed for the desired analyses. Customers were deleted from the analysis file if, during the 24-month observation period, they:

- Opted out of the Home Electricity Report pilot program;
- Moved out of their homes;
- Their SMUD account became inactive; or
- They had zero or negative kWh entries.

## ADM's Approach to the Impact Analysis

In order to effectively model the impact of the Home Electricity Reports, it was necessary to show that the treatment and control groups responded differently during the post-test period. The differential response of the two groups during the post-test period required the use of interaction terms. In ADM's regression approach, the interaction term called PARTPOST was created to measure the Home Electricity Report treatment effect. PARTPOST was the product of two dummy variables: PART_NON (the treatment-control group indicator variable) and POST (the indicator variable for the billing period, coded 1 if energy consumption was during the post-test period and 0 if during the pre-test period). PARTPOST not only measured the differential energy consumption response of the treatment and control groups as a function of exposure to the Home Electricity Reports but it also accounted for the initial differences in energy consumption between the treatment and control groups.

We expected to see an effect of the Home Electricity Reports in terms of how customers responded to changes in the weather. Interaction terms were required to model such weather-related effects. We first created weather indexes to measure cooling degree days (CDD) and heating degree days (HDD) for the Sacramento area over the 24 months of the study referenced

[6] The pre-test period consisted of the 12 months spanning April 2007 through March 2008, the year prior to the launch of the Home Electricity Report program. The post-test period consisted of the 12 months spanning April 2008 through March 2009, the year of the Home Electricity Report pilot.

to 65 degrees. We then developed two control variables to capture differential changes in our weather indexes as a function of time period: POSTCDD and POSTHDD. Of substantive interest, however, was whether the treatment and control groups responded differently to changes in the weather. These interaction terms were represented by TREATHDD and TREATCDD. The TREATHDD variable measured the extent to which SMUD customers receiving the Home Electricity Reports consumed energy differently than the control customers in response to *increasingly cold weather*. Conversely, TREATCDD measured the extent to which SMUD customers receiving the Home Electricity Reports used energy differently than the control customers in response to *increasingly hot weather*. Our ultimate interest, however, was on the two, 3-way interactions: HDD_3WAY and CDD_3WAY. These two interaction terms captured the impact of the Home Electricity Reports by measuring the extent to which the treatment and control groups had different energy responses during the post-test year in response to changes in weather.

In SAS, the GLM procedure uses the method of least squares to fit general linear models using multiple regression analysis and allows the specification of any degree of interaction effects, including continuous-by-class effects. The 2-way and 3-way interactions we wanted to specify involved the crossing of the categorical with the categorical variables and the categorical with the continuous variables, which can be accomplished through the General Linear Model. Furthermore, the GLM procedure in SAS allows us to "absorb" the idiosyncratic influences of household sites and adjust out covariates that are not involved in estimating the interaction effects of interest. The absorb feature of the GLM allowed us to account for a substantially greater proportion of the variance in the dependent variable than would otherwise have been possible. Table 2-1 below identifies the set of predictors that were entered in ADM's regression GLM.

*Table 2-1. Predictor Variables in ADM's GLM Regression Model*

| Variable Name | Variable Definition | Measurement Scale |
|---|---|---|
| CONT_ACC | Customer contract account number | Continuous variable |
| PART_NON | Treatment or control group indicator (1=HERS participant, 0 = Control) | Dummy variable |
| CDD | Cooling degree days referenced to 65°F | Continuous variable |
| HDD | Heating degree days referenced to 65°F | Continuous variable |
| VINTAGE | Age of house in years since 2009 | Continuous variable |
| SQFTHW | Square footage of a house | Continuous variable |
| ELEC_GAS | Gas or electric heated home (1 = electric, 0 = gas) | Dummy variable |
| POOL | House has a pool (1 = pool, 0 = no pool) | Dummy variable |
| POST | Billing period: pre- or post-year (1 = pilot test year, 0 = year before pilot test) | Dummy variable |
| PARTPOST | Interaction of group membership and billing period | Dummy variable |
| POSTHDD | Interaction of billing period & HDD | Continuous variable |
| POSTCDD | Interaction of billing period & CDD | Continuous variable |
| TREATHDD | Interaction of group membership & HDD | Continuous variable |
| TREATCDD | Interaction of group membership & CDD | Continuous variable |
| HDD_3WAY | Interaction of group, period, & HDD | Continuous variable |
| CDD_3WAY | Interaction of group, period, & CDD | Continuous variable |

The housing characteristics in Table 2-1 served primarily as statistical control variables in the analysis. Our main interest was in the effect of the treatment/control group indicator variable and its interaction with the billing period (*PARTPOST*), and the three-way interactions with weather conditions (*CDD_3WAY* and *HDD_3WAY*). If the Home Electricity Reports were effective, then we would expect to see statistically significant *negative regression coefficients* for:

- PARTPOST, meaning that households receiving the reports used less energy on the average in the pilot year than households that did not get the reports;
- HDD_3WAY, meaning that households receiving the reports used less energy on the average in the pilot year as the weather got colder than households that did not get the reports;
- CDD_3WAY, meaning that households used less energy on the average in the pilot year as the weather got hotter than households that did not get the reports;

The ADM regression GLM was run on the full sample, as well as for a number of subset samples, the results of which are reported below. The dependent variable in all analyses was mean kWh per day, per household. Savings were calculated by fitting a regression model involving the three parameters of primary interest (PARTPOST, HDD_3WAY, and CDD_3WAY). If any of the regression coefficients for these three parameters failed to reach statistical significance at the 85 percent level of confidence or better (i.e., $p<.15$), then that parameter was omitted from the effect estimate – the numerator of the savings calculation. Effects were calculated for a range of weather conditions, using weather data for the pre-test

year, the post-test year, and for the 24-month period of observation. *The savings reported are based on effects calculated for weather in the base year. The logic here is that we want to estimate the effect of the program, holding weather constant; that is, program effects in the absence of weather change.*[7] The denominator for the savings calculation was the mean base year energy consumption per day (measured in kWh) for treatment group households for the set of households in the model tested. See the illustration in Appendix B for further details.

## Results of the Billing Analysis

The models estimated in the billing analysis included the following:

- Overall program effect
- Effects for "monthly" reports and "quarterly" reports
- Effects for the summer and winter quarters
- Effects for electric homes and gas homes
- Effects for size of homes
- Effects for Title 24 vintages
- Effects for homes with pools

***Overall Program Effects and the Effect of Report Frequency***

ADM concluded that the overall kWh savings per day achieved by SMUD households that received home energy reports was 1.9 percent on average.[8] Appendix B shows the computation of this effect. In the overall effect model, all three parameters of theoretical significance were statistically significant. That is, the intercept term (i.e. the variable PARTPOST) was statistically significant as were both of the three-way interaction terms (i.e., the variables HDD_3way and CDD_3way). This pattern of overall effects suggests that the Home Electricity Report recipients made changes to conserve energy that were both weather-related and non-weather-related. The average net savings of 1.9 percent converts to an annualized savings of approximately 213 kWh

[7] In the 28 models developed, savings estimates vary from no difference in the estimates to one-tenth of one percent difference in two-thirds of the weather periods examined, and by no difference to two-tenths of one percent difference in 90 percent of the weather periods observed.

[8] The computed savings is -0.0187 which converts to 1.9% rounded to one decimal in percentage terms.

per household.[9] The overall effects model accounted for 75 percent of the variance in household energy consumption.

***Quarterly vs. Monthly Report Groups***

As documented in footnote 4, Home Electricity Report frequency – monthly vs. quarterly reports -- is confounded with pre-program levels of energy use. This is a result of Positive Energy assigning lower energy users to the quarterly report group and higher energy users to the monthly report group.[10] Because treatment group members were not randomly assigned to report frequency subgroups, the interpretation of monthly or quarterly effects is not straight forward.

The strong relationship (r = -.54) between prior energy use and report frequency categories indicates that quarterly report recipients started off as more conservative energy users. In fact, quarterly report recipients started off using 21 kWh less per day, on average, compared to monthly report recipients. Thus, findings about energy savings related to reporting frequency are also relationships with unknown factors associated with levels of prior energy use. For these reasons, the interpretation of reporting frequency effects is unclear. Consequently, *we emphasize findings related to overall effects in this report*.

***Non-Additive Models***

The subset models measure the effects of the Home Electricity Reports for subgroups of report recipients compared to a control group in that subset of customers. Alternatively, the overall model looks at the effect of the Home Electricity Reports on all report recipients compared to a control group. There is no inherent expectation that the average of any set of subset effects should be equivalent to the overall effect. The subset models simply measure effects for different subsets of SMUD customers.

Following from the point that the subset models simply measure the effects of different sets of SMUD customers, it is also the case that some subset models show larger effects than the overall effects model. This is the case, for example, with smaller homes, for homes built between 1993 and 2001, for homes with pools, and for both summer and winter quarter effects.

Appendix C shows the regression results for each model presented from the billing analysis.

***Seasonal Effects***

Seasonal savings effects were estimated for the summer and winter calendar quarters in terms of overall Home Electricity Report effects. Overall summer savings were estimated by applying the results of the overall model to the three-month summer season using June, July and August of

[9] The overall effect is -0.572 kWh per day, which, annualized, is a savings of 209 kWh per household. The annualized estimate of 213 kWh is based on rounding the savings estimate of 1.87 percent to 1.9 percent.

[10] Approximately 71 percent of the customers were assigned to the monthly group by Positive Energy, and 29 percent to the quarterly group.

2007, as the summer pre-test period and June, July and August of 2008, as the summer post-test period. Overall winter savings were estimated in the same way except that we used the three contiguous months of December, 2007, through February, 2008, as the winter pre-test period. December, 2008, through February, 2009, was the winter post-test period. The results presented in Table 2-2 show an overall summer savings effect of 2.0 percent and an overall winter savings effect of 2.1 percent. The resulting kWh savings for the summer and winter quarters are in the range of 62-63 kWh each.

*Table 2-2. Home Electricity Report Impacts for Summer and Winter Quarters*

| Model Effect | % Savings | kWh Savings | R Sq[11] | Comments |
|---|---|---|---|---|
| Summer Quarter | 2.0 | 63 | .75 | Savings are weather- & non-weather-related |
| Winter Quarter | 2.1 | 62 | .73 | Savings are weather- & non-weather-related |

The effects for the two quarters were almost identical: a savings of .682 kWh per day in the summer and a savings of .683 kWh per day in the winter. Summer and winter differences in base period consumption and in the number of days in each quarter affected the outcomes as expressed in percentage and absolute kWh terms. The winter savings percentage is slightly higher than the summer savings percentage because of differences in base year consumption (the summer base period consumption was 34.0 kWh while the winter base period consumption was 32.9 k). Conversely, the summer quarter kWh savings are slightly higher because there are more days in the summer quarter compared to the winter quarter (i.e., 92 days vs. 90 days).

### *Effects for Gas and Electric Homes*

Approximately 25 percent of the SMUD customer homes in the Home Electricity Report evaluation sample were electric accounts while approximately 75 percent were gas accounts. ADM separately estimated the overall impact of receiving the Home Electricity Reports for the subset of homes with electric accounts and also for the subset of homes with gas accounts. The results are displayed in Table 2-3.

*Table 2-3. Home Electricity Report Impacts for Residential Gas and Electric Accounts*

| Model Effect | % Savings | kWh Savings | R Sq | Comments |
|---|---|---|---|---|
| Gas: Overall Effect | 1.8 | 188 | .80 | Savings are weather- & non-weather-related |
| Electric: Overall Effect | 1.2 | 159 | .71 | Savings are not weather-related |

The overall effect of the Home Electricity Reports on gas homes was a net savings of .516 kWh per day and an overall net savings of 1.8 percent. Annualized, this was an average savings of 188 kWh for customers with gas accounts compared to the control group. For customers with electric

[11] The R-Squared statistic indicates the percentage of the variance in the dependent variable – kWh per day per household – accounted for by the model tested.

accounts, the overall effect of the Home Electricity Reports was a net savings of .436 kWh per day and an overall net savings of 1.2 percent. Annualized, this was an average savings of 159 kWh for customers with electric accounts compared to the control group. Savings percentages were affected by substantial differences in base year energy consumption, with electric accounts consuming 36.8 kWh per day on the average compared to gas powered homes which consumed 28.5 kWh per day on the average in the base year.

Savings for customers with gas accounts were due to both weather-related and non-weather-related actions. Savings for customers with electric accounts were generally not weather-related.

### *Effects for Size of Home*

SMUD customer homes in the Home Electricity Report Evaluation sample ranged from those with less than 1,300 square feet (the bottom quartile) to those in excess of 2,000 square feet (the top quartile). Most homes fell in the 1,100 to 2,300 square foot range, with a number of larger homes ranging over 7,000 square feet in size. The median house size distribution for SMUD customer homes in the evaluation study sample was approximately 1,600 square feet.

ADM looked at whether receipt of Home Electricity Reports resulted in differential savings effects based on house size. In short, we estimated the overall effect of the Home Electricity Reports for homes above the median in square footage and for those at, or below the median. The results are summarized in Table 2-4.

*Table 2-4. Home Electricity Report Impacts for Larger and Smaller Homes*

| Model Effect | % Savings | kWh Savings | R Sq | Comments |
|---|---|---|---|---|
| Above Median | 1.4 | 183 | .75 | Savings are weather-related only |
| At or Below Median | 2.0 | 195 | .72 | Savings are weather- & non-weather-related |

As one might expect, customers with smaller homes realized greater net energy savings compared to customers in larger homes. As shown in Table 2-4, Home Electricity Report recipients in homes at, or below the median in square footage were able to realize a net savings of 2 percent. The effect of the Home Electricity Reports on these smaller homes was an average savings of .535 kWh per day which equates to an annualized savings of 195 kWh. Home Electricity Report recipients in the larger homes (i.e., above the median in square footage) realized a net savings of only 1.4 percent on average despite a similar savings effect of .501 kWh per day. The lower savings percentage of the larger homes was adversely affected by their higher rates of energy consumption in the base year relative to the smaller homes (i.e. 35 kWh per day on the average for homes above the median square footage compared to 26.5 for the smaller homes).

The savings of Home Electricity Report recipients in the smaller homes were both weather-related and non-weather-related. Recipients in the larger homes realized their savings primarily by making weather-related changes.

### *Effects for Title 24 Vintages*

Homes vary in their energy efficiency characteristics, in part, based on the building codes that are in force at the time that a home is built. California began issuing building code regulations under Title 24 beginning in 1978. Since that time, three major revisions to residential building codes have been issued: in 1993, in 2002, and most recently in 2006. Thus, five historical periods can be identified that mark different sets of Title 24 building codes governing the construction of new homes. These home "vintages" can be categorized as follows:

- Before 1978: no Title 24 building codes (55% of SMUD territory homes)
- 1978-1992: first Title 24 building codes issued (37% of SMUD territory homes)
- 1993-2001: new Title 24 building codes issued (6% of SMUD homes)
- 2002-2005: new Title 24 building codes issued (2% of SMUD homes)
- 2006-2007: latest revisions to the Title 24 building codes (<1% of SMUD homes)

ADM examined whether receipt of the Home Electricity Reports had differential impacts for customers based on their home's Title 24 vintage. The results are summarized in Table 2-5.

*Table 2-5. Home Electricity Report Impacts for Homes varying in Title 24 Vintages*

| Model Effect | % Savings | kWh Savings | Pop % | R Sq | Comments |
|---|---|---|---|---|---|
| < 1978 | 1.9 | 196 | 54.8 | .77 | Savings are weather-related |
| 1978-1992 | 0.1 | 6 | 37.1 | .67 | Savings are not weather-related |
| 1993-2001 | 2.4 | 294 | 5.7 | .79 | Savings are weather-related |
| 2002-2005 | 0.1 | 62 | 2.3 | .78 | Savings are weather-related |
| 2006-2007 | 0% | 0 | 0.1 | .80 | No detectable savings |

The Home Electricity Reports appear to have had their greatest impact on homes built between 1993 and 2001 ("Vintage 3" homes). Approximately six percent of the homes in the evaluation study sample are of this vintage. These homes showed a net savings of 2.4 percent with Home Electricity Report recipients generating savings of .805 kWh per day which annualizes to an average savings of approximately 294 kWh. Savings associated with this vintage were due to weather-responsive changes on the part of home owners.

The other vintage showing substantial savings for Home Electricity Report recipients was for homes built before California began issuing regulations under Title 24 governing new home

construction. The majority of SMUD's single family homes are of this vintage. Home Electricity Report recipients living in homes built before Title 24 took effect realized a net savings of 1.9 percent. Although their savings percentages were approximately the same (1.9 percent), Home Electricity Report recipients in pre-Title 24 vintage homes achieved a slightly higher overall kWh impact (.592 kWh saved per day) than that found for the overall treatment group (.572 kWh per day).

It seems likely that participants living in older, pre-1978 homes found more information in the Home Electricity Reports that they could apply to saving energy in the home than did participants living in later vintage homes, for the most part. The exception is the 1993-2001 vintage. Why this might be the case is unclear and requires further research.

### *Effects for Homes with Pools*

Data on the presence or absence of pools were available for 97 percent of the homes in the sample. These data indicated that 21.9 percent of the homes in the sample had pools. The pools model accounted for 75 percent of the variance in residential energy consumption and showed that the overall effect of the Home Electricity Reports for homes with pools was an average savings of 2.4 percent compared to control group homeowners with pools. *The pool effect was a savings of .993 kWh per day, which converts to an annual savings impact of approximately 363 kWh.*

While Vintage 3 homes and homes with pools showed the same relative level of impact in terms of percent savings, 2.4%, the difference in absolute kWh impact on an annualized basis – 363 kWh for homes with pools vs. 294 kWh for Vintage 3 homes – stems from the differences in absolute effect sizes as well as differences in baseline levels of consumption. While homes with pools had much higher levels of power consumption on the average, they also realized greater benefits from the home energy reports as reflected in greater absolute effect sizes – .993 kWh savings per day for homes with pools vs. .805 kWh savings per day for Vintage 3 homes. *Thus, homes with pools realized the greatest level of impact from the home energy reports*.

### *Total Annual kWh Savings*

Based on the overall effect of 1.9 percent savings, we estimate that the total annual savings per treatment group household was 212.6 kWh on average. For the 30,813 households that received Home Electricity Reports in the pilot program year, we are 95 percent confident that the total kWh savings for Home Electricity Report recipients ranges from 6,536,721 kWh to 6,562,363, with an average total savings of 6,549,542 kWh per year. This kWh total is equivalent to 6.5 gigawatt hours (gWh). Table 2-6 presents the kWh data.

*Table 2-6. Estimates of Total Annual kWh Saved*

| **Mean Total kWh Savings** | **Upper 95% Confidence Limit** | **Lower 95% Confidence Limit** |
|---|---|---|
| 6,549,542 | 6,652,363 | 6,536,721 |

Appendix D shows the calculations for arriving at the kWh estimates.

## Billing Analysis: Summary and Conclusions

ADM finds that the overall effect of the Home Electricity Reports is a net savings of 1.9% on average which converts to a total annual average savings per home of approximately 213 kWh. Other key findings on overall effects from the billing analysis included the following impacts.

- The greatest impact of the Home Electricity Reports was on homes with pools. This was an average annual savings of 363 kWh, or a savings of 2.4 percent in relative terms.
- The Home Electricity Reports had their greatest impact on homes built between 1993 and 2001 (an annual savings of 294 kWh, or 2.4 percent in relative terms) and homes built before 1978 (an annual savings of 196 kWh, or 1.9 percent in relative terms).
- The Home Electricity Reports had a greater impact on customers in average, to smaller sized homes, defined as 1,600 square feet or less (an annual savings of 195 kWh, or 2.0 percent in relative terms) compared to customers in larger homes, defined as greater than 1,600 square feet (an annual savings of 183 kWh, or 1.4 percent in relative terms).
- The Home Electricity Reports had a greater impact on customers with residential gas accounts (an annual savings of 188 kWh, or 1.8 percent in relative terms) compared to customers with electric accounts (an annual savings of 159 kWh, or 1.2 percent in relative terms).
- The absolute impact of the Home Electricity Reports was slightly greater during the summer quarter (63 kWh, or a relative savings of approximately 2.0 percent) compared to the winter quarter (62 kWh, or a relative savings of approximately 2.1 percent).
- The total average energy savings for the 30,813 households that received the Home Electricity Reports in the pilot program year is estimated to be approximately 6,549,542 kWh per year or 6.5 gWh.
- The home energy reports appear to most benefit homes with pools and older homes which tend to be smaller and less energy efficient.
- While the home energy reports had a large positive impact on homes built between 1993 and 2001, further research on home vintages is recommended. This research should examine a combination of interacting factors including square footage and homeowner demographics, and incorporate a case study approach.

# Chapter 3: The SMUD Mail Survey

*(What kinds of energy efficiency changes made by customers are responsible for producing the observed energy savings attributed the Home Electricity Reports?*
*What percentage of the home efficiency changes made by Home Electricity Report recipients are behavioral versus equipment changes)?*

SMUD administered an Energy Use Survey to 10,000 customers, half of whom were participating in the Home Electricity Report pilot program while the other half were drawn from the study's control group. The survey was administered twice, first at the beginning of the pilot program in 2008 and later at the conclusion of the pilot program in 2009. The same instrument was administered to both groups at each point in time. A 26 percent response rate was achieved for the pre-survey and a 19 percent response rate was achieved for the post-survey. Response rates were the same for the treatment and control groups. Ninety percent of the respondents returned the survey by mail and ten percent responded to an online version of the survey. The obtained survey samples are shown in Table 3-1.

*Table 3-1. Obtained Samples on the SMUD Energy Use Survey*

| **Survey Phase** | **Treatment Group** | **Control Group** | **Total** |
|---|---|---|---|
| Pre-Survey | N=1,293 | N=1,285 | N = 2,578 |
| Post-Survey | N = 928 | N = 949 | N = 1,877 |

Question 5 on the survey was relevant to the Home Electricity Report program evaluation but did not make any reference to the pilot project itself or to any actions that Home Electricity Report recipients might have made in response to the energy saving tips that customers received in the reports. The item stem for Question 5 was: "Please select any of the following things you may have done to your home in the past year. Select all that apply." Sixteen response options were provided in checklist format. The response options were:

❑ 1 Adjusted my thermostat to save energy and costs
❑ 2 Added or improved insulation in attic, walls, pipes, or water heater
❑ 3 Added weather-stripping to doors or windows
❑ 4 Replaced old windows with more energy efficient windows
❑ 5 Replaced caulking on windows
❑ 6 Replaced standard incandescent light bulbs with CFLs (compact fluorescent light bulbs)
❑ 7 Installed a low-flow showerhead
❑ 8 Planted a tree to shade my home
❑ 9 Had my heater and/or air conditioner serviced
❑ 10 Replaced my heater or air conditioner
❑ 11 Replaced an appliance with an Energy Star ® appliance
❑ 12 Removed or unplugged a secondary refrigerator or freezer (such as one in the garage)
❑ 13 Installed shade screens

❑ 14 Installed a whole-house fan
❑ 15 Unplugged small appliances when not in use
❑ 16 Turned off computer or other electronics when not in use

Of the 16 SMUD survey items, 14 were related to the personalized tips provided to SMUD customers in Home Electricity Reports. Two items (#5 and # 8) however, were not related to the personalized action steps approved by SMUD for dissemination to Home Electricity Report recipients. Thus, question 5 on the SMUD survey had a content validity rating of 88 percent in terms of measuring actions relevant to the tips provided to Home Electricity Report recipients by SMUD. While respectable, there is no reason why the 16-item scale should not have had 100 percent content validity.

## Survey Analysis

Customer responses to each of the 16 items were coded 1 if checked by a survey respondent and zero if otherwise, in the database created by ADM Associates, Inc. In addition to analyzing each of the 16 dichotomously scored items, we created three survey scales as described below.

### *Total Scale*

A summated total scale was created by summing all 16 items. This created a scale that ranged from zero to 16 and measured the degree to which customers did something in the past year in the way of home energy saving changes.

### *Behavior Scale*

Items 1, 9, 12, 15 and 16 were summed to create a scale ranging from zero to five that measured the degree to which customers made behavior changes that potentially affected household energy savings.

### *Equipment / Materials Scale*

Items 2, 3, 4, 5, 6, 7, 8, 10, 11, 13 and 14 were summed to create a scale ranging from zero to eleven that measured the degree to which customers installed new equipment or added or improved materials that potentially affected household energy savings.

### *Weighting*

For the GLM regression analysis, the 16 survey items (coded 1 or 0) were weighted by deemed annual energy savings based on the sources identified in Appendix D. We then computed 3-way interaction terms for each weighted survey item as the product of the weighted item, the treatment group indicator variable, and the weather index variables (heating degree days and cooling degree days). This produced 32 survey items weighted by deemed annual energy savings values for the Sacramento area. The weighted survey items measured treatment and control group responses in the context of weather conditions. The three scales were also weighted in the same manner.

***Data Limitations***

SMUD did not collect data on customer account number or "reporting frequency" in the pre-survey. This eliminated the possibility of examining pre-to-post survey changes by customer. It also eliminated the possibility of examining pre-survey differences on the basis of Home Electricity Report frequency. An examination of pre-survey differences and pre / post changes by group were thus possible only for "overall" effects. The lack of a customer account number on the pre-survey also eliminated the possibility of conducting any inferential statistical analyses tied to customers or household characteristics involving pre / post change on the survey measures. *Consequently, inferential analyses of the survey data with the regression GLM were restricted to an examination of treatment-control group differences on the post-survey.*

***Statistical Analyses***

ADM first examined the differences between the post-survey sample and the overall study sample. We then conducted extensive descriptive analyses to determine if there was (a) significant change in the treatment and control groups' responses from the pre-survey to the post-survey, (b) whether there were significant treatment-control group differences on the pre-survey and also on the post-survey, and (c) whether there were significant inverse correlations[12] between the survey items and energy consumption (kWh per day). Finally, ADM ran the regression GLM analysis on the post-survey sample, with and without the survey data added, to estimate overall energy savings effects. The idea was to see if (a) we could replicate the results previously obtained with the full study sample using just the SMUD survey sample (we could not), and (b) to see if the survey contributed additional information to explaining energy savings (it did). The regression results for these analyses are shown in Appendix D.

# Differences Between the SMUD Survey Sample and the Overall Study Sample:

The SMUD survey sample was a subset of the overall study sample. Differences between these two samples were examined in terms of household characteristics for the two groups in the year prior to the study. Results for the SMUD survey sample are shown in Table 3-2.

[12] Inverse correlations would be expected if a survey item was associated with reductions in energy consumption.

*Table 3-2. SMUD Survey Sample: Treatment and Control Group Differences in Household Characteristics During the Year Prior to the Home Electricity Report Pilot Program*

| Household Characteristic | Treatment Group Mean | Control Group Mean | T-C Difference |
|---|---|---|---|
| Age in Years | 38.35 | 39.31 | -0.96 |
| Square Feet | 1785.89 | 1802.98 | -17.09 |
| % Electric Accounts | 23.96 | 24.44 | -0.48 |
| kWh per Day | 28.21 | 29.09 | -0.89 |

In general, the SMUD mail survey sample was similar to the overall study sample except that treatment group survey respondents were even more conservative energy users from the beginning than were their counterparts in the overall study sample compared to control households.

## Survey Findings

In this section, survey findings are presented for:

- changes in item response from pre-survey to post-survey for the control and treatment groups;
- treatment and control group differences on the pre-survey and the post-survey;
- item correlations with energy consumption;
- item rankings by treatment and control group; and
- GLM regression results.

### *Change over Time*

Control group households showed statistically significant[13] changes from the pre-survey to the post-survey on the five items listed in Table 3-3. Only behavior items (identified in the tables with the letter B) involving decisions to have HVAC servicing done and unplugging small appliances when not in use increased over time for control group members.

[13] Using a t-test procedure with a 90 percent confidence interval and examining change in survey cohorts.

*Table 3-3: Control Group Changes from Pre-Survey to Post-Survey*

| Survey Item | Pre-Survey Mean | Post-Survey Mean | Mean Change [14] | Statistical Significance |
|---|---|---|---|---|
| Installed energy efficient windows | .265 | .228 | -.037 | p=.04 |
| Planted a tree to shade my home | .252 | .212 | -.04 | p=.02 |
| Had HVAC serviced (B) | .458 | .514 | .057 | p<.01 |
| Installed a whole-house fan | .129 | .105 | -.024 | p=.08 |
| Unplugged small appliances when not in use (B) | .474 | .519 | .046 | p=.03 |

Note. Pre-Survey N = 1285, Post-Survey N = 949

Treatment group households showed statistically significant changes from the pre-survey to the post-survey on the four items listed in Table 3-4. *Only the behavior item involving the unplugging of small appliances when not in use increased over time.* In effect size (ES) terms, this magnitude of change would be considered a small effect (ES = .15).[15] Changes involving the installation of energy efficient equipment or the adding of energy saving materials in the home actually decreased over time for Home Electricity Report recipients.

*Table 3-4: Treatment Group Changes from Pre-Survey to Post-Survey*

| Survey Item | Pre-Survey Mean | Post-Survey Mean | Mean Change | Statistical Significance |
|---|---|---|---|---|
| Added/improved insulation in attic, walls, etc. | .278 | .244 | -.033 | p=.07 |
| Installed energy efficient windows | .281 | .245 | -.036 | p=.05 |
| Installed shade screens | .159 | .128 | -.030 | p=.04 |
| Unplugged small appliances when not in use (B) | .487 | .564 | .076 | p<.001 |

Note. Pre-Survey N = 1293, Post-Survey N = 928

However, for both the control group and treatment group, it is behavior change as opposed to equipment and materials replacement that shows any kind of general improvement over time. While not large, this change is evident from the data displayed for the behavior index in Table 3-5. Change over time was not significant for the equipment index or the total index for either group.

*Table 3-5: Treatment and Control Group Changes in the Behavior Index over Time*

| Study Group | Pre-Survey Behavior Index Mean | Post-Survey Behavior Index Mean | Mean Change | Statistical Significance |
|---|---|---|---|---|
| Treatment Group | 2.60 | 2.71 | .10 | p=.03 |
| Control Group | 2.55 | 2.68 | .12 | p=.01 |

Note. Treatment Group Pre-Survey N = 1293, Treatment Group Post-Survey N = 928
Control Group Pre-Survey N = 1285, Control Group Post-Survey N = 949

### *Treatment Control Group Differences*

In this section, between-group differences on the pre-survey and the post-survey are summarized.

[14] Post-survey mean minus pre-survey mean.

[15] ES = T-C difference/standard deviation of the difference = .076/.4984 = .15

***Group Differences on the Pre-Survey***

The only statistically significant difference on the pre-survey was on item 1 – *adjusting the home thermostat to save energy and costs*. This was an overall difference of three percent favoring the treatment group over the control group (.878 compared to .846). Both groups were clearly predisposed to using a thermostat to control energy consumption and save energy-related costs. There was no significant difference between the two groups on the post-survey in their level of thermostat use to control energy costs.

***Group Differences on the Post-Survey***

Only one item showed statistically significant differences between the treatment and control groups on the post-survey. This was item 15 – *unplugging small appliances when not in use* – which again showed a small effect (ES = .09) favoring the treatment group over the control group by a difference of 4.4 percent (.564 compared to .520) overall. The item 15 effect was quite a bit larger for "quarterly report" households with a nine percent difference (ES = .19) favoring Home Electricity Report recipients.

There were no statistically significant differences found for "monthly report" households on the post-survey. There were also no statistically significant post-survey differences between the treatment and control groups on any of the index scales.

***Survey Relationships with Energy Consumption***

Item 15 – *unplugging small appliances when not in use* – showed a statistically significant relationship with energy consumption (kWh per day) in the expected direction (i.e., a negative correlation) during the pilot test year. This relationship is rather weak but was found for both the treatment group (r = -.05) and the control group is (r = - .03).

Item 16 – *turning off computer or other electronics when not in use* – also shows a statistically significant relationship with energy consumption (kWh per day) in the expected direction (i.e., a negative correlation) during the pilot test year. Again, this relationship is rather weak and was found for both the treatment group (r = -.02) and the control group is (r = - .02).

Both items 15 and 16 are similar – unplugging or turning off electric appliances when not in use – and are classified as behavior items.

***Survey Item Rankings by Group***

Overall responses to each survey were ranked by group and the rankings were examined for a change over time. The item ranks for the control group are presented in Table 3-6 and for the treatment group in Table 3-7. Findings are summarized below each table and the general patterns in item rankings are examined at the end of this section.

***Control Group Item Rankings***

The control group retained the same relative rankings on 14 of 16 survey items from the pre-survey to the post-survey. The control group improved response rates on five of these 14 items (see bold italicized items in Table3-6). Three of these five items (1, 15, & 9) are behavioral.

*Table 3-6: Control Group Item Rankings on Overall Response*

| Rank | Item # | Pre-Survey Items | | Post-Survey Items | | Pre- to Post- |
|---|---|---|---|---|---|---|
| 1 | 1 | Adjusted thermostat to save energy | 84.7 | Item 1 | 87.0 | Same Item: +2.3 |
| 2 | 6 | Replaced standard light bulbs with CFLs | 69.1 | Item 6 | 71.8 | Same Item: +2.7 |
| 3 | 16 | Turned off PC/electronics when not in use | 67.5 | Item 16 | 67.2 | Same Item: -0.3 |
| 4 | 15 | Unplugged small appliances when not in use | 47.4 | Item 15 | 52.0 | Same Item: +4.6 |
| 5 | 9 | Had my heater or AC serviced | 45.8 | Item 9 | 51.4 | Same Item: +5.6 |
| 6 | 11 | Replaced appliance with Energy Star appliance | 33.4 | Item 11 | 33.2 | Same Item: -0.2 |
| 7 | 7 | Installed low-flow showerhead | 27.4 | Item 7 | 29.9 | Same Item: +2..5 |
| 8 | 2 | Added/improved insulation in attic, walls, etc. | 26.9 | Item 2 | 25.9 | Same Item: -1.0 |
| 9 | 3 | Added weather stripping to doors and windows | 24.6 | Item 3 | 23.9 | Same Item: -0.7 |
| 10 | 4 | Installed energy efficient windows | 26.5 | Item 4 | 22.8 | Same Item: -3.7 |
| 11 | 8 | Planted a tree to shade my home (Not a HERS tip) | 25.2 | Item 8 | 21.2 | Same Item: -4.0 |
| 12 | 10 | Replaced heater or AC | 20.3 | Item 10 | 20.2 | Same Item: -0.1 |
| 13 | 5 | Replaced caulking on windows (Not a HERS Tip) | 15.3 | Item 13 | 14.3 | Different Item |
| 14 | 13 | Installed shade screens | 13.5 | Item 5 | 13.0 | Different Item |
| 15 | 14 | Installed whole-house fan | 12.9 | Item 14 | 10.5 | Same Item: -2.4 |
| 16 | 12 | Removed/unplugged secondary fridge/freezer | 09.9 | Item 12 | 09.9 | Same Item: 0.0 |

The five improvement items for the control group are:

Item 1 (Rank 1/+2.3%): ***Adjusted thermostat to save energy.***

Item 6 (Rank 2/+2.7%): Replaced standard light bulbs with CFLs.

Item 15 (Rank 4/+4.6%): ***Unplugged small appliances when not in use***.

Item 9 (Rank 5/+5.6%): ***Had my heater or AC serviced***.

Item 7 (Rank 7/+2.5): Installed low-flow showerhead

***Treatment Group Item Rankings***

The treatment group retained the same relative rankings on 11 of 16 survey items (see Table 3-7) and improved response rates on six of these 11 items (see bold italicized items in Table 3-7). Four of these six items (16, 15, 9 & 12) are behavioral.

*Table 3-7: Treatment Group Item Rankings on Overall Response*

| Rank | Item # | Pre-Survey Items | | Post-Survey Items | | Pre- to Post- |
|---|---|---|---|---|---|---|
| 1 | 1 | Adjusted thermostat to save energy | 87.9 | Item 1 | 85.9 | Same Item -2.0 |
| 2 | 6 | Replaced standard light bulbs with CFLs | 70.9 | Item 6 | 73.7 | Same Item +2.8 |
| *3* | *16* | *Turned off PC/electronics when not in use* | 67.4 | Item 16 | 68.6 | Same Item +1.2 |
| *4* | *15* | *Unplugged small appliances when not in use* | 48.7 | Item 15 | 56.4 | Same Item +7.7 |
| *5* | *9* | *Had my heater or AC serviced* | 46.3 | Item 9 | 48.9 | Same Item +2.6 |
| 6 | 11 | Replaced appliance with Energy Star appliance | 36.4 | Item 11 | 34.3 | Same Item -2.1 |
| 7 | 4 | Installed energy efficient windows | 28.1 | Item 7 | 29.7 | Different Item |
| 8 | 2 | Added/improved insulation in attic, walls, etc. | 27.7 | Item 4 | 24.5 | Different Item |
| 9 | 7 | Installed a low-flow shower head | 27.2 | Item 2 | 24.4 | Different Item |
| 10 | 3 | Added weather stripping to doors or windows | 24.8 | Item 8 | 23.9 | Different Item |
| 11 | 8 | Planted a tree to shade my home (Not a report Tip) | 23.2 | Item 3 | 23.2 | Different Item |
| 12 | 10 | Replaced heater or AC | 19.3 | Item 10 | 20.0 | Same Item +0.7 |
| 13 | 13 | Installed shade screens (Not a report Tip) | 15.9 | Item 13 | 12.8 | Same Item -3.1 |
| 14 | 5 | Replaced caulking on windows (Not a report Tip) | 14.1 | Item 5 | 12.7 | Same Item -1.4 |
| 15 | 14 | Installed whole house fan | 12.5 | Item 14 | 11.8 | Same Item -0.7 |
| *16* | *12* | *Removed/Unplugged secondary fridge/freezer* | 10.1 | Item 12 | 10.8 | Same Item +0.7 |

The six improvement items for the treatment group are:
(bold, italicized items saw improved response rates)

Item 6 (Rank 2/+2.8%): Replaced standard light bulbs with CFLs.

Item 16 (Rank 3/+1.2%): ***Turned off computer or other electronics when not in use*.**

Item 15 (Rank 4/+7.7%): ***Unplugged small appliances when not in use***.

Item 9 (Rank 5/+2.6%): ***Had my heater or AC serviced***.

Item 10 (Rank 12/+0.7%): Replaced my heater or AC.

Item 12 (Rank 16/+0.7%): ***Removed or unplugged a secondary refrigerator or freezer***

### *Survey Response Patterns in Item Rankings*

The following patterns are apparent from the item ranking data tables:

- The top six item ranks are the same for both treatment and control groups.
- Most customers in both groups claim to have done the top five ranked items.
- The control group changed rankings on 2 of 16 items. The treatment group changed rankings on 5 of 16 items.
- The mean item ranks are the same for both groups.
- There is little difference between the treatment and control groups on the SMUD survey.

- The degree of change in the treatment group, as measured by the SMUD survey, is relatively small.

## GLM Regression Results from the Post-Survey Sample

The reader will recall that ADM's billing analysis found an overall savings of 1.9 percent kWh per day per household on the average for Home Electricity Report recipients. However, we were not able to replicate this finding with the SMUD post-survey sample. Rather, we found an overall net savings effect of only 1.3 to 1.4 percent with the SMUD survey sample. Speculation on possible reasons for the difference in findings on kWh savings are discussed in the concluding section of this chapter, but it appears likely that differences in the samples (e.g., survey respondents were significantly more likely to be energy conservers to begin with) and the nature of the SMUD survey (e.g., the use of general rather than specific response items and lack of an orienting reference in the main item stem from the Home Electricity Reports, or to actions they might have taken in response to receiving the Home Electricity Reports) may account for this.

By adding the survey items (and scales) to the regression GLM using the post-survey sample, we were able to account for a slight increase in the energy consumption variance. This was a very small effect, on the order of one percent. That is, the R-squared value for the regression increased from 75 to 76 percent. However, adding the weighted survey responses did not improve the measured impact of the Home Electricity Reports on our estimate of energy savings. By adding the weighted survey scales – either the separate subscales or the total scale – the computed savings was 1.4 percent. By entering the weighted survey items, the computed savings was 1.3 percent.

Notably, what was principally responsible for the treatment effect was the variable called CDD_3WAY.[16] This variable measures a generalized response to the need for residential home cooling among households receiving the Home Electricity Reports. However, *exactly what the Home Electricity Report recipients did to achieve energy savings is not captured well by the SMUD Energy Use Survey*.

As noted above, the energy savings in the regression GLM analysis of the survey data are primarily accounted for by the CDD_3WAY variable. The computed impact of CDD_3WAY on energy savings is a coefficient value of -.403. In contrast, the weighted behavior index was found to have an effect size of -.0004 in terms of influencing energy savings among Home Electricity Report recipients. Similarly, effect sizes for the four statistically significant weighted survey items that influenced energy savings for Home Electricity Report recipients ranged from -.002 to -.0008. These four survey items are summarized below in Table 3-8. Note that in comparison to the impact of CDD_3WAY (ES = -.404), the behaviors or equipment installations

[16]CDD_3WAY is a three-way interaction term measuring the impact on reductions in kWh per day as a function of treatment-comparison group differences in responses to the need for residential home cooling in the test period.

measured by the SMUD survey as having an influence on energy savings appear to have relatively small impacts. We pursue this point further below. Note also that three of the four SMUD survey items in Table 3-8 are behavioral (offset in italics).

*Table 3-8. Weighted Survey Items Associated with Home Electricity Report Energy Savings Identified by Regression GLM Analysis*

| Variable | Description | Effect Size |
|---|---|---|
| Q12WH | *Removed/unplugged secondary refrigerator/freezer; heating response* | -.0008 |
| Q14WC | Installed whole-house fan; cooling response | -.002 |
| Q15WC | *Unplugged small appliances when not in use; cooling response* | -.003 |
| Q16WC | *Turned off computer or other electronics when not in use; cooling response* | -.008 |

The installation of a whole-house fan (item 14) is clearly a cooling response. The behavioral items in Table 3-8 (items 12, 15 and 16) are more weather-neutral which suggests that their association with heating or cooling responses is probably an artifact of seasonal events. For example, customers might be more inclined to remove a secondary refrigerator in the winter when there is less need for it. Similarly, customers might be more inclined to unplug electric appliances and turn off electronic devices when not in use during the summer months to reduce the generation of secondary heat sources in the home.

*One of the main points to be made about the regression GLM results of the SMUD survey data is that the Home Electricity Report recipient actions identified from the SMUD survey that influenced energy savings do not account for the lion's share of energy savings that we have attributed to the Home Electricity Reports*. This is demonstrated in the computations shown below in Table 3-9.

*Table 3-9. The Impact of Energy Saving Actions Attributable to the Home Electricity Reports on Annual kWh Savings*

| Measure | Description | Treatment Effect | Weight (kWh per year) | Annual Impact |
|---|---|---|---|---|
| 12 | Recycled second refrigerator/freezer | .007 | 1161 | 8.13 |
| 14 | Installed whole-house fan | -.007 | 22 | -0.15 |
| 15 | Unplugged appliances not in use | .076 | 100 | 7.60 |
| 16 | Turned off PC when not in use | .013 | 390 | 5.07 |
| Total | | | | 20.64 |

Each of the four measures identified by the regression analysis as having an influence on energy savings attributable to the Home Electricity Reports is listed in Table 3-9.[17] The fourth column

[17]The treatment effect displayed in Table 3-9 is the change in the pre-survey cohort to the post-survey cohort on the four measures. Recall that a limitation of the survey data is that we cannot link participants from pre-to-post since the SMUD data lack account numbers for the pre-survey phase.

lists the survey weight for each measure, which is the deemed savings in annual kWh per year for each measure. The annual impact of each measure is the product of the treatment effect value and its weight. The aggregate impact of the four measures is the sum of the impacts, which is estimated to be approximately 21 kWh per year. The 1.9 percent kWh per household per year savings attributed to the Home Electricity Reports in the overall study sample is equivalent to approximately 213 kWh per year. Thus, the *energy saving measures identified by the SMUD survey account for only about ten percent of the savings attributed to the Home Electricity Reports*.

## SMUD Survey Results: Summary and Conclusions

There were two serious limitations in the SMUD survey data that limited ADM's ability to analyze the data and that also limit the usefulness of the survey data and conclusions that one might draw from an analysis of that data. These limitations are:

- Selection bias
- Inability to measure change at the respondent level

The selection bias in the survey sample is a result of self-selection into the sample by respondents who were more inclined to be lower energy users to begin with, which probably reflects a greater interest in energy conservation among those who returned a survey, hence the motive for lower energy users to respond to the survey. The predisposition toward lower energy use is greater in the treatment group survey sample relative to the control group survey sample. The bias in the survey sample toward lower energy users probably made it more difficult for the Home Electricity Report recipients in the survey sample to demonstrate energy savings. The sample bias also reduces the external validity of the survey findings for application to the overall SMUD customer population.

The fact that account numbers were not collected in the pre-survey made it impossible to measure change from pre-survey to post-survey at the individual household level. This was a serious limitation in the data, which compromises the internal validity of estimates of change that we have otherwise tried to make, based on comparisons of the two survey cohorts. However, in the main regression GLM analysis, we are simply unable to measure change because of this limitation in the data.

Given these data limitations, what we do have some tentative findings on actions that Home Electricity Report recipients took that appear to have some influence on energy savings. The four actions identified by the regression GLM analysis as relevant to residential energy savings, however, only account for approximately ten percent of the total impact on energy savings attributed to the Home Electricity Report program. *Thus, we still don't know what accounts for most of the savings attributable to the Home Electricity Reports.* The energy saving actions

measured by the SMUD survey identified in the regression GLM are summarized below in Table 3-10, ordered by their savings weight.

*Table 3-10. Energy Saving Actions Identified by the SMUD Survey*

| Measure | Category | Savings Weight | Incidence | Treatment Effect |
|---|---|---|---|---|
| Recycle old refrigerator/freezer | Behavioral | 1161 | .11 | .01 |
| Turn off PC when not in use | Behavioral | 390 | .69 | .01 |
| Unplug appliances when not in use | Behavioral | 100 | .56 | .08 |
| Install a whole-house fan | Equipment | 22 | .12 | -.01 |

Conclusions about these four actions in relation to the Home Electricity Reports can be summarized as follows:

- The energy saving actions attributed to the Home Electricity Reports are primarily behavioral;
- The incidence of the action with the biggest potential impact (recycling old refrigerators) is rather small (11%);
- The largest treatment effect was getting people to unplug their electric appliances when not in use;
- There was a small impact on getting people to turn off their home computers when not in use, but the incidence of this behavior was already rather high to begin with; and
- The Home Electricity Report program did not have a positive impact on getting more customers to install whole-house fans but the low incidence of this type of installation suggests there is considerable room for improvement in the future.

# Chapter 4: The ADM Telephone Survey

*(What kinds of energy efficiency changes made by customers are responsible for producing the observed energy savings attributed the Home Electricity Reports? What percentage of the home efficiency changes made by Home Electricity Report recipients are behavioral versus equipment changes)?*

Subsequent to analyzing the SMUD Energy Use Survey, ADM conducted a telephone survey with treatment group households that had been documented to be substantial energy savers[18] during the pilot program period. The purpose of the telephone survey was to determine whether recipients of the Home Electricity Reports remembered receiving them, and if so, whether they had done anything to save electricity in the home in response to the energy consumption information and energy saving tips provided in the Home Electricity Reports. Affirmative responses were classified using the SMUD tip codes. Negative responses were followed up with a question designed to determine the reasons for not using the Home Electricity Reports. A copy of the semi-structured telephone interview protocol can be found in Appendix E.

In this chapter, we briefly describe the process of fielding the telephone survey and then focus on summarizing the results of the telephone interviews.

## Fielding the Telephone Survey

Our goal was to obtain 75 completed interviews. We initiated the telephone survey on July 17, 2009, and concluded the survey on July 28, 2009. During the eight-day fielding period, ADM interviewers made 651 calls to 278 SMUD households,[19] achieving 78 completed interviews. Up to five attempts were made to reach the respondents identified in our sampling frame. Table 4-1 summarizes the results of our calling efforts.

A number of rates can be calculated in evaluating the efficiency of the sampling pool and the efficiency of the interviewing that was conducted. These are reviewed below.

### *Sampling Pool Efficiency*

We evaluated the efficiency of the sampling pool by estimating the proportion of the "working numbers" that we were able to reach.[20] This turned out to be a little over half – 52 percent – of the phone numbers provided by SMUD.

[18]Treatment group households with average savings of 12-36 kWh per day.

[19]We drew a random sample of 300 treatment group households from the set of substantial savers. All households were in the 916 area code and there were no duplicate SMUD accounts in this sampling frame of 300 residences.

[20]The Sampling Pool Efficiency Rate is calculated as the total number of households called, minus the sum of final disposition codes 10, 20, 22, and 23, divided by the total number of households called.

### *Completion Rate Efficiency*

We calculated two completion rates: the *gross completion rate* and the *contacted completion rate*. The gross completion rate is simply the ratio of completed interviews to the total number of households called. Our gross completion rate was 28 percent. That is, we were able to complete one interview for about every four households called. The *contacted completion rate*, on the other hand, is essentially the success rate in completing interviews with potentially eligible respondents.[21] Our contacted completion rate was 68 percent.

*Table 4-1. Final Disposition Codes Summary*

| Definition | Disposition Code | Frequency | Percent |
|---|---|---|---|
| Answering machine | 12 | 346 | 53.15% |
| Wrong number (residential) | 22 | 85 | 13.06% |
| Completed Interview | 70 | 78 | 11.98% |
| No answer after seven rings | 10 | 46 | 7.07% |
| Busy, after immediate redial | 11 | 27 | 4.15% |
| Answered by non-target resident of household | 15 | 21 | 3.23% |
| Disconnected; nonworking phone number | 20 | 13 | 2.00% |
| Refusal by target respondent | 50 | 12 | 1.84% |
| Target respondent temporarily unavailable | 30 | 7 | 1.08% |
| Household language barrier | 13 | 3 | 0.46% |
| Partial interview with target respondent | 60 | 3 | 0.46% |
| Target respondent unavailable during field period | 31 | 2 | 0.31% |
| Household refusal | 17 | 2 | 0.31% |
| Handicap barrier with target respondent | 40 | 2 | 0.31% |
| Answered by nonresident of household | 14 | 2 | 0.31% |
| Wrong number (commercial) | 23 | 1 | 0.15% |
| Temporarily out of service | 21 | 1 | 0.15% |
| Total | | 651 | 100.00% |

## Results of the Telephone Interviews

We completed interviews with 78 of the high energy saver recipients of the Home Electricity Reports. Respondents from 96 percent of these households (75 of 78) indicated that they remembered receiving the reports. However, only 55 percent of the respondents (43 of 78) indicated that they had done something to save electricity in the home that was in response to the personalized action steps or tips, or other information contained in the reports. Alternatively, 41 percent (32 of 78) said that although they remembered the Home Electricity Reports, they had not done anything in response to the information provided them by these reports.

[21]The Contacted Completion Rate is calculated as the sum of the completed interviews divided by the sum of final disposition codes 15, 50, 60, and 70.

Below, we first report on the changes that users of the Home Electricity Reports said they made. We then report on what customers said as to why they had not used the information provided in the Home Electricity Reports.

### *Changes Made to Save Electricity in Response to the Reports*

The interviewers recorded what the respondents said they did to save electricity in response to suggestions or other information contained in the Home Electricity Reports. These narratives were then coded according to the SMUD tip codes. We added one code (tip code 200) to cover the possibility of respondents identifying energy saving changes that are not on the current list of SMUD tip codes. A copy of the interview response codes may be found in Appendix D. The interviewees' responses fit 39 of the tip codes as shown in Table 4-2.

As can be seen in Table 4-2, ADM classified the tip codes into four categories, as follows:

- **Behavioral**: *The energy saving change primarily involves a behavioral response*. Turning off the lights in unoccupied rooms and setting the thermostat to save on heating and cooling were the top two responses of Home Electricity Report users.

- **Low-Cost**: *The energy saving change involves a small outlay of money, typically not exceeding $20 to $30*. Switching from standard light bulbs to CFLs was the most common, low-cost energy saving change made by Home Electricity Report users.

- **Investment**: *The energy saving change involves a significant outlay of money, typically involving a major purchase of an energy efficient appliance, equipment, or related materials and/or services*. Purchasing an Energy Star rated appliance was a common energy saving change made by Home Electricity Report users.

- **Both**: *The energy saving change involves both a significant behavioral response as well as an investment of money to implement the change*. The two tips that fit this category were (a) using [i.e., purchasing] *and* switching off power strips, and (b) making sure refrigerator seals are tight, which implies buying refrigerator seals and replacing the old ones. Refrigerator seals are not inexpensive.

*Table 4-2. Energy Saving Changes Made by Users of the Home Electricity Reports*

| Home Electricity Report Tip | Tip Code | Category | N | % |
|---|---|---|---|---|
| Turn off lights in unoccupied rooms | 52 | Behavioral | 23 | 12.43 |
| Set your thermostat for comfort and savings | 92 | Behavioral | 19 | 10.27 |
| Switch to compact fluorescent light bulbs (CFLs) | 47 | Low-Cost | 17 | 9.19 |
| Other changes | 200 | Behavioral | 14 | 7.57 |
| Reduce air conditioning costs by using fans | 84 | Behavioral | 12 | 6.49 |
| Buy ENERGY STAR | 1 | Investment | 11 | 5.95 |
| Keep out the sun's heat | 20 | Behavioral | 7 | 3.78 |
| Choose an efficient refrigerator | 2 | Investment | 7 | 3.78 |
| Install a ceiling fan | 17 | Investment | 6 | 3.24 |
| Choose an efficient dishwasher | 5 | Investment | 6 | 3.24 |
| Unplug stereos and other devices when not in use | 60 | Behavioral | 4 | 2.16 |
| Choose efficient windows | 23 | Investment | 4 | 2.16 |
| Reduce pool pump run time | 122 | Behavioral | 4 | 2.16 |
| Be smart about clothes washing | 12 | Behavioral | 4 | 2.16 |
| Choose an efficient clothes washer | 4 | Investment | 4 | 2.16 |
| Improve shading for windows | 18 | Behavioral | 3 | 1.62 |
| Upgrade your central air conditioner | 14 | Investment | 3 | 1.62 |
| Choose a laptop computer instead of a desktop computer | 53 | Investment | 3 | 1.62 |
| Use and switch off power strips | 59 | Both | 3 | 1.62 |
| Use clothes dryer efficiently | 77 | Behavioral | 3 | 1.62 |
| Stay cool and save with a whole-house fan | 79 | Investment | 3 | 1.62 |
| Shade coverings and awnings | 86 | Behavioral | 3 | 1.62 |
| Hang laundry to dry | 10 | Low Cost | 2 | 1.08 |
| Recycle your second refrigerator | 11 | Behavioral | 2 | 1.08 |
| Weather strip windows and doors | 28 | Low Cost | 2 | 1.08 |
| Reduce water heater temperature | 70 | Behavioral | 2 | 1.08 |
| Install sun screens | 87 | Investment | 2 | 1.08 |
| Improve insulation | 22 | Investment | 1 | 0.54 |
| Seal leaky ducts | 27 | Investment | 1 | 0.54 |
| Maintain your air conditioner | 15 | Investment | 1 | 0.54 |
| Use indoor light timers and sensors | 49 | Investment | 1 | 0.54 |
| Be smart about dishwashing | 13 | Behavioral | 1 | 0.54 |
| Choose an efficient television | 54 | Investment | 1 | 0.54 |
| Use solar power | 57 | Investment | 1 | 0.54 |
| Install efficient showerheads | 69 | Low Cost | 1 | 0.54 |
| Set refrigerator temperature wisely | 7 | Behavioral | 1 | 0.54 |
| Make sure refrigerator seals are tight | 6 | Both | 1 | 0.54 |
| Use solar outdoor lights | 73 | Investment | 1 | 0.54 |
| Seal air leaks | 30 | Investment | 1 | 0.54 |

Of the group that used the report information to make energy changes, over half (52 percent) of their responses fit the top six tip codes displayed in the darker shaded area at the top of Table 4-2. Four of these changes are primarily behavioral in nature. The "other change" category that we added to the SMUD tip codes turned out to be primarily behavioral in nature as well. Inspection of the data revealed that the "other change" category primarily involved lifestyle alternatives to using electric power. The alternative lifestyle choices included:

- Washing dishes by hand or using the dishwasher less often.
- Not turning on the outside lights anymore.
- Not using air conditioning at night while sleeping.
- Turning off the air conditioning when not at home.
- Switching to microwave cooking.
- Using candles more for home lighting.

Adding the next five tip codes (the lighter shaded area of Table 4-2) accounted for just over two thirds of the interviewees' responses. These additional tips primarily require investments in energy efficient appliances and purchasing fans as alternatives to air conditioning units.

Looking overall at the energy saving changes made by users of the Home Electricity Reports, we find that *the majority of changes – approximately 57 percent – are behavioral in nature*. Major investments in energy saving products and services account for a little over 29 percent of the changes made by report users. Low-cost investments account for only about 12 percent of the energy saving changes reported by users and approximately two percent of the changes involved both behavioral responses and investments of money.

***Why Customers Did Not Use the Home Electricity Reports***

Slightly more than four in ten (i.e., 41 percent) of the high-saver respondents indicated that while they did remember the Home Electricity Reports, the reports had not influenced their decisions to make any new energy saving changes in the home. Most often, this was because they had already made energy saving changes in the home and the reports weren't providing them with any new information. This subgroup of nonusers – those that had already made changes – felt that they couldn't do any more than what they were already doing. These sentiments – from people who felt they had already made sufficient energy saving changes in the home – characterized about half of the nonuser group, as shown in Table 4-3.

Another subgroup of nonusers resented receiving the Home Electricity Reports. In particular, these households did not like being reprimanded with "frowny faces" and felt they were doing the best they could to save energy in the home.

*Table 4-3. Categories of Non-Users of the Home Electricity Reports*

| Category | Description/Illustration | N | % |
|---|---|---|---|
| Already made changes | Implemented changes prior to the report. Does not know of anything else they could do. Report does not provide new information to the household. Can't do more than what they already do. | 15 | 48 |
| Resented the report | Did not like the report. Did not act on the tips. Ignored the report. Doing the best they can. Resented receiving the report. | 5 | 16 |
| Senior citizens | Senior citizen and is home all day. Does not know how else to save electricity. | 4 | 13 |
| Low energy Users | Low user and feels household is doing enough. The report has not done anything to help reduce energy consumption which is already low. | 3 | 10 |
| Gone a lot | Have another home where they stay a significant portion of the year. | 3 | 10 |
| Stay-at-home moms | "It's difficult for me to change anything, when I am home all day with my children." | 2 | 6 |
| Frugal Freddy & frugal Fanny | No money to invest in major energy saving technology. Can't afford to make big improvements that require significant investment, but open to making low cost changes in the home. | 2 | 6 |
| Renters | Feel they can't do anything to save energy because they rent the home. | 2 | 6 |
| Workaholic | Works a lot of hours and does not have any time to follow the suggestions that have been provided in the Home Electricity Report. | 1 | 3 |
| Online bill payers | Never saw the Home Electricity Report because he receives his electric bill online. | 1 | 3 |

Note. Percents are based on 31 comments which could be coded into multiple categories.

Most of the remaining categories in Table 4-3 describe different typologies of customers and why they did not use the Home Electricity Reports but they don't necessarily explain how they were able to achieve significant energy savings during the pilot year. Exceptions would include low energy user households and those that are "gone a lot" and do not spend much time in their Sacramento residence. Otherwise, the Table 4-3 categories suggest more about targeting different customer groups for energy saver promotions or interventions of one sort or another. These include at least the following subgroups for which targeted strategies might be developed to help them make additional energy saving changes in the home:

- Senior Citizens
- Low Energy Users
- Stay-at-Home Moms
- Frugal Freddy and Frugal Fanny
- Renters
- Busy Workers
- Online Bill Payers

For example, programs might be targeted to renters who perceive that they can't do anything to save on their energy bills because they are not property owners. For this demographic, behavioral and low-cost options would be more applicable, rather than investment in costly energy efficient products and services. The same thing would apply to the "Frugal Freddy" and "Frugal Fanny" types. We will return to this topic in the Conclusions and Recommendations chapter with additional suggestions for reaching "hard-to-persuade" customers.

## The ADM Telephone Survey: Summary and Conclusions

ADM Associates, Inc., completed 78 interviews with SMUD households that had received the Home Electricity Reports and that had been documented to have been substantial energy savers during the pilot program period. Almost all of these households (96 percent) remembered receiving the Home Electricity Reports but only a little more than half (55 percent) said they had made energy saving changes in response to the information contained in the Home Electricity Reports. The majority of energy saving changes (57 percent) was behavioral in nature. The most common kinds of behavioral changes cited by these high energy savers included the following:

- Turning off lights in unoccupied rooms;
- Setting thermostats to save energy;
- Using alternatives to electrical power like washing dishes by hand or not using electrical power when there were alternatives. These alternatives, for example, included sleeping without air conditioning, turning off the AC when away from home, using candles more for lighting, microwave cooking, and turning off the outside lights after going to bed;
- Reducing air conditioning costs by using fans;
- Keeping out the sun's heat; and
- Unplugging stereos and other devices when not in use.

High energy savers who said they didn't achieve their savings by following any of the tips in the Home Electricity Reports were primarily households that had already implemented energy saving changes and said the reports did not provide them with any new ideas. Other types of nonusers are consumers who could be targeted for educational or behavioral programs aimed at providing energy saving information that might correct either a misperception or a lack of information about residential energy conservation. For example, renters might believe that saving energy requires significant financial investment which they are not going to do because they are not the property owner. Making renters aware of the potential impact of behavioral and low-cost energy efficiency changes could make a difference in turning these consumers around.

# Chapter 5: The SMUD Rebate and Financing Program

*(Does participation in other SMUD energy conservation programs contribute to the observed kWh savings impact of the Home Electricity Report program)?*

SMUD administrators wanted to know whether participation in the various energy efficiency rebate and financing programs offered by SMUD made any contribution to the energy savings impact attributed to the Home Electricity Report program. Put another way: *Did SMUD's rebate and financing programs help Home Electricity Report recipients achieve some of their electricity savings when these customers participated in both programs?* Also of interest was determining whether the Home Electricity Report program had any effect on driving customers into SMUD's rebate and financing programs.

Determining the contribution of SMUD's rebate and financing programs on energy savings attributed to the Home Electricity Report program was accomplished by re-running the regression GLM without households that participated in the rebate and financing programs. An effect of the SMUD rebate and financing program would be indicated by a drop in the savings estimate when the model is run without that subgroup.

Determining whether the Home Electricity Report program had any effect on driving customers into SMUD's rebate and financing programs was accomplished by estimating whether the participation rates for the rebate and financing programs had changed differentially over time for the Home Electricity Report program treatment and control groups. If receipt of the Home Electricity Reports led households to participate more in the SMUD rebate and financing program, then we would expect to see an increase in participation during the pilot program year and the rate of participation should be greater for the treatment group relative to the control group.

## The Effect of Joint Program Participation on Energy Savings

Approximately 9,300 (or 11 percent) of the SMUD customers participating in the Home Electricity Report evaluation study also participated in SMUD's rebate and financing programs between January, 2007, and April, 2009. To see what influence this group had on the overall energy saving effects attributed to the Home Electricity Report program, we re-ran ADM's regression GLM for overall effects by including only those customers who had *not* participated in the SMUD rebate and financing programs. That is, *we excluded the SMUD rebate and finance program participants from the regression GLM analysis*. If there was no effect of the rebate and financing programs after removing the rebated group, then the results should be the same as what we reported in Chapter 2 – a savings of 1.9 percent. If there was an effect, then we should see a drop in the observed level of savings.

What we found was that the impact dropped from 1.9 percent to 1.4 percent. This drop of approximately 0.5 percent suggests that participation in the SMUD rebate and financing

programs contributed to the energy savings that we attributed to customers who received the Home Electricity Reports. That is, *the savings of the Home Electricity Report recipients were partially influenced by the SMUD rebates and financing support received by households that participated in both programs*. Additionally, we re-ran this analysis by removing the influence of only those customers who participated in the SMUD rebate and financing programs *prior* to the Home Electricity Report pilot program. The result was essentially the same. *Thus, the statistical evidence suggests that about one quarter*[22] *of the savings attributed to the Home Electricity Reports can be accounted for by the financial support provided by SMUD's rebate and financing programs designed to help residential customers purchase energy efficient products and services.*

The regression GLM results for these analyses can be found in Appendix F.

## Rebate/Finance Program Participation Rates

*Did receipt of the Home Electricity Reports promote participation in the SMUD rebate and financing programs?* That is, we wanted to know whether the Home Electricity Report recipients participated in the SMUD rebate and financing programs at a more accelerated rate relative to the control households in order to fund some of the energy efficiency changes they might have become aware of from their exposure to the Home Electricity Reports.

We examined this question by tracking the notification of SMUD rebate and financing awards for treatment and control group households who participated in the SMUD rebate and financing program during the year prior to the Home Electricity Report pilot program (January, 2007, through March, 2008) compared to the year of the pilot program (April, 2008, to April, 2009). In this analysis, households that received multiple awards in either time period were counted only once.

*Table 5-1: Participation of Treatment and Control Group Households*[23] *in the SMUD Rebate and Financing Program Before and During the Home Electricity Report Pilot Program*

| **Time Frame** | **Control Group** | | **Treatment Group** | | **Percent Difference** |
|---|---|---|---|---|---|
| | N | % | N | % | |
| Pre-Pilot | 3,173 | 6.5 | 2,261 | 6.5 | 0.0 |
| Pilot Program | 2,140 | 4.4 | 1,714 | 4.9 | 0.5 |

The data in Table 5-1 show that participation rates for the SMUD rebate and financing programs were the same (6.5 percent) for the treatment and control households during the year prior to the Home Energy Report pilot program. However, participation rates declined for both groups

[22] 0.5/1.9 = .26

[23] The percentages in Table 5-1 are derived from a control group base of approximately 49,000 households and a treatment group base of approximately 35,000 households.

during the year of the pilot program. This was also the year of the 2008-2009 economic recession which could help explain the decline in participation in the rebate and finance programs. Nevertheless, *it should be noted that the participation rate for the treatment group was higher than that of the control group in the year of the pilot program: 4.9 percent versus 4.4 percent*. Thus, the recipients of the Home Electricity Reports maintained a greater level of involvement in the SMUD rebate and financing programs compared to similar households who did not receive the Home Electricity Reports during a time of great economic stress for California, and the nation.

Taken together, the data in Table 5-1 suggest that a greater proportion of Home Electricity Report recipients became involved in the SMUD rebate and financing program compared to control households, perhaps as a way to support the implementation of energy efficiency changes that may have been prompted by the information contained in the Home Electricity Reports. The latter interpretation, however, is an area where further research is needed. Thus, exposure to the Home Electricity Reports appears to have had a positive influence on participation in the SMUD rebate and financing program, but further research is needed to clarify this finding.

## The SMUD Rebate and Financing Program: Summary and Conclusions

We found that SMUD's rebate and financing programs contributed to the energy savings of customers who received the Home Electricity Reports. We also found that recipients of the Home Electricity Reports had a higher rate of participation in the SMUD rebate and financing programs compared to control households. However, further research is needed to clarify the relationship between exposure to the Home Electricity Reports and participation in the SMUD rebate and financing programs.

# Chapter 6: Conclusions and Recommendations

In this concluding chapter, we summarize the key findings in order to answer the main research questions that have guided the study. We also offer recommendations to help SMUD promote continuing efforts to improve residential energy efficiency. Additionally, we offer some recommendations for improving future evaluations of this type and suggest directions for further research.

## What is the Overall Energy Savings Effect of the Home Electricity Reports?

ADM found that the overall effect of the Home Electricity Reports was a net savings of 1.9% on average. This is equivalent to a net savings of 213 kWh annually per household or a savings of approximately 0.6 kWh per day compared to similar households that did not receive the Home Electricity Reports. This difference is shown graphically in Figure 6-1 below.

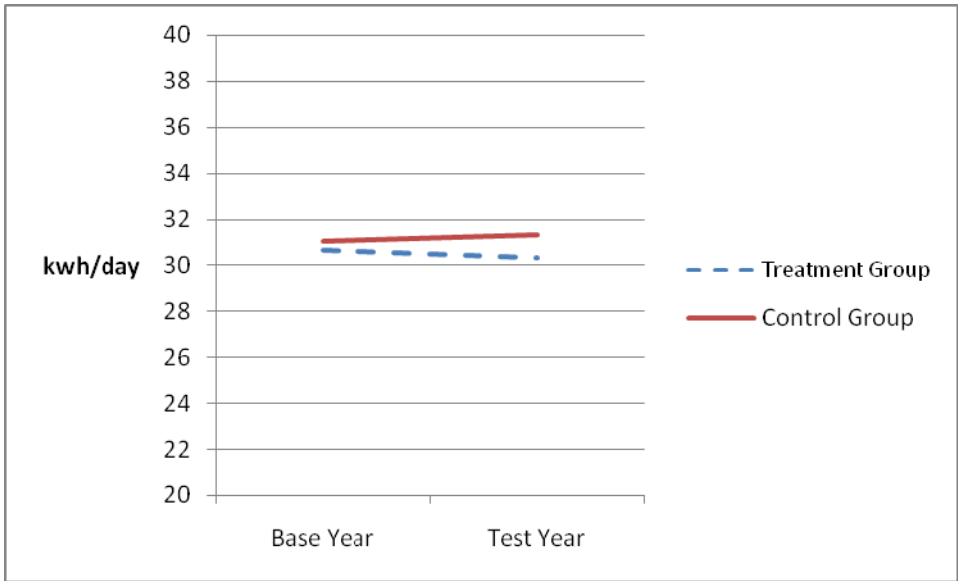



*Figure 6-1. kWh Consumption by Group over Time*

What we see in Figure 6-1, is that the Home Electricity Report recipients reduced their energy consumption over time while the control group households actually increased their electricity consumption.

## Do Savings from the Home Energy Reports Vary by Season and Housing Characteristics?

ADM found that recipients of the Home Electricity Reports realized slightly more savings in the winter quarter – an average savings of 2.1 percent compared to control households– than in the summer quarter – an average savings of 2.0 percent compared to control households. The slightly

greater savings for the winter months can be seen graphically in the bar chart for treatment group below in which reductions in energy consumption are particularly evident for the months of November through February. The total savings for the summer and winter quarters, however, are almost the same (63 vs. 62 kWh respectively). Table 6-1, below, contains the source data for the bar graphs in Figure 6-2.

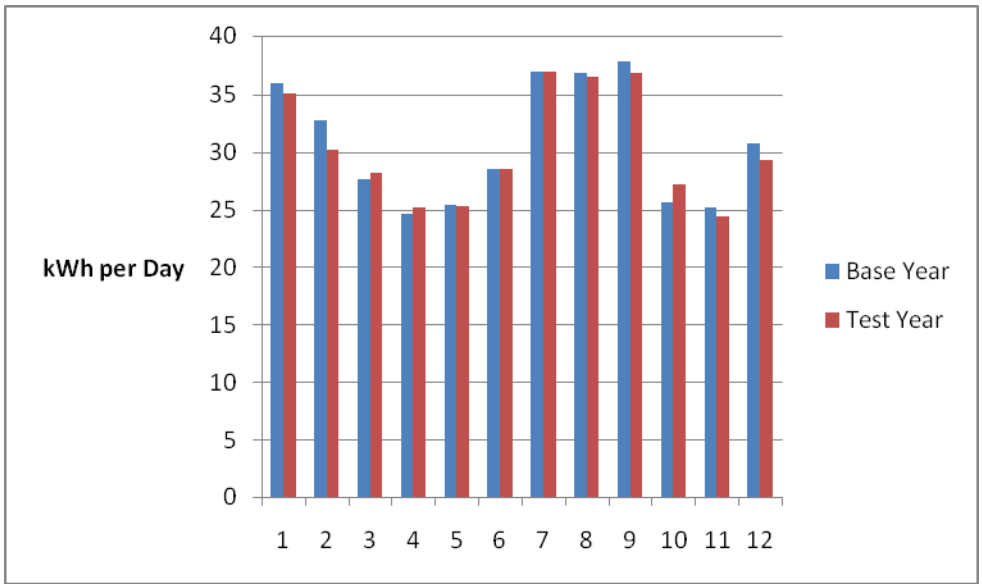



*Figure 6-2. Monthly Comparison of Energy Consumption for Treatment Group Households*

*Table 6-1: Monthly Comparison of Mean kWh per Day for Treatment Group Households*

| | **Treatment Group: Mean kWh per Day** | | |
|---|---|---|---|
| **Month** | **Base Year** | **Test Year** | **Difference** |
| January | 35.98 | 35.06 | -0.92 |
| February | 32.80 | 30.14 | -2.66 |
| March | 27.68 | 28.16 | 0.48 |
| April | 24.63 | 25.19 | 0.56 |
| May | 25.4 | 25.33 | -0.07 |
| June | 28.48 | 28.47 | -0.01 |
| July | 36.86 | 36.88 | 0.02 |
| August | 36.72 | 36.43 | -0.29 |
| September | 37.73 | 36.73 | -1.00 |
| October | 25.63 | 27.16 | 1.53 |
| November | 25.17 | 24.41 | -0.76 |
| December | 30.7 | 29.32 | -1.38 |

We also found that savings for Home Electricity Report recipients varied by certain housing characteristics, as follows:

- The Home Electricity Reports had their greatest impact on homes with pools: 2.4 percent savings (363 kWh).
- The Home Electricity Reports also had a relatively strong impact on newer homes built between 1993 and 2001 (2.4 percent savings, 294 kWh) and older homes built before 1978 (1.9 percent savings, 196 kWh).
- The Home Electricity Reports had a greater impact on customers in average to smaller size homes, defined as 1,600 square feet or less (2 percent savings, 195 kWh) compared to customers in larger homes, defined as greater than 1,600 square feet (1.4 percent savings, 183 kWh).
- The Home Electricity Reports had a greater impact on customers with residential gas accounts (1.8 percent savings, 188 kWh) compared to customers with electric accounts (1.2 percent savings, 159 kWh).

## What Kinds of Energy Efficiency Changes Accounted for the Savings Observed?

The energy saving measures implemented by recipients of the Home Electricity Reports that we were able to identify from our analysis of the SMUD survey data are listed in Table 6-2. The four actions identified, however, only *account for approximately ten percent of the total impact* on energy savings attributed to the Home Electricity Reports.

*Table 6-2. Energy Efficiency Changes Attributed to the Home Electricity Reports*

| Measure | Treatment Effect | Savings Weight | Incidence |
|---|---|---|---|
| Unplug appliances when not in use | .076 | 100 | .56 |
| Turn off PC when not in use | .013 | 390 | .69 |
| Recycle old refrigerator/freezer | .007 | 1161 | .11 |
| Install a whole-house fan | -.007 | 22 | .12 |

Specific observations about the four energy efficiency measures identified are as follows:

- The largest treatment group change due to the home electric reports was getting people to *unplug their electric appliances when not in use*. Over half (56 percent) of the treatment group households claimed to practice this.

- The Home Electricity Reports had a small impact on getting people to turn off their home computers when not in use, but the incidence of this behavior (69 percent) was already rather high to begin with.

- The action with the biggest potential impact was recycling old refrigerators and freezers but only 11 percent of the Home Electricity Report recipients laid claim to this kind of activity.

- The Home Electricity Reports did not have a positive impact on getting more customers to install whole-house fans but the low incidence of this type of installation (12 percent) suggests there is considerable room for improvement with this type of change in the future.

Table 6-3 summarizes the energy efficiency changes made by Home Electricity Report users with substantial levels of documented savings. Two-thirds of the energy efficiency changes reported by Home Electricity Report savers derive from the following actions:

- Turning off lights in unoccupied rooms

- Setting thermostats

- Switching to CFLs

- Using fans instead of air conditioning (AC)

- Using alternatives to electrical power like washing dishes by hand or not using electrical power when there are reasonable alternatives. Examples of the latter include sleeping without AC, turning off the AC when away from home, turning off the outside lights after going to bed, and microwave cooking.

- Buying Energy Star products

- Keeping out the sun’s heat

- Installing a ceiling fan

- Unplugging electrical devices when not in use

*Table 6-3. Summary Energy Saving Changes Made by Home Electricity Report Users*

| Home Electricity Report Tip | Tip Code | Category | N | % |
|---|---|---|---|---|
| Turn off lights in unoccupied rooms | 52 | Behavioral | 23 | 12.43 |
| Set your thermostat for comfort and savings | 92 | Behavioral | 19 | 10.27 |
| Switch to compact fluorescent light bulbs (CFLs) | 47 | Low Cost | 17 | 9.19 |
| Other changes | 200 | Behavioral | 14 | 7.57 |
| Reduce air conditioning costs by using fans | 84 | Behavioral | 12 | 6.49 |
| Buy ENERGY STAR | 1 | Investment | 11 | 5.95 |
| Keep out the sun's heat | 20 | Behavioral | 7 | 3.78 |
| Choose an efficient refrigerator | 2 | Investment | 7 | 3.78 |
| Install a ceiling fan | 17 | Investment | 6 | 3.24 |
| Choose an efficient dishwasher | 5 | Investment | 6 | 3.24 |
| Unplug stereos and other devices when not in use | 60 | Behavioral | 4 | 2.16 |
| Choose efficient windows | 23 | Investment | 4 | 2.16 |
| Reduce pool pump run-time | 122 | Behavioral | 4 | 2.16 |
| Be smart about clothes washing | 12 | Behavioral | 4 | 2.16 |
| Choose an efficient clothes washer | 4 | Investment | 4 | 2.16 |
| Improve shading for windows | 18 | Behavioral | 3 | 1.62 |
| Upgrade your central air conditioner | 14 | Investment | 3 | 1.62 |
| Choose a laptop computer instead of a desktop computer | 53 | Investment | 3 | 1.62 |
| Use and switch off power strips | 59 | Both | 3 | 1.62 |
| Use clothes dryer efficiently | 77 | Behavioral | 3 | 1.62 |
| Stay cool and save with a whole-house fan | 79 | Investment | 3 | 1.62 |
| Shade coverings and awnings | 86 | Behavioral | 3 | 1.62 |
| Hang laundry to dry | 10 | Low Cost | 2 | 1.08 |
| Recycle your second refrigerator | 11 | Behavioral | 2 | 1.08 |
| Weather strip windows and doors | 28 | Low Cost | 2 | 1.08 |
| Reduce water heater temperature | 70 | Behavioral | 2 | 1.08 |
| Install sun screens | 87 | Investment | 2 | 1.08 |
| Improve insulation | 22 | Investment | 1 | 0.54 |
| Seal leaky ducts | 27 | Investment | 1 | 0.54 |
| Maintain your air conditioner | 15 | Investment | 1 | 0.54 |
| Use indoor light timers and sensors | 49 | Investment | 1 | 0.54 |
| Be smart about dishwashing | 13 | Behavioral | 1 | 0.54 |
| Choose an efficient television | 54 | Investment | 1 | 0.54 |
| Use solar power | 57 | Investment | 1 | 0.54 |
| Install efficient showerheads | 69 | Low Cost | 1 | 0.54 |
| Set refrigerator temperature wisely | 7 | Behavioral | 1 | 0.54 |
| Make sure refrigerator seals are tight | 6 | Both | 1 | 0.54 |
| Use solar outdoor lights | 73 | Investment | 1 | 0.54 |
| Seal air leaks | 30 | Investment | 1 | 0.54 |

## What Percentage of the Home Energy Efficiency Changes Were Behavioral as Opposed to Equipment Changes?

The majority of energy saving changes identified by the SMUD survey and the ADM telephone interviews were behavioral in nature. Three of the four (75 percent) changes identified in the SMUD survey were behavioral and 57 percent of the changes identified by respondents in the telephone interviews were behavioral.

The most common kinds of behavioral changes cited by the high energy savers in the telephone interviews included the following:

- Turning off lights in unoccupied rooms;
- Setting thermostats to save energy;
- Using alternatives to electrical power like washing dishes by hand;
- Reducing air conditioning costs by using fans;
- Keeping out the sun's heat; and
- Unplugging stereos and other electronic devices when not in use.

Equipment changes can involve major investments in energy efficient technology like switching to solar power or buying Energy Star appliances, or low-cost solutions like purchasing CFLs. About 30 percent of the changes made by home energy report savers involved equipment changes that required significant financial investment. Alternatively, low-cost equipment changes were reported by approximately 12 percent of the home energy report savers. Approximately two percent of the changes involved both a significant behavioral component and a significant equipment change component. An example cited by respondents included buying power strips (surge protectors) and then making the decision to switch them off when the devices they controlled were not in use.

## Does Participation in Other SMUD Energy Conservation Programs Contribute to the Savings Found for Recipients of the Home Electricity Reports?

We found that SMUD's rebate and financing programs accounted for about one quarter of the energy savings attributed to the Home Electricity Reports. That is, the savings of the Home Electricity Report recipients were partially influenced by the SMUD rebate and financing support received by households that participated in both programs. This suggests that the financial support provided by SMUD's rebate and financing programs helped residential

customers purchase energy efficient products and services that they may have become aware of through the Home Electricity Reports.

That participation in the SMUD rebate and financing programs did not increase during the Home Electricity Report pilot year is somewhat understandable given the severe economic recession of 2008-2009. What is notable, however, is that recipients of the Home Electricity Reports maintained a greater level of involvement in the SMUD rebate and financing programs compared to similar households who did not receive the Home Electricity Reports in spite of the fact that the economy was facing its greatest test since the Great Depression of the 1930s.

The data examined indicate that a greater proportion of Home Electricity Report recipients became involved in the SMUD rebate and financing program compared to control households. This could have come about as a way to support the implementation of energy efficiency changes that may have been prompted by the information contained in the Home Electricity Reports. We consider this to be a working hypothesis that needs verification through further research. While exposure to the Home Electricity Reports appears to have had a positive influence on participation in the SMUD rebate and financing program, further research is needed to verify the process by which this may have taken place.

## Recommendations for Program Improvement

ADM has two recommendations for program improvement. The first is to promote high-impact energy efficiency activities that may be under-utilized in the SMUD population. Refrigerator recycling comes to mind here. The second kind of program recommendation has to do with focusing education and energy efficiency promotions of various kinds that are tailored to identifiable demographic subgroups that we found to be nonusers of energy efficiency information such as that provided in the Home Electricity Reports.

### *Promote Refrigerator Recycling*

Refrigerator recycling has one of the biggest potential payoffs for saving energy but was at the bottom of the list in terms of its incidence in the SMUD customer population. If more people could be persuaded to recycle their old refrigerators and freezer rather than keeping them as second-use appliances, then a lot more energy could be saved. Based on the SMUD Energy Use survey, the current incidence of refrigerator recycling is around 10 to 11 percent of the population. Normative data on refrigerator recycling should be examined and a determination made as to whether refrigerator recycling in the Sacramento area is under-utilized or not. If the conclusion is that refrigerator recycling is currently under-utilized, then it should be more actively promoted.

### *Conduct Targeted Energy Efficiency Promotions*

High energy savers who said they didn't achieve their savings by following any of the tips in the Home Electricity Reports were primarily households that had already implemented energy

saving changes and the reports did not provide them with any new ideas. Other types of nonusers were customers that could be targeted for educational or behavioral programs aimed at providing energy saving information that might correct either a misperception or a lack of information about residential energy conservation. Table 6-4 summarizes various subgroups that might be good candidates for such programs.

*Table 6-4. Non-Users of Energy Information and Possible Solutions*

| **Target Group** | **Barrier to using energy efficiency information** | **Possible Energy Change Solution** |
|---|---|---|
| Senior Citizen | Home all day and do not know how else to save more electricity. | Free home energy efficiency audit |
| Low Energy Users | Low user and feels household is doing enough. | Free home energy efficiency audit |
| Busy Families | No time | Free home energy efficiency audit |
| Frugal Families | Low income or no money to invest in major energy saving technology. Can't afford to make big improvements that require significant investment, but open to making low cost changes in the home. | Promote behavioral changes and low-cost energy efficiency solutions |
| Renters | Feel they can't do anything to save energy because they rent the home. | Promote behavioral changes and low-cost energy efficiency solutions |

# Recommendations for Evaluation Improvement

In this section, we discuss two sets of recommendations for improving future SMUD program evaluations based on our experience with the home energy report program evaluation. The first recommendation focuses on changes needed in the overall study sampling design and the method used for assigning households to treatment and control groups. The second recommendation discusses improvements needed in survey design.

### *Sampling Design*

The Home Electricity Report Program Evaluation could have been carried out as a randomized experiment, but was not because of the "block batch" method of assigning census blocks to groups. Rather, the block batch method produced a quasi-experiment in which the treatment and control groups differed at the outset in average kWh per day. While the initial group differences in kWh were small, so was the final measured impact on kWh savings, and the credibility of conclusions about the significance of the between group differences in the post-test period rested on the extent to which the statistical controls were effective in leveling the playing field. This produced a threat to the internal validity of the study. Such concerns would have been moot had a true experiment rather than a quasi-experiment been implemented. This would have been possible by using a stratified sampling design in which households were randomly assigned to treatment and control group within strata.

We think it was perfectly acceptable to have selected the 85 census tracts that had a high density of single-family homes. The other inclusion / exclusion criteria that were applied in identifying

the 84,000 households for the study were fine as well. Where the sampling design problem is introduced is in how the set of 84,000 households are manipulated in assigning "block batches" to the treatment or control groups.

*A better sampling plan would be to apply the Dalenius-Hodges method*[24]*in creating a stratified random sample based on the right-skewed kWh distribution of the 84,000 households from the pre-test year*. This would involve first sorting the households identified from the selected residential census tracts on the basis of the pre-test year kWh distribution. The total sample could remain at 84,000 or it could be reduced to 50,000. The Dalenius-Hodges method would then be used in a computer program to select a stratum to sample with certainty from the total sample consisting of those households with the largest initial kWh consumption in the pre-test year. This might be all single-family residential households above the 90$^{th}$ percentile rank in pre-test year kWh (which might be 2,000 kWh per month on the average, for example). A series of non-certainty strata (e.g., four to six probably) would also be identified based on an identified cut-point. In the final step, half of the certainty strata household would be randomly assigned to the treatment group and half would be randomly assigned to the control group. Similarly, half of the households in each non-certainty strata would be randomly assigned to the treatment group and half would be randomly assigned to the control group.

The recommended method of stratified random sampling would probably produce a more closely matched set of treatment and control samples which would increase the internal validity of the study. Additionally, it would probably also produce a sample with better external validity whose results could be generalized with greater confidence to the SMUD residential population. This was a characteristic of the sample selected by Positive Energy that we found not to be true.[25]

***Survey Design***

The original request for proposals (RFP) for an evaluation of SMUD's Residential Home Electricity Report Program called for the evaluation contractor to develop and implement a survey of participants to measure the effects of the program on replacement of equipment and changes in customer behavior that may affect savings detected through a statistical analysis of billing data. We learned at the kick-off meeting, however, that SMUD wanted us to analyze their Energy Use Survey, which had already been implemented with a sample of households participating in the evaluation of the Home Electricity Report Program. Our second set of recommendations for improving the Home Electricity Report program evaluation therefore address three aspects of our experience with the survey component of that study.

- Limitations in using an instrument/method developed for other purposes

[24]Dalenius,T. and Hodges, J.L., (1959). Minimum variance stratification. *Journal of the American Statistical Association*, 54, 88-101.

[25]The implication of this finding is that the results of the current evaluation will have to be weighted in order to be generalized to the SMUD residential population.

- Limitations in the SMUD Energy Use Survey
- Limitations of the SMUD Survey Sample

***Using a Method Developed for Other Purposes***

Under SMUD's original RFP framework, we would have been limited to a post-test-only design in implementing the survey component of the study. The main potential advantage of analyzing SMUD's Energy Use Survey was that it provided an opportunity to measure change from a pre-test period to a post-test period. Unfortunately, we never realized this potential advantage because of limitations in SMUD's survey's design, as noted below. Additional problems with the SMUD survey, as discussed below, further limited its usefulness to the evaluation. In retrospect, it would have been better had SMUD planners designed the evaluation to begin at the same time as the program. That way, the evaluation contractor could have designed the survey and implemented it longitudinally in a pre-test / post-test control group design – the same way that the overall study was designed.

But the main point here is that when one uses extant data, the new research will always be limited by the purposes and design of the primary researchers whose needs, intents, and orientations may be very different from that of the secondary researchers. This was definitely the case in the evaluation of the Home Electricity Report Program and seriously limited the usefulness of the survey data analyzed.

***Limitations in the SMUD Energy Use Survey***

There were three survey design problems that limited the usefulness of the SMUD Energy Use Survey: (a) Lack of ID codes on the pre-survey; (b) lack of detailed and differentiated instructions to respondents; and perhaps most importantly (c) the 16 item SMUD scale contained too few items and did not adequately cover the domain to be measured, which unnecessarily reduced the content validity of the scale. Each of these is discussed below.

**ID Codes:** The pre-survey lacked account codes to identify respondents. This was rectified on the post-survey, but the damage had already been done. Without account codes on the pre-survey, the pre- and post- versions of the survey could not be linked for longitudinal analysis which eliminated the possibility of analyzing change over time at the individual level. This limited the inferential statistical analysis to a post-test-only design.

**Instructions:** The surveys administered to the treatment and control groups were exactly the same and provided only general directions for how to respond to the 16 item scale: "*Please select any of the following things you may have done to your home in the past year*." In our opinion, it would have been better to have had more articulated instructions that directed a respondent to identify equipment changes as well as behavioral changes that had resulted from exposure to information received from SMUD that had influenced their actions. As it was, there was nothing

that alerted respondents to focus on any connection between actions they had taken at home in response to any initiatives that SMUD was interested in monitoring on behalf of its customers.

**Item Pool:** The survey scale used to measure customer change was composed of 16 items that were sometimes worded too vaguely and which did not adequately cover the range of tip code categories that were the stimulus for action under the Home Electricity Report Program. The problem was more the latter than the former.

With respect to question wording, item 10 on the SMUD survey scale for example, was vague and should have specified that the existing heater or air conditioner was replaced with an *energy efficient* heater or air conditioner. All it says is "Replaced my heater or air conditioner." Nothing is mentioned about whether the customer upgraded the existing heating or cooling system with a more energy efficient system.

The big problem with the survey is that it was under-designed and did not cover an adequate range of energy efficiency actions to accurately measure and account for a substantial portion of the total savings that customers actually implemented. In short, the 16 item survey scale was too short and had major gaps in covering the domain to be measured. A glaring omission, for example, was that there was no coverage of customer efforts to save energy with residential swimming pools. This is doubly unfortunate since the greatest savings detected from the billing analysis was for homes with pools.

The content validity of the 16-item scale was also unnecessarily reduced by including items that were unrelated to the SMUD-authorized tip codes. While 14 of the 16 items measured changes relevant to the tip codes, there is no reason why all 16 should not have been relevant.

But as mentioned above, the biggest problem was that the scale did not include enough relevant items to adequately cover the range of existing tip code categories. There should have been multiple items (at least three) measuring each of the eight tip code categories. At a minimum, a scale composed of 24-27 items would have provided better content coverage of the domain to be measured. Table 6-5 illustrates the content coverage in the existing 16-item scale compared to an alternative that we would recommend. Note that there were no items measuring the pool category and only a single item was used to measure the domains of interest in half of the categories that needed to be covered.

*Table 6-5. The Existing 16-Item Scale and a Recommended Alternative Scale*

| SMUD Category | Number of SMUD-Authorized Tip Codes | Survey Items: Current Number | Survey Items: Recommended Number |
|---|---|---|---|
| Appliances | 12 | 1 | 3 |
| Cooling | 14 | 2 | 3 |
| HAC | 12 | 5 | 5 |
| Heating | 8 | 1 | 3 |
| Lighting | 9 | 1 | 3 |
| Pool | 3 | 0 | 3 |
| Water Heating | 6 | 1 | 3 |
| Other | 15 | 3 | 4 |
| Total | 79 | 14 | 27 |

Note. Two items on the existing 16-item scale were not valid measures of the Home Electricity Report tip codes.

### *Limitations of the SMUD Survey Sample*

The bias toward energy conservation discovered in the treatment group survey sample started with the bias in the overall study sample since the survey sample was a random sample subset of the total sample. We statistically controlled for that bias as best we could by using three-way interaction terms that measured energy consumption in the pre and post- periods by treatment control group membership by changes in weather conditions over time. However, a good start to correcting the sampling bias in the survey sample would be to use the same solution as recommended for selecting the overall study sample. That is, use a stratified random sampling technique such as the Dalenius-Hodges method to select the survey sample.

In the mail survey context, however, the other problem is how to minimize the sampling bias resulting from self-selection that produced a sample in the Home Electricity Report program evaluation that was more conservative in its energy use than the overall study sample. We believe this happened because interest in the topic of energy conservation likely influenced the decision to complete and return the SMUD Energy Use questionnaire, and this probably affected the treatment group more than the control group. A solution to this problem would be to change the survey method from a mail questionnaire to a telephone interview. While refusals do occur in telephone interviews, the interviewer has more control of the survey completion outcome compared to a questionnaire in which the respondent is the one who exercises complete control over the decision to complete the survey or not.

One could ask whether the sample sizes that we ended up with were adequate. The 19 percent response rate on the post-survey generated a treatment group sample of 928 households and a control group sample of 949 households. These samples appeared adequate for the analyses we conducted, but could have been larger, particularly if more fine-grained analyses were desired. In the future, ways to increase response rates above 20 percent might be considered, including the use of incentives and instituting a follow-up procedure.

***Specific Recommendations for Improving Evaluation Designs***

In summary, ADM makes the following recommendations for improving future SMUD evaluations of energy conservation programs:

- Where the population kWh distribution is skewed, select a stratified random sample based on applications of the Dalenius-Hodges method or similar techniques.
- Implement the evaluation concurrently with the program so that the evaluation contractor can collaborate with program planners in a timely fashion, particularly in the interest of collecting longitudinal data.
- Always collect unique ID codes from respondents at each point of data collection to enable the linking of data collection forms.
- Use detailed instructions that are appropriately differentiated for different study groups so that respondents provide data specific to SMUD's monitoring and evaluation interests.
- Write survey items with adequate detail that clearly describe the phenomena of interest.
- Develop longer surveys that adequately measure all domains of interest. Use survey blueprints to design and evaluate the item structure of a proposed survey.
- Consider the use of a telephone interview procedure as an alternative to a mail survey as a way of reducing selection bias when interest in the topic is likely to influence the decision to complete and return a mail questionnaire, as well as when education and age levels are also likely to influence self-selection into the survey sample.
- Consider the use of incentives and follow-up procedures for increasing survey response rates.

## Directions for Further Research

The big unanswered question at this point is: What accounts for the savings in energy detected from the billing analysis? We know some things that the recipients of the Home Electricity Reports did that account for the observed savings. From the SMUD survey analysis, we identified three to four actions that account for about ten percent of the savings attributed to the Home Electricity Reports. We also suspect that another 25 percent of the savings can be attributed to energy efficiency changes that were facilitated by SMUD rebates and financing provided to Home Electricity Report recipients. This leaves 65 percent of the savings unaccounted for.

Clearly, there is a need to focus much more directly on discovering the processes and actions taken by Home Electricity Report recipients that led them to realize savings. This need points to the relevance of conducting more rigorous survey research focused on understanding what

different types of customers do with the information they get from the Home Electricity Reports, using representative, unbiased samples of the SMUD residential population. In particular, there is a need to focus more directly and intensely on what customers do with the Home Electricity Reports in combination with interactions they might have with other SMUD energy conservation programs like the SMUD rebate and financing programs that customers might pursue to help them achieve energy efficiency changes they want to realize. Similarly, better information is needed on what non-participants do to save energy on their own and in cooperation with SMUD rebate and financial assistance opportunities.

We also understand that SMUD is interested in developing a better understanding of customer persistence in energy conservation and the factors that influence such persistence. This calls for a longitudinal study that contrasts known-savers with non-savers on characteristics that distinguish them and that identifies factors that predict membership in each group. The ADM telephone survey began to explore some descriptive characteristics in this regard on a relatively small scale with home energy report recipients who were documented savers. These characteristics focused on financial investment decisions and behavioral changes that supported energy efficiency outcomes. This kind of rigorous research needs to be continued on a larger scale with a broader scope of data collection, include a comparison group, and be carried out longitudinally. One area in which the data need to be broadened is in examining the savings impact of specific actions, similar to what ADM did by weighting the SMUD survey data in terms of annualized kWh impacts. However, we suggest taking a longer view by extrapolating these savings impacts over an estimated useful life. It would also be important to validate our extrapolations by monitoring the persistence of identified investment effects and behavior changes over time.

A study to evaluate persistence in energy conservation that follows-up on the present evaluation to account for a greater proportion of the identified savings would want use the same sample of 84,000 households as a sampling frame, and sample from it. The following research questions might be used to focus such a study:

1. *What accounts for the observed savings identified from the billing analysis?*
2. *What factors (demographic and energy efficiency related) discriminate energy savers from non-savers?*
3. *How long do estimated savings and savers persist?*
4. *To what extent do non-savers become savers?*
5. *What factors predict persistence?*

A general strategy for answering these research questions might include the following steps:

- Design a survey to better account for energy savings and to measure persistence in cases that could be subset as savers and non-savers.

- Select a stratified random sample of savers and non-savers from SMUD's Home Electricity Report database, subset for households that received Home Electricity Reports and those that did not.

- Survey the samples and conduct a discriminate function analysis and logistic regression analysis to identify the factors that characterize membership in each group and subgroup.

- Continue to implement the survey longitudinally to measure savings and persistence over time and the factors that predict each.

- Monitor a subset of households for case study and to verify lifetime savings extrapolations.

- Continue to apply appropriate multivariate methods in a longitudinal field experiment.

## Final Thoughts on Program Effectiveness

The finding of an average impact of 1.9 percent savings for the Home Electricity Report Program is the net overall difference between the treatment and control groups in the evaluation study, statistically controlling for measured covariates like initial differences in kWh consumption. The mean impact of the Home Electricity Reports varies depending on housing characteristics, season, and concurrent participation in other energy conservation programs like SMUD's rebate and financing programs. Depending on the circumstances of a given household, the net impact of the Home Electricity Reports varies in the range of approximately 1.2 to 2.4 percent. These findings are consistent with an independent analysis of home energy reports carried out by Ayres at Yale University using the SMUD database and a similar field experiment conducted by Puget Sound Energy. Ayres found energy reductions attributable to the home energy reports in the range of 1.2 percent to 2.1 percent on the average in these two field experiments, and in SMUD's case Ayres "suggests that the reductions may be driven by more 'behavioral' changes (such as turning off lights in empty rooms) rather than 'durable' changes (such as caulking or replacing inefficient appliances."[26] While the magnitude of the impact of the Home Electricity Reports might be considered to be on the small side, the available evidence from the present study is that they can make a positive difference in helping consumers save energy in the home.

[26]Ayres, I, Raseman, S., and Shih, A. "Evidence from Two Large Field Experiments that Peer Comparison Feedback Can Reduce Residential Energy Usage" http://ssrn.com/abstract=1434950

# Appendix A: Sample Home Electricity Report

SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More.®

Account number: [redacted]

## Home electricity report

bill period: 12/22/07 - 01/24/08

**WHAT IS THIS?** This report contains information and analysis about your electricity consumption and personalized tips to help you reduce your use and bills.

**WHY AM I RECEIVING IT?** 35,000 randomly selected SMUD customers are receiving these reports as part of a pilot program.

**HOW DO THE COMPARISONS WORK?** Your neighbors were selected based on location, home size and heat type to make the comparisons as fair and relevant as possible.

We hope the information in this report helps you to better understand and make choices about your electricity use!

**********AUTO**MIXED AADC 430

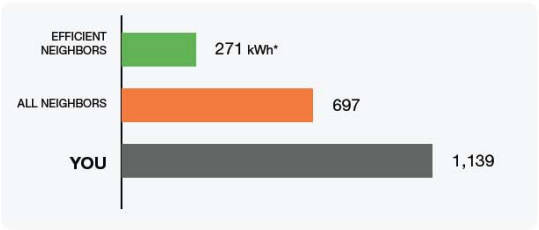
[redacted]

SACRAMENTO, CA 95833

**Last month you used 63% MORE electricity than your neighbors.**

Your efficiency standing: **BELOW AVERAGE**.

This means that many of your neighbors in similar-sized homes used less electricity than you did. See the back of this report for some personalized suggestions to help you save significant energy and cost.

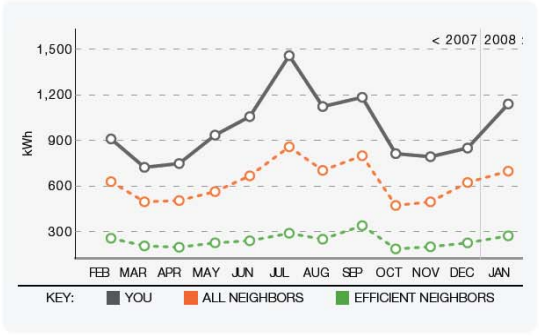



* kWh: A 100-Watt bulb burning for 10 hours uses 1 kilowatt-hour.

**In the last 12 months you used 56% MORE than your neighbors.**
**At today's rates this COSTS YOU ABOUT $430 EXTRA PER YEAR.**

This means you have a great opportunity to save energy and money in the future.

You consume more energy than your neighbors in the winter, which means you probably spend a lot on heating. You can reduce your home heating costs by maintaining your heating system each year and improving your insulation.




**YOUR NEIGHBORS** "All neighbors" means approximately 100 occupied homes nearby that are similar in size to yours (avg. 1,003 sq ft) and have the same heat type as you. "Efficient neighbors" are the 20% with the lowest usage from that group.

Personalized Action Steps

- ☐ Be smart about heated blankets and pads
- ☐ What to look for in a space heater
- ☐ Choose an efficient television

TURN OVER TO LEARN MORE

**You used 1% MORE electricity this December than you did last year.**

**Dec 1 - Dec 31 Usage (kWh/day)**


In all of 2007 you used 19% more electricity than you did in 2006. Start off the new year right by taking steps to reduce your energy use in 2008. We've provided some tips selected especially for you below.

STARS ARE AWARDED WHEN YOU USE LESS THAN IN 2006.

| JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| +28% | +17% | +11% | +61% | +78% | +26% | +3% | +9% | +11% | +18% | +10% | +1% |

## Action Steps | Personalized tips chosen for you based on your energy use and housing profile

### Quick Fixes
Things you can do right now

☐ **Be smart about heated blankets and pads**

Our analysis shows you have high electricity use in the winter. Electricity use for heated blankets and heating pads can add up and may contribute to your high overall use.

If you use one of these devices to stay warm while under bedcovers, you likely need only minimal supplemental heat in the room overall, so consider turning down the thermostat or other heating device.

Remember to turn off the blanket or pad when it's not in use.

**SAVE UP TO $10 PER YEAR**

### Smart Purchases
Save a lot by spending a little

☐ **What to look for in a space heater**

A space or portable heater can be an efficient form of heat if you use it to warm a small area and reduce the temperature in the rest of your home.

Safety is a primary concern, so be certain the model you choose has the Underwriter's Laboratory (UL) label and will automatically sound an alarm or shut off if tipped.

Look for models with a thermostat control and timer for added convenience and savings.

**SAVE UP TO $55 PER YEAR**

### Great Investments
Big ideas for big savings

☐ **Choose an efficient television**

Some large flat screen televisions use more energy than a refrigerator. When shopping for a new television, look not only for a brilliant resolution but also the ENERGY STAR® label.

Televisions qualified to earn the ENERGY STAR use 30% less energy than non-labeled models of the same type—without any sacrifice in picture quality.

Before you move your old TV into another room, consider its energy costs—recycling it may be a better option.

**SAVE UP TO $40 PER TV PER YEAR**

SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More ®

powered by Positive Energy

1-888-742-SMUD (7683)
electricityreports@smud.org

For information about this home electricity report please visit www.smud.org/reports.

# Appendix B: Computation of the Savings Effect

| | | | | | OVERALL EFFECT: FULL SAMPLE | | |
|---|---|---|---|---|---|---|---|
| | CDD-3WAY | HDD-3WAY | PARTPOST | | PRE | POST | 24 MONTHS |
| OVERALL | -0.001754024 | 0.0006427 1 | 0.1506099 | CDD | 109.5848 | 128.237 | 118.8161 |
| SIG | 0.0001 | 0.0001 | 0.14 | HDD | 357.4963 | 378.9376 | 368.1079 |

| | PRETEST | POSTTEST | 24 MONTHS |
|---|---|---|---|
| CDD | -0.192214369 | -0.2249308 | -0.20841 |
| HDD | -0.229766447 | -0.243547 | -0.23659 |
| INTERCEPT | -0.150609884 | -0.1506099 | -0.15061 |
| EFFECT | **-0.5725907** | **-0.6190876** | **-0.5956** |
| SAVINGS | -0.018681772 | -0.0201988 | -0.01943 |

| | |
|---|---|
| PRETEST MEAN DV | 30.6497 |

The regression coefficients for overall effects for the three theoretically important variables in ADM's model are displayed in the first row, above, with their corresponding levels of statistical significance in the second row. All three are statistically significant at the 85 percent confidence level. Weather index data are displayed to the right of this information for cooling degree days (CDD) and heating degree days (HDD) for each period of observation: the pre-year, the post-year, and the 24-month period of the study. Below all of this information, we calculate the effects and percent savings for each study period.

The CDD pre-test result in the first column is calculated as a product of the CDD_3way coefficient and the CDD index value for the pre-period; this product is -0.192214369. The HDD pre-test result in the first column is calculated as a product of the HDD_3way coefficient and the HDD index value for the pre-period; this product is -0.229766447. The intercept term is inserted from the PARTPOST variable. *The overall effect of the program is the sum of these three product terms, which is bolded as* ***-0.5725907****.* This estimate is the overall average amount of energy saved per day per household in kWh units for customers who received the Home Electricity Reports.

Percent savings is calculated as a ratio of the program effect and mean kWh consumption in the pre-year. This computation is -0.018681772/30.6497 = -.0187 = -1.9 = a savings of 1.9 percent.

Calculating program effects and savings in the same way for the post-test year and for the 24 months of observation suggests that the overall effect of the Home Electricity Reports is essentially in the range of 1.9 percent savings to 2.0 percent savings. *We report the 1.9 percent savings primarily because it comes from using the pre-weather conditions and essentially represents the effect of the Home Electricity Reports holding weather constant.*

# Appendix C: Regression GLM Results for the Billing Analysis

**Note: * = statistically significant at p <= .15**
**** = statistically significant at p <= .05**
***** = statistically significant at p <= .01**

**The GLM Procedure: Overall Effects**
Dependent Variable: kwh_day

| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.054592704 | 0.00018883 | 289.11 | <.0001 |
| hdd | 0.016890496 | 0.00007241 | 233.25 | <.0001 |
| post | 0.299674144 | 0.06490702 | 4.62 | <.0001 |
| *PartPost* | *-0.150609884* | *0.10202427* | *-1.48* | *0.1399** |
| Elec_Gas | 3.866711709 | 0.40671355 | 9.51 | <.0001 |
| Posthdd | -0.003198167 | 0.00009514 | -33.62 | <.0001 |
| Postcdd | -0.001673906 | 0.00025877 | -6.47 | <.0001 |
| Treathdd | -0.000220480 | 0.00011349 | -1.94 | 0.0521 |
| Treatcdd | -0.001786318 | 0.00029595 | -6.04 | <.0001 |
| *HDD_3way* | *-0.000642710* | *0.00014931* | *-4.30* | *<.0001**** |
| *CDD_3way* | *-0.001754024* | *0.00040650* | *-4.31* | *<.0001**** |

**The GLM Procedure: Overall Effects for Gas Homes**

Dependent Variable: kwh_day

| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.052702171 | 0.00017987 | 293.00 | <.0001 |
| hdd | 0.010667440 | 0.00006897 | 154.66 | <.0001 |
| post | -1.012926613 | 0.06182654 | -16.38 | <.0001 |
| *PartPost* | *-0.160360017* | *0.09779856* | *-1.64* | *0.1011** |
| Posthdd | -0.000470278 | 0.00009061 | -5.19 | <.0001 |
| Postcdd | 0.002549733 | 0.00024648 | 10.34 | <.0001 |
| Treathdd | -0.000500228 | 0.00010878 | -4.60 | <.0001 |
| Treatcdd | -0.000850360 | 0.00028367 | -3.00 | 0.0027 |
| *HDD_3way* | *-0.000465595* | *0.00014311* | *-3.25* | *0.0011*** |
| *CDD_3way* | *-0.001726102* | *0.00038965* | *-4.43* | *<.0001**** |

**The GLM Procedure: Overall Effects for Electric Homes**

Dependent Variable: kwh_day

| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.060411662 | 0.00046953 | 128.66 | <.0001 |
| hdd | 0.035989580 | 0.00018008 | 199.85 | <.0001 |
| post | 4.310805230 | 0.16139649 | 26.71 | <.0001 |
| *PartPost* | *-0.435606173* | *0.24910084* | *-1.75* | *0.0803** |
| Posthdd | -0.011511559 | 0.00023665 | -48.64 | <.0001 |
| Postcdd | -0.014622332 | 0.00064346 | -22.72 | <.0001 |
| Treathdd | -0.000947595 | 0.00027719 | -3.42 | 0.0006 |
| Treatcdd | -0.004896000 | 0.00072271 | -6.77 | <.0001 |
| HDD_3way | -0.000497494 | 0.00036470 | -1.36 | 0.1725 (ns) |
| CDD_3way | -0.000834649 | 0.00099255 | -0.84 | 0.4004 (ns) |

**The GLM Procedure: Overall Effects for Homes LE 1600 sq ft**
Dependent Variable: kwh_day

| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.045334701 | 0.00023911 | 189.60 | <.0001 |
| hdd | 0.014746256 | 0.00009169 | 160.82 | <.0001 |
| Elec_Gas | 1.949581353 | 0.61072349 | 3.19 | 0.0014 |
| post | 0.589259751 | 0.08237760 | 7.15 | <.0001 |
| *PartPost* | *-0.204565219* | *0.12939053* | *-1.58* | *0.1139** |
| Posthdd | -0.003125859 | 0.00012060 | -25.92 | <.0001 |
| Postcdd | -0.002437602 | 0.00032826 | -7.43 | <.0001 |
| Treathdd | 0.000319804 | 0.00014366 | 2.23 | 0.0260 |
| Treatcdd | -0.000895688 | 0.00037463 | -2.39 | 0.0168 |
| *HDD_3way* | *-0.000607122* | *0.00018918* | *-3.21* | *0.0013**** |
| *CDD_3way* | *-0.001031215* | *0.00051534* | *-2.00* | *0.0454*** |

**The GLM Procedure: Overall Effects for Homes GT 1600 sq ft**
Dependent Variable: kwh_day

| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.064214214 | 0.00029028 | 221.21 | <.0001 |
| hdd | 0.019138299 | 0.00011132 | 171.93 | <.0001 |
| Elec_Gas | 4.783602561 | 0.55285393 | 8.65 | <.0001 |
| post | 0.054175480 | 0.09953980 | 0.54 | 0.5863 |
| PartPost | -0.121939804 | 0.15654201 | -0.78 | 0.4360 (ns) |
| Posthdd | -0.003339974 | 0.00014608 | -22.86 | <.0001 |
| Postcdd | -0.000986313 | 0.00039704 | -2.48 | 0.0130 |
| Treathdd | -0.000790135 | 0.00017448 | -4.53 | <.0001 |
| Treatcdd | -0.002543818 | 0.00045499 | -5.59 | <.0001 |
| *HDD_3way* | *-0.000633669* | *0.00022933* | *-2.76* | *0.0057**** |
| *CDD_3way* | *-0.002506193* | *0.00062397* | *-4.02* | *<.0001**** |

**The GLM Procedure: Overall Effects for Homes Built Before 1978**
Dependent Variable: kwh_day

| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.0500023590 | 0.00022393 | 223.30 | <.0001 |
| hdd | 0.0125056612 | 0.00008587 | 145.63 | <.0001 |
| post | -.5365869453 | 0.07687330 | -6.98 | <.0001 |
| PartPost | -.0164857823 | 0.12356833 | -0.13 | 0.8939 (ns) |
| Posthdd | -.0013321142 | 0.00011275 | -11.81 | <.0001 |
| Postcdd | 0.0008597953 | 0.00030656 | 2.80 | 0.0050 |
| Treathdd | 0.0006396431 | 0.00013789 | 4.64 | <.0001 |
| Treatcdd | -.0021745265 | 0.00035958 | -6.05 | <.0001 |
| *HDD_3way* | *-.0008785720* | *0.00018115* | *-4.85* | *<.0001**** |
| *CDD_3way* | *-.0020269076* | *0.00049266* | *-4.11* | *<.0001**** |

**The GLM Procedure: Overall Effects for Homes Built Between 1978 and 1992**
Dependent Variable: kwh_day

| Parameter | Estimate | Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.060501545 | 0.00035402 | 170.90 | <.0001 |
| hdd | 0.024718608 | 0.00013576 | 182.07 | <.0001 |
| post | 1.808730016 | 0.12169375 | 14.86 | <.0001 |
| *PartPost* | *-0.717097516* | *0.18735111* | *-3.83* | *0.0001* *** |
| Posthdd | -0.006510951 | 0.00017836 | -36.50 | <.0001 |
| Postcdd | -0.006544139 | 0.00048515 | -13.49 | <.0001 |
| Treathdd | -0.002775670 | 0.00020787 | -13.35 | <.0001 |
| Treatcdd | -0.003789717 | 0.00054205 | -6.99 | <.0001 |
| *HDD_3way* | *0.000356420* | *0.00027381* | *1.30* | *0.1930* (ns) |
| *CDD_3way* | *-0.000065093* | *0.00074605* | *-0.09* | *0.9305* (ns) |

**The GLM Procedure: Overall Effects for Homes Built Between 1993 and 2001**
Dependent Variable: kwh_day

| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.0615126463 | 0.00076134 | 80.80 | <.0001 |
| hdd | 0.0122380608 | 0.00029195 | 41.92 | <.0001 |
| post | -.7524594615 | 0.26342226 | -2.86 | 0.0043 |
| *PartPost* | *0.1809515921* | *0.39543967* | *0.46* | *0.6472* (ns) |
| Posthdd | -.0010965702 | 0.00038475 | -2.85 | 0.0044 |
| Postcdd | 0.0025613085 | 0.00104876 | 2.44 | 0.0146 |
| Treathdd | 0.0005560492 | 0.00043626 | 1.27 | 0.2025 |
| Treatcdd | 0.0055694962 | 0.00113762 | 4.90 | <.0001 |
| *HDD_3way* | *-.0010395786* | *0.00057620* | *-1.80* | *0.0712** |
| *CDD_3way* | *-.0039600595* | *0.00157286* | *-2.52* | *0.0118*** |

**The GLM Procedure: Overall Effects for Homes Built Between 2002 and 2005**
Dependent Variable: kwh_day

| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.057519746 | 0.00125382 | 45.88 | <.0001 |
| hdd | 0.010371643 | 0.00048083 | 21.57 | <.0001 |
| post | -1.159208190 | 0.43777618 | -2.65 | 0.0081 |
| *PartPost* | *2.139993373* | *0.64787254* | *3.30* | *0.0010**** |
| Posthdd | -0.000592489 | 0.00063640 | -0.93 | 0.3519 |
| Postcdd | 0.004906378 | 0.00173962 | 2.82 | 0.0048 |
| Treathdd | 0.005983664 | 0.00071588 | 8.36 | <.0001 |
| Treatcdd | 0.000141439 | 0.00186678 | 0.08 | 0.9396 |
| *HDD_3way* | *-0.004033081* | *0.00094477* | *-4.27* | *<.0001**** |
| *CDD_3way* | *-0.007919984* | *0.00257770* | *-3.07* | *0.0021**** |

The GLM Procedure: **Overall Effects for Homes Built Between 2006 and 2007**
Dependent Variable: kwh_day

| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.046962110 | 0.00596133 | 7.88 | <.0001 |
| hdd | 0.016534442 | 0.00228606 | 7.23 | <.0001 |
| post | 1.598834694 | 2.10551438 | 0.76 | 0.4477 |
| PartPost | -1.677949264 | 4.24127080 | -0.40 | 0.6924 (ns) |
| Posthdd | -0.003887642 | 0.00304275 | -1.28 | 0.2015 |
| Postcdd | 0.005182540 | 0.00834751 | 0.62 | 0.5348 |
| Treathdd | -0.002014158 | 0.00469740 | -0.43 | 0.6681 |
| Treatcdd | 0.009588220 | 0.01224936 | 0.78 | 0.4339 |
| HDD_3way | 0.002025291 | 0.00619271 | 0.33 | 0.7437 (ns) |
| CDD_3way | -0.004979655 | 0.01688325 | -0.29 | 0.7681 (ns) |

**The GLM Procedure: Overall Effects for Homes with Pools**
Dependent Variable: kwh_day

| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| | |
|---|---|---|---|---|---|
| cdd | 0.0713016565 | 0.00044603 | 159.86 | <.0001 | |
| hdd | 0.0180006952 | 0.00017104 | 105.24 | <.0001 | |
| post | -.8863524609 | 0.15271258 | -5.80 | <.0001 | |
| *PartPost* | *-.3554664134* | *0.24427570* | *-1.46* | *0.1456* | * |
| Posthdd | -.0020514869 | 0.00022430 | -9.15 | <.0001 | |
| Postcdd | 0.0010257135 | 0.00060933 | 1.68 | 0.0923 | |
| Treathdd | -.0012678546 | 0.00027250 | -4.65 | <.0001 | |
| Treatcdd | -.0029457587 | 0.00071060 | -4.15 | <.0001 | |
| *HDD_3way* | *-.0008328691* | *0.00035803* | *-2.33* | *0.0200* | ** |
| *CDD_3way* | *-.0031023466* | *0.00097386* | *-3.19* | *0.0014* | *** |

# Appendix D: Calculations for Total kWh Savings Estimates

The absolute annualized kWh savings was calculated by multiplying the mean kWh per day for the treatment group in the base year by the number of days in a year and multiplying that product by the total number of customers in the treatment group. Since the size of the treatment group shrank over time due to attrition from several sources, we used the number of treatment households in the test year. This product was then multiplied by the observed savings value of .019. The formula as implemented is: [(30.65 * 365)* 30,813] * .019 = 6,549,541.95; which rounds to 6,549,542.

The upper and lower bounds at the 95 percent confidence interval were calculated by adding and subtracting from the mean total annual kWh saved the value of two standard errors and recalculating the total annual kWh. The standard error at the 95 percent confidence interval was .056, which meant that the lower bound for kWh per day was 30.59 and the upper bound was 30.71. Plugging those values into the above formula yielded an upper limit of 6,562,363 and a lower limit of 6,536,721.

Converting from total households to annual savings per household was calculated by dividing the total mean annual savings by the number of households in the treatment group. As implemented, this was 6,549,542 divided by 30,813 = 212.56; which rounds to 213 kWh as the average annual savings per household. This, in turn, converts to a daily savings of approximately 0.6 kWh per day per household.

# Appendix E: The SMUD Survey Analysis

**Survey Item Weights**

| Measure | Description | Weight (kWh per year) | Source |
|---|---|---|---|
| 1 | Adjust thermostat | 33 | DEER-based simulation |
| 2 | Add/replace insulation | 57 | DEER |
| 3 | Add weather stripping | 32 | RESFEN 2.0 software |
| 4 | Efficient windows | 38 | DEER |
| 5 | Caulking | 20 | RESFEN 2.0 software |
| 6 | CFLs | 50 | DEER |
| 7 | Low flow showerhead | 144 | Engineering calculation |
| 8 | Shade tree | 100 | SMUD |
| 9 | AC/Heater tune-up | 130 | DEER |
| 10 | New AC/Heater | 700 | SMUD |
| 11 | Energy Star appliances | 190 | Energy Star |
| 12 | Unplug/remove second refrigerator | 1161 | SMUD |
| 13 | Install shade screens | 260 | RESFEN 2.0 software |
| 14 | Whole-house fan | 22 | DEER |
| 15 | Unplug small appliances | 100 | Energy Star |
| 16 | Turn off PC/electronics when not in use | 390 | Energy Star |

**The GLM Procedure: Overall Effects of Weighted Survey Scales**

Dependent Variable: kwh_day

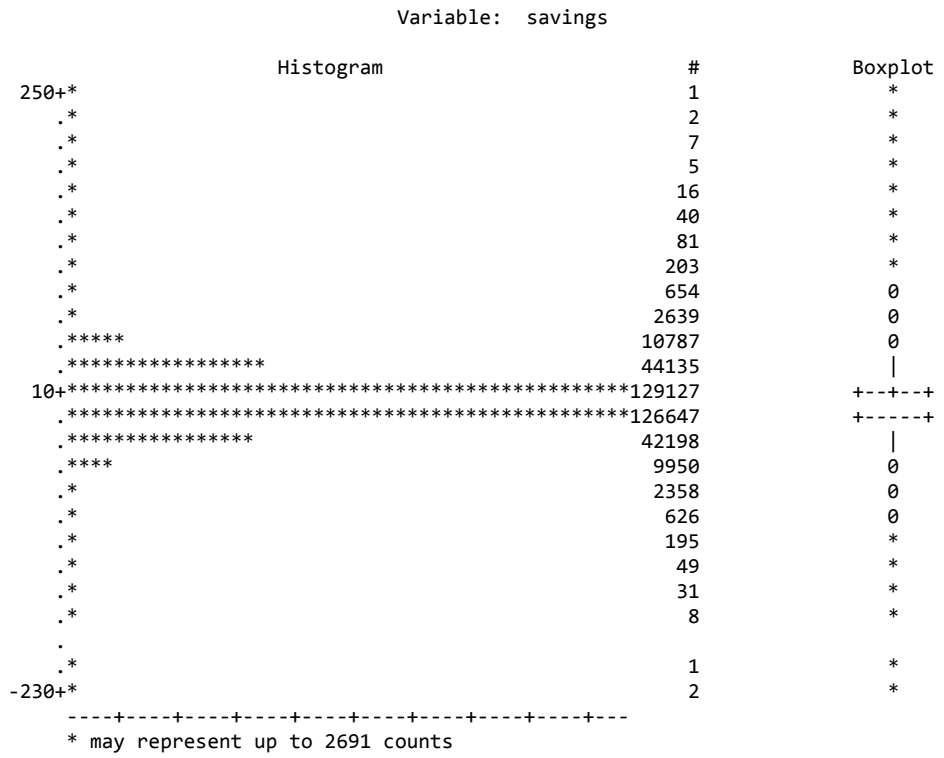
| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.047521932 | 0.00117762 | 40.35 | <.0001 |
| hdd | 0.016042734 | 0.00045159 | 35.52 | <.0001 |
| post | -0.100333616 | 0.40498603 | -0.25 | 0.8043 |
| PartPost | -0.225443029 | 0.57651514 | -0.39 | 0.6958 |
| Elec_Gas | 6.614723934 | 1.65950881 | 3.99 | <.0001 |
| Posthdd | -0.002659130 | 0.00059342 | -4.48 | <.0001 |
| Postcdd | 0.000524727 | 0.00161440 | 0.33 | 0.7452 |
| Treathdd | -0.000883482 | 0.00076741 | -1.15 | 0.2496 |
| Treatcdd | -0.001288029 | 0.00203404 | -0.63 | 0.5266 |
| HDD_3way | -0.000818202 | 0.00084390 | -0.97 | 0.3323 |
| CDD_3way | -0.003679068 | 0.00229725 | -1.60 | 0.1093 |
| bindexwh | -0.000001208 | 0.00000068 | -1.79 | 0.0735 |
| eindexwh | 0.000002015 | 0.00000076 | 2.64 | 0.0082 |
| bindexwc | -0.000000988 | 0.00000186 | -0.53 | 0.5945 |
| eindexwc | 0.000006015 | 0.00000209 | 2.87 | 0.0041 |

**The GLM Procedure: Overall Effects of Weighted Survey Items**

Dependent Variable: kwh_day

| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.047521900 | 0.00117526 | 40.44 | <.0001 |
| hdd | 0.016042735 | 0.00045069 | 35.60 | <.0001 |
| post | -0.100315576 | 0.40417298 | -0.25 | 0.8040 |
| PartPost | -0.214784182 | 0.57536459 | -0.37 | 0.7089 |
| Elec_Gas | 6.626533723 | 1.65736176 | 4.00 | <.0001 |
| Posthdd | -0.002659119 | 0.00059223 | -4.49 | <.0001 |
| Postcdd | 0.000524755 | 0.00161116 | 0.33 | 0.7447 |
| Treathdd | -0.001594651 | 0.00109452 | -1.46 | 0.1451 |
| Treatcdd | -0.005503994 | 0.00295407 | -1.86 | 0.0624 |
| HDD_3way | -0.000828995 | 0.00084221 | -0.98 | 0.3250 |
| CDD_3way | -0.003716634 | 0.00229266 | -1.62 | 0.1050 |
| q1wh | 0.000042212 | 0.00002683 | 1.57 | 0.1157 |
| q1wc | 0.000040333 | 0.00007368 | 0.55 | 0.5841 |
| q2wh | -0.000004260 | 0.00001352 | -0.32 | 0.7526 |
| q2wc | 0.000068774 | 0.00003708 | 1.85 | 0.0637 |
| q3wh | -0.000034825 | 0.00002337 | -1.49 | 0.1361 |
| q3wc | -0.000070728 | 0.00006417 | -1.10 | 0.2704 |
| q4wh | -0.000018880 | 0.00001970 | -0.96 | 0.3379 |
| q4wc | -0.000084316 | 0.00005411 | -1.56 | 0.1192 |
| q5wh | 0.000017417 | 0.00004813 | 0.36 | 0.7175 |
| q5wc | 0.000099472 | 0.00013216 | 0.75 | 0.4516 |
| q6wh | -0.000028272 | 0.00001370 | -2.06 | 0.0391 |
| q6wc | 0.000103061 | 0.00003765 | 2.74 | 0.0062 |
| q7wh | 0.000001967 | 0.00000479 | 0.41 | 0.6817 |
| q7wc | -0.000006985 | 0.00001317 | -0.53 | 0.5959 |
| q8wh | 0.000011588 | 0.00000750 | 1.54 | 0.1224 |
| q8wc | 0.000003094 | 0.00002060 | 0.15 | 0.8806 |
| q9wh | 0.000001708 | 0.00000459 | 0.37 | 0.7097 |
| q9wc | 0.000046853 | 0.00001261 | 3.72 | 0.0002 |
| q10wh | 0.000000404 | 0.00000112 | 0.36 | 0.7191 |
| q10wc | 0.000000234 | 0.00000309 | 0.08 | 0.9395 |
| q11wh | 0.000008996 | 0.00000341 | 2.64 | 0.0083 |
| q11wc | 0.000032502 | 0.00000936 | 3.47 | 0.0005 |
| q12wh | -0.000002219 | 0.00000085 | -2.62 | 0.0089 |
| q12wc | -0.000000156 | 0.00000233 | -0.07 | 0.9466 |
| q13wh | 0.000013082 | 0.00000357 | 3.66 | 0.0003 |
| q13wc | 0.000014820 | 0.00000982 | 1.51 | 0.1311 |
| q14wh | -0.000040343 | 0.00004353 | -0.93 | 0.3541 |
| q14wc | -0.000206072 | 0.00011969 | -1.72 | 0.0851 |
| q15wh | -0.000002574 | 0.00000640 | -0.40 | 0.6877 |
| q15wc | -0.000028229 | 0.00001758 | -1.61 | 0.1084 |
| q16wh | 0.000000373 | 0.00000174 | 0.21 | 0.8304 |
| q16wc | -0.000007951 | 0.00000478 | -1.66 | 0.0962 |

# Appendix F: Average Monthly Savings Pre to Post



# Appendix G: The Telephone Survey

## Telephone Interview

Name on Account: Telephone Number: ID#

Hello, may I speak with _____? (GET ADULT ON THE LINE WHO IS LISTED ON THE CALL SHEET)

My name is _____, and I'm calling from ADM Associates on behalf of SMUD. We are conducting a brief survey to determine how homes like yours responded to the *Home Electricity Reports* that SMUD sent to customers over the past year. We would really like to know your reaction to these reports, but participating in this brief interview is totally voluntary. This survey should only take a couple minutes to complete and your responses will be kept strictly confidential. Do I have your permission to proceed with the interview?

___ No (THANK THE RESPONDENT &TERMINATE THE INTERVIEW)

___ Yes (PROCEED TO QUESTION 1)

1. Do you remember receiving the *Home Electricity Reports* from SMUD in the last year or so?

___ Yes [ASK QUESTION 2]

___ No [PROVIDE HOME ELECTRICITY REPORT EXPLANATION BELOW AND ASK QUESTION 1A]

*The Home Electricity Reports provided information on how much electricity you used in the previous month and in the previous 12 months compared to your neighbors and provided personalized action steps or tips on how you could lower your electricity use and costs in becoming more energy efficient.*

1(a) Do you remember the *Home Electricity Reports* now?

___ Yes [ASK QUESTION 2]

___ No [THANK THE RESPONDENT AND TERMINATE THE INTERVIEW]

2. Have you done anything to save electricity in your home in the past year or so in response to the personalized action steps or tips, or other information contained in the Home Electricity Reports?

___ No [ASK QUESTION 3]

___ Yes [ASK QUESTION 4]

3. Can you tell me why not? [RECORD RESPONSE, THANK RESPONDENT, & TERMINATE INTERVIEW]

_____
_____
_____
_____

4. What have you done as a result of the Home Electricity Reports to save electricity at home?

_____
_____
_____
_____
_____

PROBES: Do anything with appliances?
Do anything that affected the cooling of your home?
Do anything that affected the heating of your home?
Do anything that affected the lighting in your home?
Do anything with home computers or electronics?
Do anything to affect hot water heating in your home?
Do you have a pool? If so, did you do anything with the pool?

| TIP CODES: |
|---|
| |

5. Have you done anything else because of the Home Electricity Reports?

_____
_____
_____
_____

PROBES: Do anything with appliances?
Do anything that affected the cooling of your home?
Do anything that affected the heating of your home?
Do anything that affected the lighting in your home?
Do anything with home computers or electronics?
Do anything to affect hot water heating in your home?
Do you have a pool?

| TIP CODES: |
|---|
| |

6. Anything else?

_____
_____
_____
_____
_____
_____

| TIP CODES: |
| --- |
| |

Thank you for your time. Good bye.

| Tip Code | Tip Description | SMUD Category |
|---|---|---|
| 2 | Choose an efficient refrigerator | APPLIANCES |
| 4 | Choose an efficient clothes washer | APPLIANCES |
| 5 | Choose an efficient dishwasher | APPLIANCES |
| 6 | Make sure refrigerator seals are tight | APPLIANCES |
| 7 | Set refrigerator temperature wisely | APPLIANCES |
| 8 | Choose efficient ventilating fans | APPLIANCES |
| 10 | Hang laundry to dry | APPLIANCES |
| 11 | Recycle your second refrigerator | APPLIANCES |
| 12 | Be smart about clothes washing | APPLIANCES |
| 13 | Be smart about dish washing | APPLIANCES |
| 75 | Care for your fridge | APPLIANCES |
| 77 | Use clothes dryer efficiently | APPLIANCES |
| 14 | Upgrade your central air conditioner | COOLING |
| 15 | Maintain your air conditioner | COOLING |
| 18 | Improve shading for windows | COOLING |
| 19 | Seal window air conditioners | COOLING |
| 20 | Keep out the sun's heat | COOLING |
| 21 | Let your AC unit breathe | COOLING |
| 79 | Stay cool and save with a whole-house fan | COOLING |
| 81 | Deflect high energy bills with a cool roof | COOLING |
| 84 | Reduce AC costs with fans | COOLING |
| 86 | Shade coverings and awnings | COOLING |
| 87 | Install sun screens | COOLING |
| 88 | Cool your home in zones | COOLING |
| 133 | Choose efficient room air conditioners | COOLING |
| 134 | Let your window AC unit breathe | COOLING |
| 17 | Install a ceiling fan | HAC |
| 22 | Improve insulation | HAC |
| 23 | Choose efficient windows | HAC |
| 25 | Install a programmable thermostat | HAC |
| 26 | Clean or replace air filters | HAC |
| 27 | Seal leaky ducts | HAC |
| 28 | Weather strip windows and doors | HAC |
| 30 | Seal air leaks | HAC |
| 33 | Clear area around vents | HAC |
| 89 | Maintain your cooling and heating system | HAC |
| 92 | Set your thermostat for comfort and savings | HAC |
| 136 | Insulated home siding | HAC |
| 38 | Choose an efficient furnace | HEATING |
| 40 | Improve fireplace sealing | HEATING |
| 41 | Maintain your furnace or boiler | HEATING |
| 45 | Use your fireplace wisely | HEATING |
| 46 | Let the sun in for warmth | HEATING |
| 94 | Choose an efficient space heater and use correctly | HEATING |
| 95 | Efficiently use electric blanket or heating pad | HEATING |

| Tip Code | Tip Description | SMUD Category |
|---|---|---|
| 131 | Install fireplace insert | HEATING |
| 47 | Switch to compact fluorescent bulbs | LIGHTING |
| 48 | Spotlight your work spaces | LIGHTING |
| 49 | Use indoor light timers and sensors | LIGHTING |
| 50 | Use motion detectors outdoors | LIGHTING |
| 51 | Install dimmers | LIGHTING |
| 52 | Turn off lights in unoccupied rooms | LIGHTING |
| 73 | Use solar outdoor lights | LIGHTING |
| 97 | Choose LED holiday lights | LIGHTING |
| 99 | Efficient light fixtures | LIGHTING |
| 1 | Buy ENERGY STAR | OTHER |
| 53 | Choose a laptop instead of a desktop computer | OTHER |
| 54 | Choose an efficient television | OTHER |
| 55 | Use a power-use monitor to save | OTHER |
| 56 | Select efficient home office machines | OTHER |
| 57 | Use solar power | OTHER |
| 59 | Use and switch off power strips | OTHER |
| 60 | Unplug stereos and other devices | OTHER |
| 61 | Use computer power-saving modes | OTHER |
| 62 | Turn off your computer at night | OTHER |
| 63 | Adjust display setting on your TV | OTHER |
| 105 | Find savings with our DVD audit tool | OTHER |
| 107 | New Year's Resolutions for savings | OTHER |
| 108 | Talk with your household members | OTHER |
| 111 | Unplug set top boxes when not in use | OTHER |
| 117 | Install a variable speed pool pump | POOL |
| 119 | Save by covering your pool | POOL |
| 122 | Reduce pool pump run-time | POOL |
| 64 | Install a solar water heater | WATER_HEATING |
| 67 | Recycle the heat from drain water | WATER_HEATING |
| 69 | Install efficient showerheads | WATER_HEATING |
| 70 | Reduce water heater temperature | WATER_HEATING |
| 71 | Turn off water heater when away | WATER_HEATING |
| 129 | Shave a minute off shower time | WATER_HEATING |
| 200 | Other change | OTHER |

# Appendix H: Regression Results - Analysis of the SMUD Rebate and Financing Program

**The GLM Procedure: Overall Effects *excluding* SMUD Rebate/Finance Program Participants**

Dependent Variable: kwh_day

| Parameter | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| cdd | 0.054189538 | 0.00019972 | 271.32 | <.0001 |
| hdd | 0.016606577 | 0.00007659 | 216.82 | <.0001 |
| post | 0.264338569 | 0.06866127 | 3.85 | 0.0001 |
| PartPost | -0.127007747 | 0.10813593 | -1.17 | 0.2402 |
| Elec_Gas | 2.381731049 | 0.94931726 | 2.51 | 0.0121 |
| Posthdd | -0.003025254 | 0.00010063 | -30.06 | <.0001 |
| Postcdd | -0.001247640 | 0.00027373 | -4.56 | <.0001 |
| Treathdd | -0.000205776 | 0.00012028 | -1.71 | 0.0871 |
| Treatcdd | -0.001828013 | 0.00031364 | -5.83 | <.0001 |
| HDD_3way | -0.000645734 | 0.00015825 | -4.08 | <.0001 |
| CDD_3way | -0.001723025 | 0.00043084 | -4.00 | <.0001 |