
## Central Hudson Gas & Electric Corporation

# Home Energy Comparison Report Program

**2011 Impact Evaluation · July 2014**

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# Executive Summary

Applied Energy Group, Inc. ("AEG") was retained by Central Hudson Gas & Electric ("Central Hudson" or "Company") to conduct an impact evaluation of its Home Energy Comparison Report Program for program year 2011. The program is part of Central Hudson's effort to help the State of New York meet its goal of reducing statewide electricity usage by 15% by 2015.

Central Hudson is a regulated transmission and distribution utility serving approximately 300,000 electric customers and 75,000 natural gas customers in New York State's Mid-Hudson River Valley, which extends from the suburbs of metropolitan New York City to the Capital District of Albany.

Administered by Opower, Inc., the Home Energy Comparison Report (HECR) Program[1] encouraged Central Hudson's residential customers to make behavioral changes in regards to energy usage when seeing how they compare to their "neighbors." The Home Energy Reports compare residents' electric and/or natural gas usage with comparable peer households, and provides customers with clearly defined, actionable information that complements their energy bills. Information includes energy efficiency tips based on past usage and household characteristics.

Customers also had access to an interactive web portal designed to help them actively engage in energy saving measures. The web portal enabled participants to review additional efficiency tips, conduct an automated 30-second home energy audit, and develop a savings plan. Central Hudson targeted over 110,000 customers to receive the home energy reports during the 15-month duration. Targeting was based on energy consumption patterns, housing data, past program participation, and demographic area. The targeted customers were able to opt-out of the program at any time.

The unique nature of the HECR Program, as a behavioral-based EE program, necessitates the application of an evaluation methodology with sufficient rigor and flexibility to measure program-induced changes in energy consumption within the home that results from behavioral changes in energy use. The crux of the evaluation methodology is a statistical billing analysis to compare the change in energy usage between customers who participated in the program to a representative control group of non-participants.

The average daily energy savings observed in the participant sample is 0.575 kWh, or 2.11 percent less, compared to usage before the implementation of the program. The middle range estimate reveals that the program achieved an average yearly savings of approximately 210 kWh per participant.

Overall, AEG determined that the HECR program resulted in a net energy savings of 18,650 MWh and 286,226 therms, as shown in Table ES1.

**Table ES1. HECR Energy Impact Summary**

| Service Type | Count | Estimated Avg Annual Savings per Participant per Year (kWh) | Net Savings | Units |
|---|---|---|---|---|
| Electric | 91,174 | 204.5 | 18,650 | MWh |
| Natural Gas | 24,929 | 11.48 | 286,226 | therm |

[1] HECR is sometimes referred to as the Opower Program.

# 1. Net Energy Savings

## 1.1 Net Savings Methodology

AEG calculated the net energy savings for the Home Energy Comparison Report Program based on the International Performance Measurement and Verification Protocols (IPMVP) Option C.[2] Consistent with the IPMVP protocols, AEG directly evaluated any changes in participants billed energy usage before and after the program using a series of statistical methods. The complete billing analysis conducted for the HECR program is detailed in Appendix III of this report.

AEG estimated the impact of the HECR program using two alternative statistical approaches:

- T-Test
- Regression Analysis

AEG estimated the overall impact of the HECR program using average daily energy usage as the unit of analysis. Using the billing data provided by Central Hudson, AEG calculated the average daily energy usage with the following equation:

**Equation 1. Average Daily kWh Usage**

$$Average\ Daily\ kWh = \frac{Billing\ Period\ kWh}{Number\ of\ Days}$$

### Program Data

The HECR program was administered through Opower, Inc., a private company that specializes in behavior change programs. Table 2 summarizes the program participation data provided by Opower. Opower only provided the account numbers of the active participants and those customers who have opted out of the program since its inception. The data provided by Opower indicated certain account numbers designated as part of a control group that was ostensibly used for Opower's own independent analysis of the program. Providing the active participants, opt-outs, and the participants they use for their control group was the only involvement of Opower in the evaluation. AEG used active Opower participants to conduct this evaluation. Participants who opted-out were not included in the analysis. AEG developed a control group of non-participants separately from Opower in order to ensure that the control sample was independent.

**Table 2. HECR Program Data Tracking Results, 2011**

| Type | Count | % |
|---|---|---|
| Active | 95,313 | 86% |
| Opt-out | 15,772 | 14% |
| Total | 111,085 | 100% |

Overall 111,085 Central Hudson customers were selected to receive bi-monthly energy reports through the HECR program. Approximately 14 percent of the original participants opted out of the program and

[2] More information about the IPMVP protocols is available at http://www.evo-world.org/

are not included in the analysis. This impact evaluation estimates the change in energy usage from the 95,313 Central Hudson customers who received bi-monthly reports through the HECR program for the entire length of the evaluated period from February 2011 through December 2011.[3]

Central Hudson provided AEG with approximately four (4) years of customer billing data covering 24 prorated bi-monthly billing periods from January 2009 through March 2013. The billing data was cross-referenced with the HECR data to determine the distribution of participants by service type. Central Hudson services gas, electric, and dual-service customers who receive both electric and gas service from the utility. The number of participants by service type is summarized in Table 3.

**Table 3. HECR Participants by Service Type, 2011**

| Service Type | Count | % |
|---|---|---|
| Electric | 66,263 | 70% |
| Dual-Service | 24,911 | 26% |
| No Match | 4,121 | 4% |
| Gas | 18 | <1% |
| Total | 95,313 | 100% |

Central Hudson customers who participated in the HECR program utilized a variety of different service types. The majority of participants were electric service only customers (70%), followed by dual-service (26%). Only 18 participants were gas service only customers. AEG notes that approximately 4 percent of participants were not found in the Central Hudson billing database.

## Data Segmentation

The billing data was cross referenced with HECR participants as well as participants in other residential EE programs offered by Central Hudson, including the Residential Appliance Recycling Program, Natural Gas and/or Electric HVAC Program.

AEG segmented customer participation data into four separate groups based on participation in Central Hudson's energy efficiency programs. In order to isolate the HECR program impacts, Central Hudson customers who participated in other programs were removed from the sample. Table 4 summarizes the data segmentation used in the analysis.

**Table 4. Segmentation Analysis of Residential Customers**

| | Other CH Program Participants | Other CH Program Non-Participants |
|---|---|---|
| **HECR Participants** | *Group A* | *Group B* |
| **Non-HECR Participants** | *Group C* | *Group D* |

The statistical analysis of the HECR program utilizes the comparison between a treatment group of HECR participants (Group B) and a control group of customers who did not participate in any Central Hudson

[3] The HECR program was launched in February 2011

programs (Group D). Structuring the analysis in this way ensures that any observed change in energy usage between the two groups is comparable. The control group was developed independently by AEG with no involvement or input from Opower.

Table 5 shows the descriptive statistics of participants and non-participants in the time period before the HECR program was implemented.

**Table 5. Sample Statistics for Electric Customers: Pre-HECR Billing Periods**

| Sample Statistics (Unweighted) | Treatment Group | Control Group |
|---|---|---|
| Number of Unique Customer Accounts | 22,904 | 23,833 |
| Mean Average Daily kWh (Pre-HECR Periods) | 27.31 | 21.97 |
| Median Avg. Daily kWh Use | 25.17 | 19.38 |
| Standard Deviation | 15.74 | 17.05 |
| Coefficient of Variation (CV) | 57.62 | 77.63 |

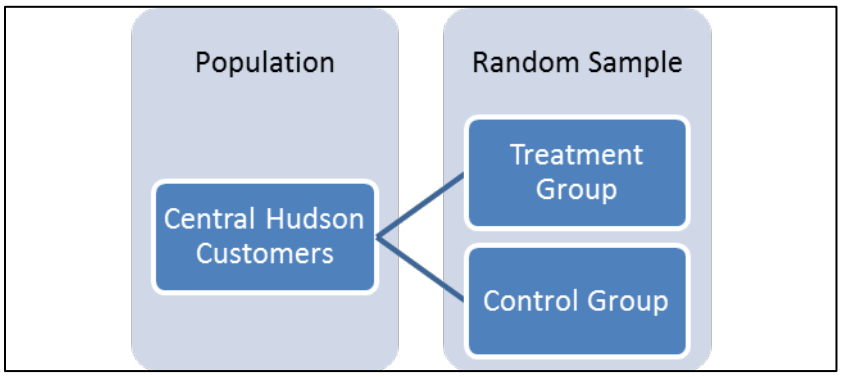
The treatment group includes 22,904 HECR participants compared to a statistically equivalent control group of 23,833 randomly sampled residential customers. The table indicates that the energy usage and overall distribution of the two groups before the implementation of the HECR program is comparable. In particular, the two groups show similar metrics before the implementation of the Opower program. The average daily energy use for the two groups is approximately 27 kWh/day and 22 kWh/day for the treatment and control groups, respectively. Although the energy usage of the treatment group is slightly higher than the control group, there is more variation in the control group's usage. Comparing the standard deviation and the coefficient of variation between the two groups shows that the average daily energy usage for the control group is more volatile.

## T-Test Analysis of Electric Savings

The Randomized Controlled Trial (RCT) method is an effective way to measure the energy impacts of behavior change programs, such as, HECR.[4] The RCT method is an experimental design that attempts to mitigate selection bias among the comparison groups. A central feature of the RCT method is that customers are randomly assigned to either the treatment or control group, thus eliminating the potential for self-selection bias. Figure 1 illustrates the RCT experimental design method.

[4] State and Local Energy Efficiency (SEE) Action Network, "Energy Efficiency Program Impact Evaluation Guide: Evaluation, Measurement, and Verification Working Group". December 2012

**Figure 1. Randomized Control Trial Experimental Design**




The statistical analysis of HECR program impacts presented in this report resembles the RCT requirements that help to mitigate the self-selection bias. Opower designed the target population of Opower participants based on energy consumption patterns and demographic data. Eligible customers were randomly chosen to receive the home energy reports on a bi-monthly basis for the duration of the program. HECR participants were given the opportunity to opt-out of the program if they did not wish to participate.

Estimating the savings attributable to the program using a t-test involves comparing changes in energy usage between the treatment group of HECR participants and the control group of non-participants before and after the program was implemented. Table 6 describes the impact of the HECR program using a t-test scoring of changes in billed kWh use.

**Table 6. T-Test Results for HECR Electric: Weighted Samples**

| Sample Statistics* | HECR Participants | Control Group |
|---|---|---|
| Sample Size: | 22,904 | 23,833 |
| Mean Delta kWh Use/Day: | -0.282 | 0.293 |
| Avg. Daily kWh Savings (Difference-in-Differences): | 0.575 | |
| Standard Error: | 0.050 | |
| t-test Statistic (Null Hypothesis: D-o-D = 0.0): | 11.500 | |
| Lower Savings Estimate (kWh/Day): | 0.493 | |
| Upper Savings Estimate (kWh/Day): | 0.656 | |

* Based on weighted sample at 90% (+/- 10%) Confidence Interval

The results were weighted based on the customer rate code found in the Central Hudson billing data. Weighting the results in this way makes the results more representative of the entire customer population. The weighted results enable more generalization about the expected savings from future program participants.

After the implementation of the HECR program the average daily energy usage of the treatment group decreased by 0.282 kWh per day per participant while the control groups' usage actually increased by 0.293 kWh. The difference in the average daily energy usage changes between the two groups (i.e. difference-in-differences) reveals the net savings attributable to the HECR program. The savings are net because the control group represents what participant behavior would have been absent the program.

The average daily energy savings observed in the participant sample is 0.575 kWh, or 2.11 percent less, compared to usage during the pre-HECR period.[5]

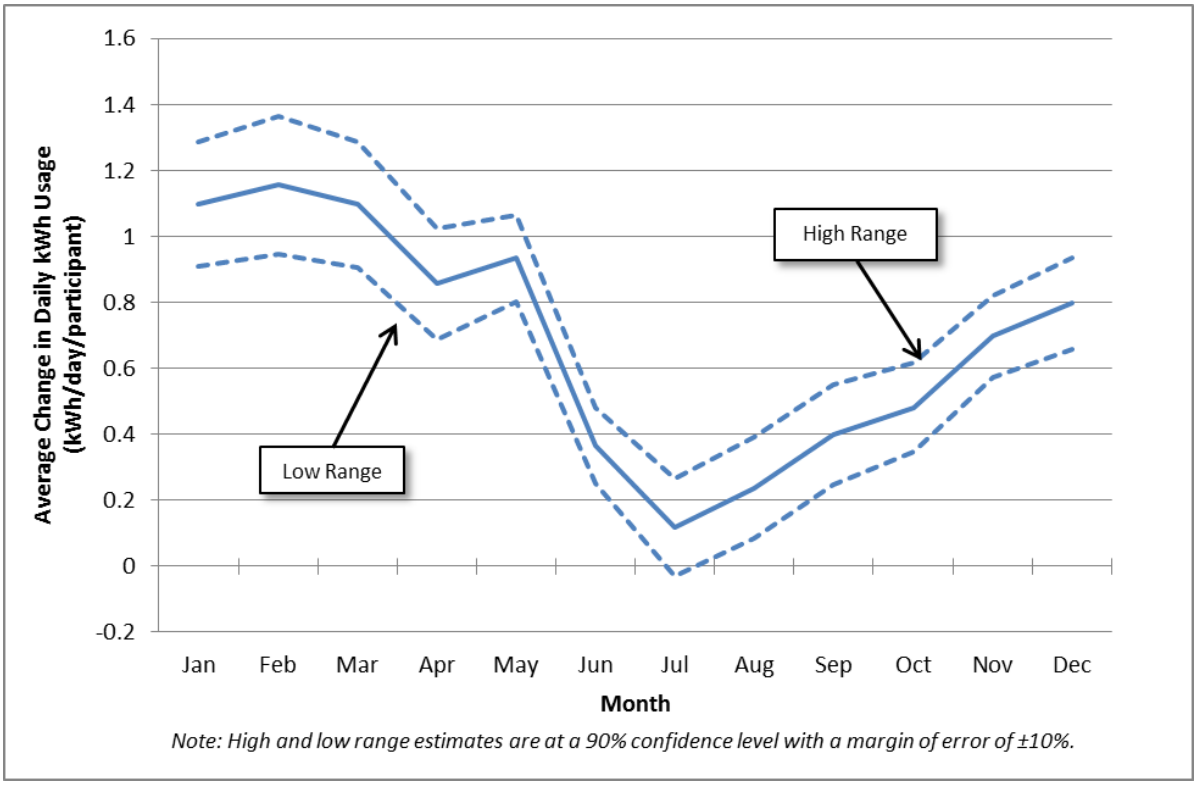
Table 7 shows the annualized impacts of the HECR program utilizing the average daily kWh savings per participant derived from the t-test. The middle range estimate reveals that the program achieved an average yearly savings of approximately 210 kWh per participant.

**Table 7. Electric HECR Participant T-Test Results**

| Range | Avg. Daily Savings (kWh) per Participant | Avg. Yearly Savings (kWh) per Participant |
|---|---|---|
| Lower | 0.493 | 180 |
| Middle | 0.575 | 210 |
| High | 0.656 | 239 |

AEG also performed a t-test scoring of the HECR participant sample and the non-participant control group on a monthly basis to determine the influence of seasonal factors. Figure 2 shows the difference of changes in average daily kWh usage by month between HECR participants and the control group of non-participants, weighted by residential rate code.

**Figure 2. Change in Average Daily kWh Usage by Month**




The monthly impacts of the HECR program vary significantly from a high of 1.16 kWh per day in February to a low of 0.12 in July. Energy savings impacts are greater during the winter months than the summer

[5] The t-test Statistic of 11.5 results in a rejection of the null hypothesis

months, with energy usage increasing for HECR participants during July in the lower range savings estimate. The data suggests that energy demand is less elastic during summer weather conditions primarily due to HVAC usage. The data presented in the figure shows that the program is more impactful when demand is elastic.

## Electric Savings Regression Analysis

In addition to the t-test method, AEG estimated energy savings attributable to the program by performing a regression analysis using a fixed effects model. The fixed effects model estimates a unique intercept variable for each participant describing the energy impacts associated with the program. The regression model also accommodates weather-related influences using heating and cooling degree day variables (HDD and CDD). By including variables to account for weather-induced changes in energy use, this impact estimate isolates program impacts attributable to the program, independent of changes in weather.

Table 8 shows the fixed effects regression results for each of the explanatory variables used in the analysis, including HECR participation and heating and cooling degree days. The results show that the HECR program resulted in a statistically significant average annual energy usage reduction of approximately 2.45 percent.[6]

**Table 8. Fixed Effects Regression Results, Electric**

| Parameter | Estimate | t-value |
|---|---|---|
| HECR Participation | -2.45% | -84.5 |
| Heating Degree Days (HDD) | 1.05% | 88.7 |
| Cooling Degree Days (CDD) | 3.13% | 197.1 |

Next, AEG utilized the Princeton Scorekeeping Method (PRISM) to estimate the normalized annual consumption of energy (NAC) of HECR participants in order to determine the net energy savings. PRISM is a standardized statistical tool that is used to estimate weather normalized energy savings from customer billing data and daily temperature data.[7] The PRISM analysis was performed using HECR participants' customer billing data before the program was implemented along with the corresponding weather data of the Central Hudson service territory.[8] The PRISM tool estimated the NAC use if actual weather were equal to typical weather conditions over the most recent 20-year historical period.

AEG derived the net energy savings attributable to the HECR program by applying the percentage change in energy use from the regression analysis to the NAC value. According to the PRISM results, the program achieved average annual net weather normalized energy savings of approximately 4,685 MWh for the participant sample group, or 205 kWh per participant. Table 9 shows the energy savings for the HECR participant sample.

[6] T-statistics for each variable are not equal to zero resulting in a rejection of the null hypothesis
[7] More information about the PRISM method is available at http://www.princeton.edu/~marean/
[8] Heating and cooling degree days reported at Poughkeepsie Airport

Table 9. Average Annual Electric Savings of Participant Sample using Fixed Effects and PRISM

| Range | Avg. Annual Energy Usage Reduction (%) | Avg Annual Energy Usage (MWh) | Avg Annual Energy Savings (MWh) | HECR Participant Sample (n) | Avg Annual Savings per Participant (kWh) |
|---|---|---|---|---|---|
| Lower | 2.40% | 191,224 | 4,589 | 22,904 | 200 |
| Middle | 2.45% | | 4,685 | | 205 |
| Upper | 2.50% | | 4,781 | | 209 |

Comparing the results of the t-test and the regression analysis reveals that the savings estimates per participant are consistent. The middle range annual savings estimate for the t-test is 210 kWh per participant compared to 205 kWh per participant from the regression analysis. The seasonal influence of weather offers one possible explanation for the variance between the two estimates. The regression analysis results take into account heating and cooling degree days, while the t-test does not. The table below shows that the savings results of the t-test and regression analysis are comparable.

Table 10. Comparison of T-Test and Regression Results

| | | Average Annual Savings per Participant (kWh/yr) | |
|---|---|---|---|
| | | T-Test | Regression |
| Range | Low | 180 | 200 |
| | Mid | 210 | 205 |
| | High | 239 | 209 |

## Gas Savings Regression Analysis

AEG performed a fixed effects regression analysis using Central Hudson natural gas billing information to determine the natural gas savings attributable to the program. AEG performed the statistical analysis accounting for the impacts due to heating degree days (HDD). Overall, AEG determined that the HECR program accounted for an approximate 1.44 percent average reduction in natural gas usage. Table 11 shows the results of the fixed effects regression analysis for natural gas.

Table 11. Fixed Effects Regression Results, Natural Gas

| Parameter | Estimate | STD Error | t-value | 90% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | High | Low |
| HECR Participation | -1.44% | 0.0020 | -8.01 | -1.73% | -1.14% |
| Heating Degree Days (HDD) | 3.63% | 0.0000 | 95.47 | 3.57% | 3.70% |

AEG determined the average annual savings attributable to the HECR program by applying the fixed effects regression results to an estimate of average annual energy usage derived using the PRISM model, similar to the electric savings methodology. As a result of inputting the pre-program natural gas customer billing data into the PRISM model, AEG determined the normalized annual consumption to be approximately 400,980 Dth for the participant sample group. Table 12 presents the natural gas savings for the sample of HECR participants.

Table 12. Average Annual Natural Gas Savings of Participant Sample using Fixed Effects and PRISM

| Range | Avg. Annual Energy Savings (%) | Avg. Annual Energy Usage (Dth) | Avg. Annual Energy Savings (Dth) | HECR Participant Sample (n) | Avg. Annual Savings per Participant (thm) |
|---|---|---|---|---|---|
| Lower | 1.14% | 400,980 | 4,571 | 5,029 | 9.09 |
| Middle | 1.44% | | 5,774 | | 11.48 |
| Upper | 1.73% | | 6,937 | | 13.79 |

According to the PRISM results the HECR program resulted in a middle range savings estimate of approximately 11.48 therms per participant per year. AEG calculated the average annual savings per participant by multiplying the average annual natural gas usage by 1.44 percent and dividing the savings by the total participants in the treatment sample. The average annual energy savings of the participant sample presented in Table 12 does not reflect the net savings attributable to the program.

## 1.2 Net Savings Results

AEG determined the net savings impacts attributable to the HECR program using the program tracking data and the observed change in energy usage from the fixed effects regression analysis results. AEG used the middle range estimate from the analysis to calculate the net savings. The savings estimate was multiplied by the number of active participants for each service type, including electric, natural gas, and dual-service customers.[9]

Any impacts of free ridership or spillover are accounted for in the fixed effects model; therefore, no net-to-gross adjustment is needed. However, AEG assessed the impact of free ridership and spillover in a separate analysis using the results of a participant survey, which is provided in Appendix IV of this report.[10]

Table 13 shows the net savings attributable to the HECR program for each customer type. The HECR program resulted in a net annual natural gas savings of 28,623 Dth and 18,650 MWh of electric savings.

Table 13. HECR Program Nets Savings Results by Service Type

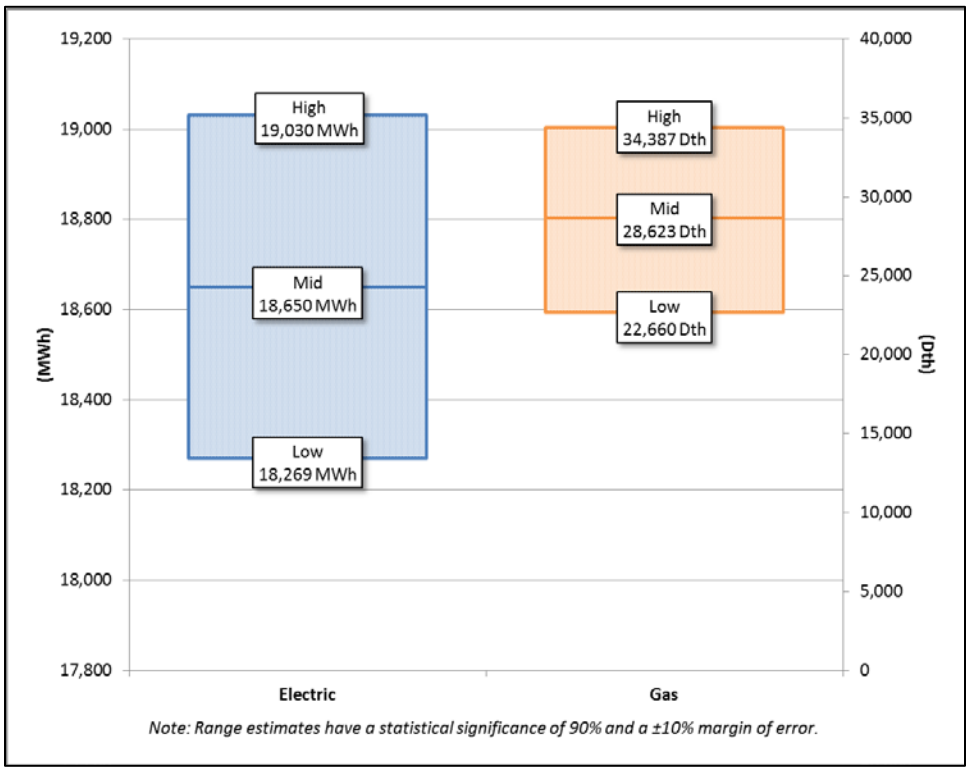
| Service Type | Count | Estimated Avg. Annual Savings per Participant | Net Savings | Units |
|---|---|---|---|---|
| Electric | 91,174 | 205 | 18,650 | MWh |
| Natural Gas | 24,929 | 11.48 | 28,623 | Dth |

Figure 3 shows the range of net savings results for electricity and natural gas using the low, middle, and high range estimates.

[9] Note that the unmatched participants from Table 3 are excluded from the net savings calculation.

[10] The purpose of the free ridership and spillover analysis is to provide additional insight into the program's influence on participant behavior. Due to methodological differences in the two analyses, the calculated net-to-gross ratio cannot be used to make inferences on net savings results and is not applicable to savings calculated in the billing analysis.

## Figure 3. Fixed Effects Regression Analysis Net Savings Results



# 2. Program Cost Effectiveness

## 2.1 Cost-Effectiveness Methodology

Cost-effectiveness analysis compares the costs and benefits of efficient equipment with those of baseline (non-efficient) equipment. Cost-effectiveness analysis indicates whether the efficient technology(s) improves a customer's financial position, decrease overall energy costs to ratepayers, or raise society's well-being. A program is considered cost-effective if the benefit-cost ratio is greater than one (1.0). There are many approaches to performing cost-effectiveness tests and key assumptions regarding critical factors, such as future energy prices, can vary among experts. DPS has not required cost-effectiveness tests as part of EEPS evaluation studies and has not confirmed the assumptions and approaches in this analysis.

AEG analyzed the cost-effectiveness of the Home Energy Comparison Report Program utilizing four standard cost-effectiveness tests taken from the California Standard Practices Manual.[11] Each test analyzes cost-effectiveness from a different perspective and answering a separate question:

- Participant Cost Test: Compares customer costs and benefits of installing the measure. Will the participant benefit over the life of the measure?
- Program Administrator Cost Test (Utility Cost Test): Comparison of program administrator costs to supply-side resource benefits. Will utility costs to save energy be less than utility costs to deliver the same amount of energy?
- Ratepayer Impact Measure: Measures the impact of the DSM program on utility rates if rates were to be adjusted to account for the program. Comparison of utility program costs and bill reductions associated with energy savings to supply-side resource benefits. Will customer rates increase?
- Total Resource Cost Test: Comparison of program administrator and customer costs to utility resource savings. Will the total costs of energy in the utility service territory decrease?

Results from the impact evaluation, utilizing IPMVP best practices, are utilized in the four cost-effectiveness tests taken from the California Standard Practices Manual.

BenCost, an updated version of a public domain model that AEG customized for Central Hudson, was utilized to perform the cost-effectiveness modeling. BenCost is an input-output model that calculates all four cost-effectiveness tests. Central Hudson specific inputs, including: avoided costs, discount rates, participation and incentives, were used to conduct the cost-effectiveness analysis.

AEG received financial accounting information for the HECR program from Central Hudson to determine actual program costs and expenditures. All program costs and benefits are discounted to present-day dollar values in order to accurately compare future benefits with current costs. The table below summarizes the key program inputs used to perform the cost-effectiveness analysis.

[11] The California Standard Practices Manual details cost-effectiveness guidelines and procedures for standardized cost-effectiveness evaluations.

Table 14. HECR Program Cost-Effectiveness Input Summary

| Component | Net Savings | Direct Participant Cost | Program Costs | Project Life |
|---|---|---|---|---|
| Electric | 18,650 MWh | $0 | $263,050 | 1 year |
| Natural Gas | 28,623 Dth | $0 | $882,029 | 1 year |

## 2.2 HECR Program Cost-Effectiveness Results

The cost per participant including those participants who opted-out of the program is $10.31 and the cost per active participant is slightly higher at $12.01. The cost-effectiveness results reflect the net energy savings of active participants only. Table 15 summarizes the cost per participant for the HECR program.

Table 15. HECR Program Cost per Participant

| Participant Type | Count | Total Program Costs | Cost per Participant |
|---|---|---|---|
| Active | 95,313 | $1,145,079 | $12.01 |
| Total | 111,085 | | $10.31 |

The levelized cost of energy saved through the program represents the total program costs divided by the total energy saved over the lifetime energy savings. The total program costs include any rebates paid to participants as well as all administrative costs to run the program. The total energy saved through the program represents the net bus-bar energy reduction at the point of generation, thus taking into account the energy line losses. The levelized costs for each service type are summarized in Table 16.

Table 16. HECR Program Levelized Costs

| Service Type | Lifetime Savings | Line Loss | Total Costs | Levelized Cost |
|---|---|---|---|---|
| Electricity | 20,096 MWh | 7.20% | $882,029 | 0.06 $/kWh |
| Natural Gas | 29,132 Dth | 1.75% | $263,050 | 3.93 $/thm |

Table 17 presents the combined cost-effectiveness results for both the natural gas and electric components of the HECR program. AEG determined that the overall TRC benefit-cost ratio for the HECR program is 1.19, and is therefore cost-effective.

Table 17. HECR Program Cost-Effectiveness Results

| Test Results | NPV | B/C | Total Costs | Total Benefits |
|---|---|---|---|---|
| Total Resource Cost Test | $934,973 | 1.82 | $1,145,079 | $2,080,052 |
| Societal Test | $1,071,864 | 1.94 | $1,145,079 | $2,216,943 |
| Participant Test | $3,475,214 | 0.00 | $0 | $3,475,214 |
| Ratepayer Impact Measure Test | ($2,540,241) | 0.45 | $4,620,293 | $2,080,052 |
| Utility Cost Test | $934,973 | 1.82 | $1,145,079 | $2,080,052 |

## 2.3 HECR Natural Gas and Electric Cost-Effectiveness Results

AEG performed separate cost-effectiveness tests for both electricity and natural gas components of the HECR program.

### Electric Results

The cost-effectiveness test results for the electric component of the HECR program are summarized in Table 18. AEG determined that the electric component has a TRC benefit-cost ratio of 1.97 and is therefore cost-effective.

**Table 18. HECR Cost-Effectiveness Results, Electric**

| Test Results | NPV | B/C | Total Costs | Total Benefits |
|---|---|---|---|---|
| Total Resource Cost Test | $854,642 | 1.97 | $882,029 | $1,736,671 |
| Societal Test | $991,534 | 2.12 | $882,029 | $1,873,563 |
| Participant Test | $2,892,669 | 0.00 | $0 | $2,892,669 |
| Ratepayer Impact Measure Test | ($2,038,027) | 0.46 | $3,774,698 | $1,736,671 |
| Utility Cost Test | $854,642 | 1.97 | $882,029 | $1,736,671 |

### Natural Gas Results

The cost-effectiveness test results for the natural gas component of the HECR program are summarized in Table 19. AEG determined that the natural gas component has a TRC benefit-cost ratio of 1.31, and is therefore cost-effective.

**Table 19. HECR Cost-Effectiveness Results, Natural Gas**

| Test Results | NPV | B/C | Total Costs | Total Benefits |
|---|---|---|---|---|
| Total Resource Cost Test | $80,330 | 1.31 | $263,050 | $343,380 |
| Societal Test | $80,330 | 1.31 | $263,050 | $343,380 |
| Participant Test | $582,545 | 0.00 | $0 | $582,545 |
| Ratepayer Impact Measure Test | ($502,214) | 0.41 | $845,595 | $343,380 |
| Utility Cost Test | $80,330 | 1.31 | $263,050 | $343,380 |

## 2.4 HECR Cost-Effectiveness Results including NEBs

Non-energy benefits (NEBs) refer to those benefits that accrue to society that are not directly related to energy reductions. NEBs typically include improvements in public health and comfort, job creation, reduced emissions, labor productivity, etc. Since these benefits are not readily quantified, they are incorporated into the cost-effectiveness analysis by applying an adder to the avoided costs.

AEG performed a separate set of cost-effectiveness tests applying a 10 percent adder to the avoided costs to account for non-energy benefits. NEBs were calculated by multiplying the avoided costs (energy, demand, etc.) for each year to account for externalities. The following tables present the cost-effectiveness test results including NEBs.

Table 20 presents the combined cost-effectiveness results for both the natural gas and electric components of the HECR program with NEBs included. AEG determined that the overall TRC benefit-cost ratio for the HECR program is 2.00, slightly higher than the previous results.

**Table 20. HECR Program Cost-Effectiveness Results with NEBs**

| Test Results | NPV | B/C | Total Costs | Total Benefits |
|---|---|---|---|---|
| Total Resource Cost Test | $1,142,978 | 2.00 | $1,145,079 | $2,288,057 |
| Societal Test | $1,279,869 | 2.12 | $1,145,079 | $2,424,948 |
| Participant Test | $3,475,214 | 0.00 | $0 | $3,475,214 |
| Ratepayer Impact Measure Test | ($2,332,236) | 0.50 | $4,620,293 | $2,288,057 |
| Utility Cost Test | $1,142,978 | 2.00 | $1,145,079 | $2,288,057 |

## Electric Results including NEBs

The cost-effectiveness test results including NEBs for the electric component of the HECR program are summarized in Table 21. AEG determined that the TRC benefit-cost ratio of the electric component including NEBs is 2.17, which is slightly higher than the previous results.

**Table 21. HECR Cost-Effectiveness Results with NEBs, Electric**

| Test Results | NPV | B/C | Total Costs | Total Benefits |
|---|---|---|---|---|
| Total Resource Cost Test | $1,028,310 | 2.17 | $882,029 | $1,910,339 |
| Societal Test | $1,165,201 | 2.32 | $882,029 | $2,047,230 |
| Participant Test | $2,892,669 | 0.00 | $0 | $2,892,669 |
| Ratepayer Impact Measure Test | ($1,864,359) | 0.51 | $3,774,698 | $1,910,339 |
| Utility Cost Test | $1,028,310 | 2.17 | $882,029 | $1,910,339 |

## Natural Gas Results including NEBs

The cost-effectiveness test results including NEBs for the natural gas component of the HECR program are summarized in the table below. AEG determined that the TRC benefit-cost ratio of the natural gas component including NEBs is 1.44, which is slightly higher than the previous results. However, the ratio is still less than one, meaning it is not cost-effective.

**Table 22. HECR Cost-Effectiveness Results with NEBs, Natural Gas**

| Test Results | NPV | B/C | Total Costs | Total Benefits |
|---|---|---|---|---|
| Total Resource Cost Test | $114,668 | 1.44 | $263,050 | $377,718 |
| Societal Test | $114,668 | 1.44 | $263,050 | $377,718 |
| Participant Test | $582,545 | 0.00 | $0 | $582,545 |
| Ratepayer Impact Measure Test | ($467,876) | 0.45 | $845,595 | $377,718 |
| Utility Cost Test | $114,668 | 1.44 | $263,050 | $377,718 |

# Appendix I. HECR Impact Evaluation Survey

**CENTRAL HUDSON GAS & ELECTRIC**
**INTERVIEW GUIDE**
**PARTICIPATING CUSTOMERS**
**HOME ENERGY COMPARISON REPORT**

| | |
|---|---|
| Customer Name | |
| Customer Phone Number | |
| Interviewer | |

*Hello, I'm _____with Applied Energy Group. We are conducting a survey on behalf of Central Hudson Gas & Electric as part of their continual effort to improve their energy efficiency programs. According to our records, your household received Home Energy Comparison Reports in 2012.*

Do you recall receiving the Home Energy Comparison Reports?

1. Yes
2. No (The reports estimate your energy consumption compared to your neighbors and provides action steps to reduce energy usage. If they still do not remember, **terminate the interview.**)

*The survey should only take about 10 minutes. The information you provide will be kept strictly confidential and be used to improve Central Hudson's Energy Savings programs.*

May I ask you a few questions about the Home Energy Comparison Reports?

1. Yes
2. No (Attempt to set another date/time: If "No," thank them for their time and **terminate.**)

### *Participation*

P1. How frequently do you receive these reports?

1. Monthly
2. Every other month
3. Quarterly
4. Annually
5. Don't know

P2. About how many of the Home Energy Comparison Reports have you read? (read answers)

1. None
2. Some
3. All

P3. Do you…. (read answers)
Glance at the graphics/headlines

1. Skim the article content (what percentage of articles do you skim?)
2. Read some of the article content (what percentage of articles do you partially read?)
3. Read the reports from cover to cover (what percentage of articles do you read in full?)

P4. About how much time do you spend reading each report? (read answers)

1. 1 to 4 minutes
2. 5 to 10 minutes
3. More than 10 minutes

P5. Have you discussed the reports with others?

1. Yes
2. No

P6. If yes, with whom did you discuss the report? (multiple answers, specify if overlapping)

1. Members of your household
2. Neighbors
3. Friends
4. Coworkers
5. Other (specify)

P7. What types of things did you discuss? (multiple answer, do not read)

1. Saving money
2. Saving energy
3. Turning things off (lights, computers, other)
4. Environment/climate change
5. Closing doors/windows/shades
6. Saving water/hot water usage
7. Thermostat settings/turning down the heat
8. Insulation improvements
9. Other (specify)

### *Report Usefulness*

R1. How useful is the

| | **Very Useful** | **Somewhat Useful** | **Not Very Useful** | **Not at all Useful** | **Don't know** |
|---|---|---|---|---|---|
| Home Energy Comparison Report | | | | | |
| Comparison of your household consumption to your neighbors | | | | | |
| Comparison of your household efficiency rank to your neighbors | | | | | |
| Comparison of your household consumption to the prior year | | | | | |
| 'How you are doing' summary (smiley faces) | | | | | |
| Energy savings action tips | | | | | |

R2. What information do you find most useful?

1. None
2. Comparison of your household consumption to your neighbors
3. Comparison of your household efficiency rank to your neighbors
4. How you are doing (Smiley faces and label 'Great, Good, More than average')
5. Comparison of household consumption to the prior year
6. Energy savings action tips
7. Other (specify)

R3. Do you feel that the level of detail in the report is sufficient? (read answers)

1. The level of detail is sufficient

2. More detail needed
3. Less detail needed

R4. Please rate your satisfaction with the following program components on a five-point scale, where "5" means "Very Satisfied" and "1" means "Very Dissatisfied." How satisfied are you with

| | Very Satisfied | 4 | 3 | 2 | Very Dissatisfied | DK/Refused |
|---|---|---|---|---|---|---|
| The report content | | | | | | |
| The report frequency | | | | | | |
| The energy saving tips | | | | | | |

Comments (verbatim)

## *Actions Taken*

A1. Did your household take any energy savings actions in the past two years? Some examples of actions include (read list from A4).

1. Yes
2. No

A2. Have you participated in other Central Hudson energy efficiency programs?

1. Yes
2. No (proceed to A4)

A3. Which programs have you participated in? (Do Not Read)

1. Residential Appliance Recycling
2. Residential Electric HVAC
3. Residential Natural Gas HVAC

***If answered 'NO' to A1 and A2, proceed to D1.***

A4. Within the past two years, has your household taken any of the following energy savings actions? (read responses)

| | Yes | No |
|---|---|---|
| Install compact fluorescent bulbs or LEDs | | |
| Purchase and install a new heating or cooling system | proceed to A5 | |
| Purchase household appliances | proceed to A10 | |
| Recycle an appliance | proceed to A12 | |
| Install insulation (attic, wall, floor, duct) | proceed to A15 | |
| Other (specify) | | |

***If purchased and installed a new heating or cooling system:***

A5. What type of heating or cooling system did you install? (read answers)

1. Furnace
2. Boiler
3. Central Air Conditioner (skip to A8)
4. Room Air Conditioner
5. Air Source Heat Pump (skip to A8)
6. Geothermal Heat Pump (skip to A8)

7. Ductless Mini-Split (skip to A8)
8. Other (specify)

A6. What fuel does your new (Furnace/Boiler) use?
1. Natural Gas
2. Electricity
3. Propane
4. Other (specify)

A7. What fuel did your old system use?
1. Natural Gas
2. Electricity
3. Propane
4. Other (specify)

A8. Approximately how old was the system replaced?
_____ approximate age in years

A9. Is your new system ENERGY STAR?
1. Yes
2. No

***If purchased household appliance:***

A10. What type of appliance did you purchase? (read answers)
1. Refrigerator
2. Freezer
3. Clothes Washer
4. Clothes Dryer
5. Dishwasher
6. Dehumidifier
7. Other (specify)

A11. Is the new appliance ENERGY STAR?
1. Yes
2. No

***If recycled an appliance:***

A12. What type of appliance did you recycle? (read answers)
1. Refrigerator
2. Freezer
3. Room Air Conditioner
4. Other (specify)

A13. Did you replace the appliance?
1. Yes
2. No (skip next question)

A14. Is the new appliance ENERGY STAR?
1. Yes
2. No

***If installed insulation:***

A15. What type of insulation did you install? (read answers)

1. Attic
2. Wall
3. Floor
4. Duct
5. Other (specify)

***If answered yes to A4***

A16. What, if anything, influenced your decision to take an energy savings action (Do Not Read – multiple answers)

1. Saving money
2. Saving energy
3. Central Hudson energy efficiency program
4. Home Energy Comparison Report
5. Other (specify)

A17. On a scale of 1-10 with 10 being very important and 1 meaning little importance, what influence did the program have in your decision to take additional energy savings actions in your home?

(RECORD SCORE FROM 1-10)

A18. Were you planning to take the energy savings actions prior to receiving the Home Energy Comparison Report?

1. Yes
2. No (skip to A20)

A19.What factors prevented you from taking the energy savings actions prior to receiving the Home Energy Comparison Report? (read responses)

1. I did not have the money at that time.
2. I was not sure how long I would remain in my home.
3. I was not sure what kind of energy savings action to take.
4. I was not convinced I would save more.
5. Other (verbatim)

A20. How likely is it that you would have taken the energy savings action had you not received the Home Energy Comparison Report? (read responses)

1. Very Unlikely
2. Somewhat Unlikely
3. Neither Likely nor Unlikely
4. Somewhat Likely
5. Very Likely

## *Demographics*

D1. Do you own or rent your home?

1. Own
2. Rent

D2. What type of residence do you live in?

1. Single family residence
2. Duplex or two family residence
3. Apartment/Condominium

4. Other (specify)

D3. Approximately what year was your residence built?

1. Before 1900
2. 1900 to 1930
3. 1931 to 1950
4. 1951 to 1970
5. 1971 to 1990
6. 1991 to present
7. Don't know

D4. What is your age?

1. Less than 24 years old
2. 25 to 34 years old
3. 35 to 44 years old
4. 45 to 54 years old
5. 55 to 64 years old
6. 65 years and over

D5. Including yourself, how many people currently live in your home year-round?

_____ People

D6. What is the highest level of education you have completed?

1. High school or equivalent
2. Some college
3. College
4. Graduate degree
5. Other (specify)

# Appendix II. HECR Program Survey Results

### *Participation*

Do you recall receiving the Home Energy Comparison Reports?

| Response | Count | % |
|---|---|---|
| Yes | 101 | 83% |
| No | 21 | 17% |
| Total | 122 | 100% |

May I ask you a few questions about the Home Energy Comparison Reports?

| Response | Count | % |
|---|---|---|
| Yes | 88 | 77% |
| No | 26 | 23% |
| Total | 114 | 100% |

How frequently do you receive these reports?

| Response | Count | % |
|---|---|---|
| Annually | 1 | 1% |
| Quarterly | 25 | 30% |
| Every other month | 26 | 31% |
| Monthly | 20 | 24% |
| DK/Refused | 11 | 13% |
| Total | 83 | 100% |

About how many of the Home Energy Comparison Reports have you read?

| Response | Count | % |
|---|---|---|
| All | 61 | 73% |
| Some | 20 | 24% |
| None | 1 | 1% |
| DK/Refused | 1 | 1% |
| Total | 83 | 100% |

Do you glance at the graphics/headlines?

| Response | Count | % |
|---|---|---|
| Yes | 79 | 96% |
| No | 3 | 4% |
| DK/Refused | 0 | 0% |
| Total | 82 | 100% |

Do you skim the article content?

| Response | Count | % |
|---|---|---|
| Yes | 74 | 91% |
| No | 7 | 9% |
| DK/Refused | 0 | 0% |
| Total | 81 | 100% |

Do you read some of the article content?

| Response | Count | % |
|---|---|---|
| Yes | 65 | 81% |
| No | 14 | 18% |
| DK/Refused | 1 | 1% |
| Total | 80 | 100% |

Do you read the reports from cover to cover?

| Response | Count | % |
|---|---|---|
| Yes | 36 | 44% |
| No | 44 | 54% |
| DK/Refused | 1 | 1% |
| Total | 81 | 100% |

About how much time do you spend reading each report?

| Response | Count | % |
|---|---|---|
| 1 to 4 minutes | 49 | 60% |
| 5 to 10 minutes | 28 | 34% |
| More than 10 minutes | 5 | 6% |
| Total | 82 | 100% |

Have you discussed the reports with others?

| Response | Count | % |
|---|---|---|
| Yes | 43 | 52% |
| No | 38 | 46% |
| DK/Refused | 1 | 1% |
| Total | 82 | 100% |

With whom did you discuss the report?

| Response | Count | % |
|---|---|---|
| Members of your household | 36 | 73% |
| Neighbors | 11 | 22% |
| Friends | 2 | 4% |
| Coworkers | 0 | 0% |
| Total | 49 | 100% |

What types of things did you discuss?

| Response | Count | % |
|---|---|---|
| Saving money | 17 | 21% |
| Saving energy | 40 | 49% |
| Turning things off (lights, computers, other) | 16 | 20% |
| Environment/climate change | 2 | 2% |
| Closing doors/windows/shades | 0 | 0% |
| Saving water/hot water usage | 0 | 0% |
| Thermostat settings/turning down the heat | 1 | 1% |
| Insulation improvements | 0 | 0% |
| Accuracy of report | 6 | 7% |
| Total | 82 | 100% |

## *Report Usefulness*

How useful were the following components of the program?

| Response | Home Energy Comparison Report | Comparison of your household consumption to your neighbors | Comparison of your household efficiency rank to your neighbors | Comparison of your household consumption to the prior year | "How you are doing"™ summary (smiley faces) | Energy savings action tips |
|---|---|---|---|---|---|---|
| Very Useful | 25% | 25% | 25% | 44% | 25% | 30% |
| Somewhat Useful | 43% | 32% | 37% | 35% | 42% | 45% |
| Not Very Useful | 20% | 25% | 17% | 12% | 17% | 14% |
| Not at all Useful | 11% | 18% | 21% | 9% | 15% | 12% |
| DK/Refused | 0% | 3% | 4% | 5% | 11% | 7% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% |

| Response | Home Energy Comparison Report | Comparison of your household consumption to your neighbors | Comparison of your household efficiency rank to your neighbors | Comparison of your household consumption to the prior year | "How you are doing"™ summary (smiley faces) | Energy savings action tips |
|---|---|---|---|---|---|---|
| Very Useful | 20 | 19 | 19 | 33 | 18 | 22 |
| Somewhat Useful | 34 | 25 | 28 | 26 | 30 | 33 |
| Not Very Useful | 16 | 19 | 13 | 9 | 12 | 10 |
| Not at all Useful | 9 | 14 | 16 | 7 | 11 | 9 |
| DK/Refused | 0 | 2 | 3 | 4 | 8 | 5 |
| Total | 79 | 77 | 76 | 75 | 71 | 74 |

What information do you find most useful?

| Response | Count | % |
|---|---|---|
| Comparison of your household efficiency rank to your neighbors | 5 | 8% |
| Energy savings action tips | 5 | 8% |
| Comparison of your household consumption to your neighbors | 11 | 17% |
| Comparison of household consumption to the prior year | 24 | 38% |
| How you are doing (Smiley faces and label “Great, Good, More than average”™) | 1 | 2% |
| None | 17 | 27% |
| Total | 63 | 100% |

Do you feel that the level of detail in the report is sufficient?

| Response | Count | % |
|---|---|---|
| The level of detail is sufficient | 53 | 67% |
| More detail needed | 16 | 20% |
| Less detail needed | 3 | 4% |
| DK/Refused | 7 | 9% |
| Total | 79 | 100% |

Please rate your satisfaction with the following program components on a five-point scale, where 5 means “Very Satisfied” and 1 means “Very Dissatisfied.”

| Response | The report content | The report frequency | The energy saving tips |
|---|---|---|---|
| Very Satisfied | 28% | 34% | 34% |
| Satisfied | 24% | 24% | 23% |
| Neutral | 27% | 24% | 23% |
| Dissatisfied | 13% | 9% | 11% |
| Very Dissatisfied | 8% | 6% | 6% |
| DK/Refused | 1% | 3% | 3% |
| Total | 100% | 100% | 100% |

| Response | The report content | The report frequency | The energy saving tips |
|---|---|---|---|
| Very Satisfied | 22 | 27 | 27 |
| Satisfied | 19 | 19 | 18 |
| Neutral | 21 | 19 | 18 |
| Dissatisfied | 10 | 7 | 9 |
| Very Dissatisfied | 6 | 5 | 5 |
| DK/Refused | 1 | 2 | 2 |
| Total | 79 | 79 | 79 |

## *Actions Taken*

Did your household take any energy savings actions in the past two years?

| Response | Count | % |
|---|---|---|
| Yes | 53 | 65% |
| No | 26 | 32% |
| DK/Refused | 2 | 2% |
| Total | 81 | 100% |

**Cross Program Participation**

Have you participated in other Central Hudson energy efficiency programs?

| Response | Count | % |
|---|---|---|
| Yes | 11 | 20% |
| No | 38 | 68% |
| DK/Refused | 7 | 13% |
| Total | 56 | 100% |

Which programs have you participated in?

| Response | Count | % |
|---|---|---|
| Residential Appliance Recycling | 5 | 38% |
| Residential Electric HVAC | 2 | 15% |
| Residential Natural Gas HVAC | 0 | 0% |
| DK/Refused | 6 | 46% |
| Total | 13 | 100% |

**Lighting**

Have you installed compact fluorescent bulbs or LEDs?

| Response | Count | % |
|---|---|---|
| Yes | 45 | 83% |
| No | 6 | 11% |
| DK/Refused | 3 | 6% |
| Total | 54 | 100% |

Approximately how many CFLs or LEDs have you installed?

| Response | Count | % |
|---|---|---|
| 0 ≤ 3 | 1 | 3% |
| 3 ≤ 6 | 12 | 34% |
| 6 ≤ 10 | 7 | 20% |
| 10 ≤ 14 | 6 | 17% |
| 14 ≤ 30 | 9 | 26% |
| Total | 35 | 100% |
| Average | 11.31 | |

**HVAC System**

Have you purchased and installed a new heating or cooling system?

| Response | Count | % |
|---|---|---|
| Yes | 11 | 20% |
| No | 32 | 59% |
| DK/Refused | 11 | 20% |
| Total | 54 | 100% |

What type of heating or cooling system did you install?

| Heating Type | Count | % |
|---|---|---|
| Furnace | 3 | 18% |
| Boiler | 8 | 47% |
| Central AC | 3 | 18% |
| Room AC | 2 | 12% |
| Air Source Heat Pump | 1 | 6% |
| Geothermal Heat Pump | 0 | 0% |
| Ductless Mini-Split | 0 | 0% |
| Total | 17 | 100% |

Old vs. New Heating Fuel

| Heating Fuel | Old | New |
|---|---|---|
| Electricity | 0 | 1 |
| Natural Gas | 2 | 1 |
| Propane | 1 | 1 |
| Oil | 4 | 4 |
| Total | 7 | 7 |

Approximately how old was the system replaced? - # of Years

| Quartile | Count | % |
|---|---|---|
| 0.0 ≤ 6.0 | 2 | 25% |
| 6.0 ≤ 7.5 | 0 | 0% |
| 7.5 ≤ 17.5 | 2 | 25% |
| 17.5 ≤ 32.5 | 2 | 25% |
| 32.5 ≤ 40.0 | 2 | 25% |
| Total | 8 | 100% |
| Average | 20.63 | |

Is your new system ENERGY STAR?

| Response | Count | % |
|---|---|---|
| Yes | 9 | 82% |
| No | 2 | 18% |
| Total | 11 | 100% |

**Household Appliance**

Have you purchased a household appliance?

| Response | Count | % |
|---|---|---|
| Yes | 29 | 54% |
| No | 21 | 39% |
| DK/Refused | 4 | 7% |
| Total | 54 | 100% |

What type of appliance did you purchase?

| Appliance | Count | % |
|---|---|---|
| Refrigerator | 14 | 33% |
| Clothes Dryer | 7 | 16% |
| Dishwasher | 5 | 12% |
| Clothes Washer | 5 | 12% |
| Freezer | 4 | 9% |
| Stove | 3 | 7% |
| Microwave Oven | 3 | 7% |
| Window AC | 1 | 2% |
| Coffee Maker | 1 | 2% |
| Total | 43 | 100% |

Is the new appliance ENERGY STAR?

| Response | Count | % |
|---|---|---|
| Yes | 25 | 86% |
| No | 0 | 0% |
| DK/Refused | 4 | 14% |
| Total | 29 | 100% |

Have you recycled any appliances?

| Response | Count | % |
|---|---|---|
| Yes | 18 | 33% |
| No | 26 | 48% |
| DK/Refused | 10 | 19% |
| Total | 54 | 100% |

What type of appliance did you recycle?

| Appliance | Count | % |
|---|---|---|
| Refrigerator | 9 | 33% |
| Freezer | 4 | 15% |
| Room Air Conditioner | 1 | 4% |
| Dishwasher | 1 | 4% |
| Clothes Washer | 5 | 19% |
| Clothes Dryer | 5 | 19% |
| Stove | 2 | 7% |
| Total | 27 | 100% |

Did you replace the appliance?

| Response | Count | % |
|---|---|---|
| Yes | 17 | 100% |
| No | 0 | 0% |
| DK/Refused | 0 | 0% |
| Total | 17 | 100% |

Is the new appliance ENERGY STAR?

| Response | Count | % |
|---|---|---|
| Yes | 17 | 94% |
| No | 0 | 0% |
| DK/Refused | 1 | 6% |
| Total | 18 | 100% |

**Insulation**

Have you installed insulation?

| Response | Count | % |
|---|---|---|
| Yes | 8 | 15% |
| No | 30 | 56% |
| DK/Refused | 16 | 30% |
| Total | 54 | 100% |

What type of insulation did you install?

| Insulation Type | Count | % |
|---|---|---|
| Attic | 6 | 55% |
| Wall | 1 | 9% |
| Floor | 3 | 27% |
| Duct | 0 | 0% |
| Other | 1 | 9% |
| Total | 11 | 100% |

## *Motivation*

What, if anything, influenced your decision to take an energy savings action?

| Response | Count | % |
|---|---|---|
| Saving money | 29 | 40% |
| Saving energy | 29 | 40% |
| Central Hudson EE program | 2 | 3% |
| HECR Report | 3 | 4% |
| Other | 10 | 14% |
| Total | 73 | 100% |

On a scale of 1-10 with 10 being very important and 1 meaning little importance, what influence did the program have in your decision to take additional energy savings actions in your home?

| Response | Count | % |
|---|---|---|
| 1 | 6 | 11% |
| 2 | 4 | 7% |
| 3 | 3 | 6% |
| 4 | 1 | 2% |
| 5 | 9 | 17% |
| 6 | 4 | 7% |
| 7 | 5 | 9% |
| 8 | 5 | 9% |
| 9 | 0 | 0% |
| 10 | 2 | 4% |
| DK/Refused | 15 | 28% |
| Total | 54 | 100% |

Were you planning to take the energy savings actions prior to receiving the Home Energy Comparison Report?

| Response | Count | % |
|---|---|---|
| Yes | 26 | 48% |
| No | 11 | 20% |
| DK/Refused | 17 | 31% |
| Total | 54 | 100% |

What factors prevented you from taking the energy savings actions prior to receiving the Home Energy Comparison Report?

| Response | Count | Percent |
|---|---|---|
| I was not sure what kind of energy savings action to take. | 3 | 10% |
| I was not sure how long I would remain in my home. | 1 | 3% |
| I did not have the money at that time. | 4 | 13% |
| I was not convinced I would save more. | 6 | 19% |
| No need to replace | 9 | 29% |
| Other | 4 | 13% |
| Don't Know/Refused | 4 | 13% |
| Total | 31 | 100% |

How likely is it that you would have taken the energy savings action had you not received the Home Energy Comparison Report?

| Response | Count | Percent |
|---|---|---|
| Very Unlikely | 4 | 7% |
| Somewhat Unlikely | 7 | 13% |
| Neither Likely nor Unlikely | 5 | 9% |
| Somewhat Likely | 13 | 24% |
| Very Likely | 8 | 15% |
| DK/Refused | 17 | 31% |
| Total | 54 | 100% |

## *Demographics*

Do you own or rent your home?

| Response | Count | Percent |
|---|---|---|
| Own | 63 | 79% |
| Rent | 11 | 14% |
| DK/Refused | 6 | 8% |
| Total | 80 | 100% |

What type of residence do you live in?

| Response | Count | Percent |
|---|---|---|
| Single family residence | 60 | 81% |
| Apartment/Condominium | 7 | 9% |
| Duplex or two family residence | 4 | 5% |
| Other | 3 | 4% |
| Total | 74 | 100% |

Approximately what year was your residence built?

| Response | Count | Percent |
|---|---|---|
| 1991 to present | 13 | 16% |
| 1971 to 1990 | 18 | 23% |
| 1951 to 1970 | 18 | 23% |
| 1931 to 1950 | 8 | 10% |
| 1900 to 1930 | 6 | 8% |
| Before 1900 | 2 | 3% |
| DK/Refused | 15 | 19% |
| Total | 80 | 100% |

What is your age?

| Response | Count | Percent |
|---|---|---|
| 25 to 34 years old | 4 | 5% |
| 35 to 44 years old | 2 | 3% |
| 45 to 54 years old | 19 | 24% |
| 55 to 64 years old | 17 | 21% |
| 65 years and over | 30 | 38% |
| DK/Refused | 8 | 10% |
| Total | 80 | 100% |

Including yourself, how many people currently live in your home year-round?

| Response | Count | Percent |
|---|---|---|
| 1 | 19 | 25% |
| 2 | 33 | 44% |
| 3 | 9 | 12% |
| 4 | 7 | 9% |
| 5 | 4 | 5% |
| 6 | 2 | 3% |
| 7 | 1 | 1% |
| Total | 75 | 100% |

What is the highest level of education you have completed?

| Response | Count | Percent |
|---|---|---|
| High school or equivalent | 25 | 31% |
| Some college | 14 | 18% |
| College | 19 | 24% |
| Graduate degree | 10 | 13% |
| Other | 4 | 5% |
| DK/Refused | 8 | 10% |
| Total | 80 | 100% |

# Appendix III. Billing Analysis

## Introduction

### *Opower HECR Program*

The Opower program utilizes a social marketing campaign, with normative messaging techniques to encourage responsible energy behavior and choices. The campaign provides Home Energy Comparison Reports (HECR) to households in CHG&E-NY's combined gas and electric service territories in the Mid-Hudson Valley region of upstate NY. The Home Energy Reports provide recipients with feedback on their household energy use including a comparison of the recipient household's energy usage with that of neighboring homes, thereby introducing a subtle form of competition among like households to achieve energy savings. The current program serves dual fuel, single family households. Each report provides the following:

- **Information on home's energy use:** Recipients are able to see their home's energy use in the context of the energy use of other homes that are nearby and similar in size.
- **Progress tracking:** Track changes in a home's energy use over time and across seasons.
- **Ideas on Energy Efficiency:** Each report includes information on the rebates and other special programs customers can access to reduce energy use.[12]

The HECR program administered through Opower is unusual among energy efficiency (EE) programs through its use of randomized customer assignments to either participant or non-participant (control) groupings, or what is often called program participation on an *Opt-Out basis*. Within most EE programs, customers opt-in to the EE program voluntarily, upon review of information about the program(s), and the perceived benefits and costs therewith. Similarly, customers can voluntarily choose not to participate in the program(s), if the perceived benefits are not materially larger than the costs of participating borne by the customer. This feature of program design has important implications for program evaluation.

This opt-out program design, comes very close to achieving what researchers have defined as a Randomized Controlled Trial (RCT), defining program/experimental designs in which participants (the treatment group) and non-participants (control group) are randomly assigned to the program. (This should not be confused with random sampling.)

When properly designed and administered, the RCT method effectively mitigates the problem(s) of self-selection bias – one of the more pernicious and difficult problems to address in statistical impact evaluation studies of EE programs.[13] Opower claims the program design for the HECR meets the requirements for RCT, through random assignment of customers into mutually exclusive bins of HECR recipients, and customers not receiving the HECR.

[12] New York residents and customers of one of the independently-owned investors utilities (IOUs) can participate in a wide range of energy efficiency programs including those offered by their local utility (e.g. CHG&E), the New York Energy Research & Development Authority (NYSERDA), and/or other third-party energy service providers (e.g. ESCOs).

[13] Self-selection bias among program participants invalidates the use of a control group, because the control group does not provide a true and unbiased baseline of what participants would have done, absent the program influence, since both groups are fundamentally different.

***Evaluation of Electricity Impacts***

DNV KEMA employed two alternative statistical approaches to estimate changes in electricity use associated with HECR program participation. These included the following:

- A T-Test scoring of changes in monthly billed kWh use among HECR recipients and a comparison with changes in monthly billed energy use to the non-recipient control group.
- A pooled time-series/cross-sectional analysis framework to model changes in average daily billed energy use.

The following factors were taken into consideration in choosing to apply multiple statistical analysis methods:

- When viewed on a percentage of energy use basis, HECR programs typically result in average energy savings of less than 4% per household, including impacts already claimed by other EE programs.
- Each measurement approach differs in data requirements and statistical complexity, and alternative representations of program impacts from HECR.
- Statistical methods have different strengths and weaknesses, that must be traded-off against the data requirements (and costs) of each.
- Using multiple methods provides a sensitivity analysis of how savings estimates vary by measurement method(s).
- Variations in weather conditions over time represents the biggest confounding influence in isolating and quantifying energy impacts attributable to HECR, even with a properly selected control group.

## Initial Findings

***Summary of Evaluated Households***

The following tables provide a summary of the households covered in this study. These tables provide context for the remaining analyses. These tables were derived from the billing records DNV KEMA received from CHG&E.

**Table 1: Sample Statistics for Electric Customers: Over *Pre-HECR Billing Periods***

| Unweighted Sample Statistics: | Electric Pre-HECR: | |
|---|---|---|
| | HECR Participants | Control Group |
| Number of Unique Customer Accounts: | 22,904 | 23,833 |
| Mean Average Daily kWh (Pre-HECR Periods): | 27.31 | 21.97 |
| Median Avg. Daily kWh Use: | 25.17 | 19.38 |
| Standard Deviation : | 15.74 | 17.05 |
| Coeff of Variation (CV): | 57.62 | 77.63 |
| Skewness Measure: | 1.38 | 16.25 |

**Table 2: Sample Statistics for Electric Customers: Delta Change in Avg Daily kWh Use (Post minus Pre-*HECR Billing Period(s)***

| Weighted Sample Statistics: | Electric Delta Use: | |
|---|---|---|
| | HECR Participants | Control Group |
| Number Unique Customer Accounts: | 22,904 | 23,833 |
| Mean Delta Change in Avg Daily kWh Use (Post - Pre-HECR Billing Periods): | -0.259 | 0.302 |
| Median Delta Change in Avg. Daily kWh Use: | -0.0049 | 0.213 |
| Standard Deviation : | 5.23 | 5.19 |
| Coeff of Variation (CV): | -2,017.2 | 1,718.5 |
| Skewness Measure: | -0.359 | 3.56 |

The sets of descriptive statistics in Tables 1 and 2 above were for the participant and control group samples examined in this study. They reveal sample sizes that are very close to each other, but vary in terms of both pre-period average daily usage and delta changes in average daily (kWh) use across most statistical measures. The tables of results that follow were generated using Proc TTest in SAS, and test the (Null) hypothesis, that there is no statistical difference between changes in average daily kWh use among the sample of (22,904) participants, and the control group of non-HECR-participants (23,833).

**Table 3: T-Test (Scoring) Results for HECR Electric: *Unweighted* Samples**

| Unweighted Sample Statistics from Proc TTEST: | Electric Pre-HECR: | |
|---|---|---|
| | HECR Participants | Control Group |
| Sample Size (=Customer Accounts): | 22,904 | 23,833 |
| Mean Delta kWh Use/Day: | -0.2953 | 0.302 |
| Difference of Differences in Avg Daily kWh Use (Control – Treatment Group): | 0.5612 | |
| Standard Error of the Estimate: | 0.0482 | |
| T-Test Statistic (Null Hypothesis: D-o-D = 0.0): | 11.64 | |
| 90% (+/- 10%) Confidence Interval:<br>- Lower Savings Estimate (kWh/Day):<br>- Upper Savings Estimate (kWh/Day): | <br>0.4820<br>0.6405 | |

**Table 4: T-Test (Scoring) Results for HECR Electric: Weighted Samples**

| Unweighted Sample Statistics from Proc TTEST: | Electric Pre-HECR: | |
|---|---|---|
| | HECR Participants | Control Group |
| Sample Size (=Customer Accounts): | 22,904 | 23,833 |
| Mean Delta kWh Use/Day: | -0.2822 | 0.2927 |
| Difference of Differences in Avg Daily kWh Use (Control – Treatment Group): | 0.5750 | |
| Standard Error of the Estimate: | 0.050 | |
| T-Test Statistic (Null Hypothesis: D-o-D = 0.0): | *11.50* | |
| 90% (+/- 10%) Confidence Interval:<br>- Lower Savings Estimate (kWh/Day):<br>- Upper Savings Estimate (kWh/Day): | 0.4926<br>0.6556 | |

A simple annualization of average daily kWh savings un-weighted and weighted yields the following:

a) Un-weighted average annual savings = 205 kWh per HECR Participant / Year
b) Weighted average annual savings = 210 kWh per HECR Participant / Year.

The above estimates should be interpreted in the following manner:

A comparison of the measured changes in average daily kWh use from the sets of pre to post-HECR billing periods reveals that HECR participants saw their annual energy consumption fall by an average of 205 kWh per year, with no adjustments to the analysis samples reflecting the sampling distribution of customers by rate codes, versus the population distribution of customers by rate code.

Weighting the participant and non-participant (i.e. control group) samples by case weights that calibrate the sampling distribution to the population distribution, results in a slightly larger estimate of changes in annual consumption of about 210 kWh per year, per HECR participant.

In both sets of results, we can comfortably *reject the Null Hypothesis* that the observed *differences-of-differences* in energy consumption observed between participant and non-participant samples, from the pre- to the post-HECR billing periods, is *not* statistically different from zero.

Not explicitly reported in the above tables (3 & 4) are the relative precision estimates which are the following;

- +/- *14.1% relative precision* for the *unweighted* savings estimates, and
- +/- 14.3% relative precision for the savings estimates weighted by rate code.

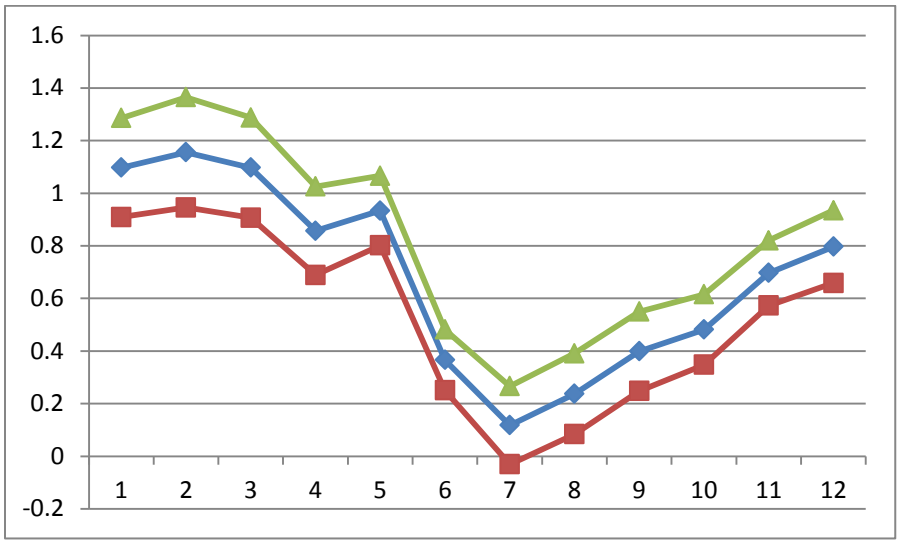
We can conclude from these sets of results obtained from a t-scoring of differences-of-differences in energy use, that HECR program participation had a statistically meaningful impact on energy use among program participants versus a like-sample of non-participants.

***T-Scoring of Monthly Energy Savings***

This section provides DNV KEMA's initial estimates of monthly changes in energy use following introduction of the HECR program year (April 2011 to March 2012).

The following set of results apply the same t-scoring of differences-of-differences in energy use, by month. We will focus on the set of results that are weighted by customers segmented by residential rate codes, as they present the best representation of changes in energy consumption for the HECR program population.

**Figure 4. Delta Changes in Average Daily kWh Usage by Month: Weighted Results for the Treatment vs. Control Group(s)**




Note: this figure presents the plot of differences of differences with upper and lower confidence intervals.

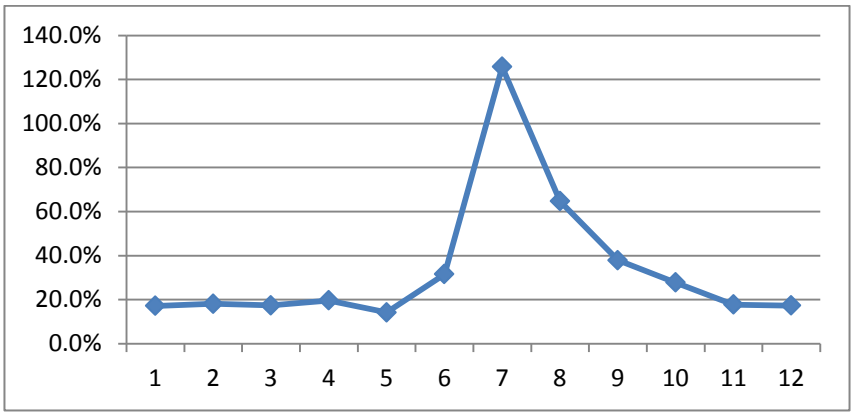
Figure 4 presents a plot of the monthly changes in average daily kWh use observed among HECR program participants (delta kWh), that nets-out monthly changes in kWh use within the control group. This is sometimes called differences-of-differences between the treatment and control groups. DNV KEMA ran a T-scoring of these monthly changes to obtain upper and lower confidence intervals, calculated at a 90 +/- 10% level of statistical significance.

Figure 4 (for electric) clearly identifies the observed change(s) in monthly kWh use, shortly after the time period when CHG&E introduced the HECR program. It reveals that monthly changes in average daily kWh use, between the control group of non-participants, and the sample of HECR participants can vary significantly from a high of about 1.16 kWh/day, recorded over the February billing period(s), to a low value of about 0.12 kWh/day in the July billing period(s).

The confidence bands reveal a fairly tight fit around the set of monthly mean impact estimates, with savings dipping into negative territory on the lower band, only during the month of July.

Figure-2 below plots the relative statistical precision of the monthly estimates of savings, and clearly reveals that HECR program impacts display far lower rates of statistical precision during summer months (June through August), compared to other months of the year.

**Figure 2. Plot of the Relative Statistical Precision of Monthly Impacts: T-Scoring Analysis Results**




Summer weather is the obvious causal factor driving the observed variance in the monthly impacts. Relative precision is very stable and consistent over month months, lying just below (+/-) 20%, until you reach the summer months: No other influence emerges as a causal factor in this variance pattern.

The regression analysis of savings attempts to account for weather-related influences that may confound (bias) the impacts estimates attributable directly to HECR participation.

Before turning to the results of this regression analysis, we report some other useful results from this t-scoring of monthly impacts. Table 5 (below), presents estimates of the average kWh impacts from HECR over the entire month, and reports these estimates, as a percentage of average monthly kWh use among non-participants, during the pre-HECR program period(s).[14]

**Table 5. Estimates of HECR Program Savings By Month**

| Month: | HECR kWh Savings | Average Monthly kWh usage by Non-Participants Pre-HECR | Savings as % of Use: |
|---|---|---|---|
| 1 | 34 | 771 | 4.5% |
| 2 | 37 | 706 | 5.2% |
| 3 | 33 | 736 | 4.5% |
| 4 | 25 | 614 | 4.1% |
| 5 | 28 | 575 | 4.9% |
| 6 | 11 | 547 | 2.0% |
| 7 | 4 | 698 | 0.5% |
| 8 | 7 | 784 | 0.9% |
| 9 | 12 | 729 | 1.6% |
| 10 | 15 | 654 | 2.2% |
| 11 | 21 | 572 | 3.7% |
| 12 | 25 | 627 | 3.9% |
| Totals: | 251 | 8,012 | 3.1% |

[14] It was necessary to apply some adjustment factors to the billing period data, to report these results on a monthly basis, as customers are billing bi-monthly rather than monthly, in most instances.

We summarize these results as follows:

a) When savings are calculated and reported on a monthly basis, including adjustments for billing-period reporting and metering cycles, average kWh impacts from HECR is about 251 kWh per year, per HECR participant (vs. our prior estimate of about 210 kwh for the annual model) .

b) Average monthly savings vary widely, from a low of about 4 kWh/month per participant in July, to a high of about 37 kWh per participant during February.

c) When calculated as a percentage of average monthly usage, among non-participants (i.e. the control group sample) during the pre-HECR program period, HECR impacts translate into about 3.1% of average kWh use per year.

***Regression Analysis of Changes in Electricity Usage***

This section present the results of a statistical regression analysis of changes in energy consumption, associated with participation in the HECR program. The previous section presented the results of a T-Test analysis of changes in monthly electricity use, and revealed the impact weather conditions have within the impact evaluation framework.

The specific model specification applied in this analysis is referred to as a fixed effects model. The fixed effects model is a pooled time-series/cross sectional modeling technique that estimates a unique intercept variable (the fixed effects variable), for each cross-section of the data (account number). Fixed effects represent the combined set of influences unique to each cross-section in the sample.

The regression model presented in this section, also accommodates the modeling of weather-related influences, through the construction of heating and cooling degree day variables (HDD and CDD), as explanatory variables in the model.

Additionally, we applied a weighting scheme to the data set, again using the same set of case weights reflecting the population-weighted distribution of customers by rate code variable. Proc SurveyReg in SAS was used to perform the regression estimation.

The model was first estimated (i.e. pooled) over all months to obtain an overall estimate of the percentage change in average daily kWh use per HECR customer, compared to the control group sample of non-HECR participants, adjusted for changes in average daily heating and cooling degree days calculated uniquely to correspond to the billing cycle of each customer in the sample. Table 6 presents the parameter estimates for this pooled, fixed effects model specification.

**Table 6. Fixed Effects Regression Parameter Estimation Results**

| Explanatory Variable: | Parameter Estimate | Coefficient T-Statistic (H0 = 0.0) |
|---|---|---|
| HECR Participation Indicator Variable: | -0.02447 | - 84.5 |
| Delta Change in Avg Daily HDD | 0.01049 | 88.7 |
| Delta Change in Avg Daily CDD | 0.03126 | 197.1 |

The parameter estimate on the HECR participation variable represents the mean percentage change in average daily energy use, estimated over all months of the year and is equal to a 2.45% reduction in energy use, among HECR participants. The t-statistic easily passes the threshold value of -2.0.

Table 7 reports the aggregate savings estimate, preceded by the set of monthly savings estimates, also expressed as percentages. (In the far right column, we have included the percentage estimates obtained from the T-scoring savings method discussed above, for comparison purposes.)

These monthly savings estimates were derived from a domain analysis of savings in the regression procedure – an estimation technique whereby parameter estimates are generated for each value of the domain variable – *months-of-the-year* in this model.

**Table 7: Monthly Savings Estimates (in %) from Regression Analysis Model**

| Month: | (%) Savings Estimates | Std. Error: | T-Statistic: | T-Score Percentages: |
|---|---|---|---|---|
| 1 | -2.86% | 0.00071681 | -39.96 | 4.5% |
| 2 | -2.16% | 0.00079442 | -27.20 | 5.2% |
| 3 | -1.98% | 0.00110537 | -17.89 | 4.5% |
| 4 | -1.93% | 0.00038913 | -49.51 | 4.1% |
| 5 | -3.71% | 0.00066358 | -55.85 | 4.9% |
| 6 | -2.23% | 0.00050251 | -44.47 | 2.0% |
| 7 | -0.97% | 0.00054916 | -17.74 | 0.5% |
| 8 | -1.39% | 0.00044118 | -31.46 | 0.9% |
| 9 | -1.32% | 0.00042472 | -31.04 | 1.6% |
| 10 | -3.01% | 0.00032352 | -93.07 | 2.2% |
| 11 | -2.71% | 0.00080703 | -33.60 | 3.7% |
| 12 | -1.75% | 0.00055836 | -31.41 | 3.9% |
| Annual Avg: | 2.45% | 0.000289 | -84.5 | 3.1% |

These monthly estimates do not consistently match-up with those obtained from the T-Scoring analysis methodology: In some months they are higher and are lower in HECR. Note however, that the t-statistics easily pass the threshold criteria of 2.0 in all months in the regression model, including the summer months. The overall impact from taking into account the impacts of weather on changes in average daily energy use, within the regression modeling framework, is to lower the (%) estimate of savings attributable to the HECR program from about 3.1% to 2.45%.

**Calculation of Weather-Normalized Annual kWh Savings**

The regression analysis described above, quantifies the observed relationship between changes in electricity use (the dependent variable), represented on a percentage basis, against changes in weather conditions, represented by average daily heating and cooling degree days, a set of intercept variables – one for each customer in the sample, and a binary (i.e. program participation) variable reflecting both the timing and participation in the Opower (HECR) program (the set of explanatory variables). When estimated in this manner, the coefficient estimate(s) on the participation variable(s) are interpreted as the percentage change in average daily electricity use observed in billing-periods (months) following the

HECR program, when compared against average daily usage in similar billing periods before HECR was introduced.[15]

The pooled regression analysis results presented above, revealed a weighted average reduction in average daily energy use of 2.45% associated with Opower participation, over a 1-year period. By including variables to account for weather-induced changes in energy use, this impact estimate isolates program impacts attributable to Opower, independent of changes in weather observed in the data over the estimation period.[16]

However, this parameter only provides a compact estimate of the average percentage change in daily electricity use among a sample of Opower participants, and says nothing about the kWh savings we can expect to observe, when customers participate in the HECR program, and begin to respond to the information designed to promote lower electricity use. More specifically, we must answer the following question: If so-called typical, or normal weather conditions were to prevail over a 1-year period (i.e. calendar year), what level of *kWh savings* could we expect the average residential customer on HECR to achieve, and by extension, what would be the cumulative level of kWh savings attained over all HECR program participants?

DNV KEMA proceeded to answer these twin questions, by applying a PRISM-based statistical analysis methodology to obtain weather-normalized estimates of annual electricity use, and applying the percentage savings estimates obtained in the regression analysis (=2.45% per year), for the program participant sample.[17] The following set of steps were performed in this analysis:

a) Usage data was gathered for the census-level sample of Opower participants over the pre-HECR program (2010-2011) period

b) The billing-period usage data was subjected to a set of data quality screens to check and verify completeness

c) Estimates of average daily billing period usage (kWh/day) were constructed for each participant

d) A set of weather data were obtained for the CHG&E service territory (HDD and CDD Poughkeepsie airport), against which the billing period usage data were fit against, using a regression model (PRISM)

e) Next, the parameter estimates from this PRISM-based analyses were used to estimate what normalized annual consumption (NAC) energy use would be, if actual weather were equal to typical weather conditions, represented in this analysis, by the median weather year, over the most recent 20-year historical period.

[15] Since residential customers are billed bi-monthly in the CHG&E service territory, the calculation of (delta %) changes in average daily energy use going from the pre-to-post HECR program periods are performed over similar 60-day periods, e.g. Post-HECR(Jan-Feb) vs. Pre-HECR (Jan-Feb) average daily percentage changes in use.

[16] It is important to note that including variables that reflect changes in weather from post-to pretreatment periods does not mean that the impacts from Opower are independent of weather. Rather, changes in weather represent another influence on average daily energy use that must be accounted for in the model.

[17] PRISM is an acronym for the *Princeton Score-keeping Method*, a statistical weather normalization methodology developed by Mimi Goldberg and Meg Fels, applicable to the calculation of estimates of normalized annual consumption, or NACs, for almost any fuel type (electricity, natural gas), used by households.

The resulting set of NAC estimates obtained from this analyses, adjust actual billed, or metered annual electricity from deviations from so-called typical (or normal) weather conditions, as well as variations in the number of days evident in billing period data, to yield estimates of typical electricity use over a *calendar year*.

The final step in the estimation of annual program savings, is to apply our (%) savings estimates to this set of customer-level NACS, and aggregate the resulting estimates of annualized kWh savings over all participants in our sample, to obtain an estimate of total, weather-normalized net program impacts. Dividing this aggregate estimate of net kWh savings, by the number of Opower participants in our sample, provides an estimate of average, W-N kWh savings, per Opower participant, per year.

Table 8 presents the estimation results from this analysis. The set of results labeled as the *Base Savings Estimate* are bracketed by range estimates derived from a 90% confidence interval around the point estimate: On average, an Opower participant reduced average, weather-normalized annual energy use by about 205 kWh over a calendar year, where so-called normal weather conditions are represented by the median year calculated over the last 20-year period (1992-2012).

**Table 8: Weather Normalized Savings Estimate**

| Savings Estimate: | Model-Based Savings Est. (*Avg. %/Year*); | PRISM W-N Population Sample (N=): | Total Weather-Normalized kWh/Year | Estimated Opower W-N kWh Savings/Yr: | Avg W-N kWh Savings per Customer/Yr: |
|---|---|---|---|---|---|
| Lower Range Estimate: | 2.40% | 22,904 | 191,224,220 | 4,589,381 | 200 |
| Base Savings Estimate: | 2.45% | | | 4,684,993 | 205 |
| Upper Range Estimate: | 2.50% | | | 4,780,605 | 209 |

Over the full sample of Opower participants examined in this analysis (=22,904), net program savings were estimated to be about 4,685 MWh on a calendar year basis, during a typical weather-year, or about 4.7 GWh/year. The lower and upper range estimates of savings are tightly distributed around the base estimate consistent with the high degree of relative statistical precision obtained in the analysis.

**Opower Savings for Natural Gas**

***Overview***

A similar statistical analysis of Opower impacts on natural gas (NGas) consumption by residential customers in the CHG&E service territory was performed as part of this impact evaluation study. The general analysis framework applied to electricity was similarly applied to NGas savings estimation and thus will not be re-stated here, except where there are notable differences between the analyses. To summarize, the following set of analysis steps were employed in the impact evaluation of NGas:

- Sets of billing period data were obtained for samples of NGAS HECR program participants and a representative sample of non-participants that met the requirements of an RCT experimental design (discussed above),

- The customer samples under-went a set of screening and data quality checks, to ensure accuracy of the meter-reads, remove estimated and/or adjusted reads, ensure sufficient numbers of read dates before and after the program period, and screen for other possible aberrations in the billing period data.

- Weather data, in the form of heating degree days were merged into the billing period data for each customer aligned with read dates for use in calculating average daily Therm use per billing period, per customer, along with average daily heating degree days (HDD), consistent with the number of days in each billing period interval: A CDD was not included in the model for NGAS.

- Sets of summary statistics for each customer sample were generated, covering the pre and post-treatment periods, and examined to determine the statistical similarity between the participant (i.e. treatment) and control group of non-participant. (These statistical summaries are reported in the next section.)

- A regression model of changes in average daily Therm use, measured as the log-difference between post-treatment period average daily Therm use, and average daily use prior to HECR serving as the dependent variable, against a set of fixed effects variables, a delta change variable for average daily HDD, and the 0/1 (binary) HECR participation indicator variable was estimated by season (the domain variable), using the fixed effects model specification option in PROC SURVEYREG in SAS.

- A diagnostic analysis was performed on the resulting model estimation results to confirm the statistical validity of the (%) savings parameter estimate in the model.

Following completion of the above analysis steps to derive the mean (β) estimates of the average net estimate of (%) program savings for HECR, a PRISM analysis was performed on the NGAS sample of program participants, in the same manner as applied to electric participants, for use in deriving an estimate of net therm savings for HECR, weather-normalized to reflect so-called typical or normal weather conditions, on a *calendar year basis*.[18]

And lastly, confidence intervals are constructed around the mean estimate of average (%) savings from HECR and similarly applied to customer NACS, to reveal the range of variation in net savings estimates, at a 90% (+/- 10%) level of statistical confidence.

[18] Recall from the previous discussion that billing period data does not conform to a calendar year, for most customers. The PRISM analysis and estimation of customer NACS addresses this issue.

***Statistical Description and Summary of the Customer Samples for NGas***

In this section we present summary statistics for the samples of customers examined in the estimation of program impacts for natural gas.[19]

**Table 9. Sample Statistics for HECR Program Participant Sample, Average Daily Therm Use Through May, 2011**

| Month | N Obs | Mean | Std Dev | Std Error | CV |
|---|---|---|---|---|---|
| 1 | 2091 | 5.095 | 2.444 | 0.053 | 47.969 |
| 2 | 3007 | 6.177 | 3.084 | 0.056 | 49.928 |
| 3 | 2404 | 5.282 | 2.529 | 0.052 | 47.869 |
| 4 | 2849 | 3.931 | 2.069 | 0.039 | 52.621 |
| 5 | 2147 | 2.162 | 1.244 | 0.027 | 57.514 |
| 6 | 2951 | 1.242 | 0.839 | 0.015 | 67.574 |
| 7 | 2107 | 0.766 | 1.089 | 0.024 | 142.104 |
| 8 | 2958 | 0.650 | 0.843 | 0.016 | 129.732 |
| 9 | 2406 | 0.624 | 1.072 | 0.022 | 171.786 |
| 10 | 2684 | 0.788 | 0.727 | 0.014 | 92.242 |
| 11 | 2159 | 1.730 | 1.189 | 0.026 | 68.716 |
| 12 | 2771 | 3.135 | 1.769 | 0.034 | 56.442 |

**Table 10. Sample Statistics for HECR Program Participant Sample, Average Daily Therm Use after May, 2011**

| Month | N Obs | Mean | Std Dev | Std Error | CV |
|---|---|---|---|---|---|
| 1 | 2613 | 4.328 | 2.204 | 0.043 | 50.937 |
| 2 | 2652 | 5.180 | 2.625 | 0.051 | 50.678 |
| 3 | 2463 | 4.370 | 2.294 | 0.046 | 52.493 |
| 4 | 2568 | 3.196 | 1.720 | 0.034 | 53.801 |
| 5 | 2309 | 1.767 | 1.139 | 0.024 | 64.470 |
| 6 | 3093 | 1.250 | 0.880 | 0.016 | 70.417 |
| 7 | 2406 | 0.717 | 1.041 | 0.021 | 145.297 |
| 8 | 3181 | 0.644 | 0.839 | 0.015 | 130.216 |
| 9 | 2303 | 0.613 | 1.165 | 0.024 | 189.898 |
| 10 | 2924 | 0.758 | 0.700 | 0.013 | 92.322 |
| 11 | 2501 | 1.713 | 1.220 | 0.024 | 71.256 |
| 12 | 2842 | 2.847 | 1.595 | 0.030 | 56.035 |

[19] Additional tables of summary statistics will be reported in the appendix section of the final report.

### Table 11. Delta Avg Daily Therm Use by Month: Participant Sample

| Month | N= | Mean | Std Dev | Std Error |
|---|---|---|---|---|
| 1 | 2091 | (0.791) | 0.833 | 0.018 |
| 2 | 2564 | (1.087) | 0.956 | 0.019 |
| 3 | 2337 | (0.842) | 0.916 | 0.019 |
| 4 | 2507 | (0.707) | 0.712 | 0.014 |
| 5 | 2051 | (0.357) | 0.495 | 0.011 |
| 6 | 2946 | 0.027 | 0.342 | 0.006 |
| 7 | 2080 | (0.037) | 0.265 | 0.006 |
| 8 | 2951 | 0.003 | 0.208 | 0.004 |
| 9 | 2231 | (0.010) | 0.321 | 0.007 |
| 10 | 2624 | (0.016) | 0.268 | 0.005 |
| 11 | 2148 | (0.048) | 0.414 | 0.009 |
| 12 | 2694 | (0.326) | 0.594 | 0.011 |

### Table 12. Sample Statistics for Natural Gas Non-Participant Sample Average Daily Therm Use Through May, 2011

| Month | N | Mean | Std Dev | Std Error | CV |
|---|---|---|---|---|---|
| 1 | 1796 | 4.864 | 2.276 | 0.054 | 46.799 |
| 2 | 1558 | 6.138 | 3.060 | 0.078 | 49.850 |
| 3 | 1956 | 5.106 | 2.365 | 0.053 | 46.316 |
| 4 | 1530 | 3.847 | 2.114 | 0.054 | 54.961 |
| 5 | 1835 | 2.060 | 1.022 | 0.024 | 49.592 |
| 6 | 1562 | 1.222 | 1.023 | 0.026 | 83.749 |
| 7 | 1823 | 0.703 | 0.947 | 0.022 | 134.824 |
| 8 | 1552 | 0.640 | 1.168 | 0.030 | 182.601 |
| 9 | 1928 | 0.567 | 0.692 | 0.016 | 122.028 |
| 10 | 1470 | 0.776 | 0.977 | 0.025 | 125.838 |
| 11 | 1783 | 1.588 | 1.042 | 0.025 | 65.598 |
| 12 | 1509 | 3.171 | 1.946 | 0.050 | 61.375 |

**Table 13. Sample Statistics for Natural Gas Non-Participant Sample Average Daily Therm Use After May, 2011**

| Month | N | Mean | Std Dev | Std Error | CV |
|---|---|---|---|---|---|
| 1 | 2022 | 4.136 | 2.022 | 0.045 | 48.895 |
| 2 | 1452 | 5.113 | 2.550 | 0.067 | 49.881 |
| 3 | 1962 | 4.301 | 2.150 | 0.049 | 49.982 |
| 4 | 1384 | 3.102 | 1.611 | 0.043 | 51.956 |
| 5 | 1888 | 1.742 | 1.088 | 0.025 | 62.435 |
| 6 | 1683 | 1.215 | 1.024 | 0.025 | 84.237 |
| 7 | 1928 | 0.662 | 0.601 | 0.014 | 90.757 |
| 8 | 1781 | 0.645 | 1.340 | 0.032 | 207.636 |
| 9 | 1862 | 0.559 | 0.611 | 0.014 | 109.306 |
| 10 | 1597 | 0.754 | 0.969 | 0.024 | 128.617 |
| 11 | 1952 | 1.603 | 1.010 | 0.023 | 62.977 |
| 12 | 1538 | 2.823 | 1.575 | 0.040 | 55.798 |

**Table 14. Delta Avg Daily Therm Use by Month: Non-Part Sample**

| Month | N | Mean | Std Dev | Std Error |
|---|---|---|---|---|
| 1 | 1794 | (0.745) | 0.770 | 0.018 |
| 2 | 1397 | (1.062) | 1.080 | 0.029 |
| 3 | 1905 | (0.766) | 0.818 | 0.019 |
| 4 | 1348 | (0.693) | 0.764 | 0.021 |
| 5 | 1776 | (0.307) | 0.611 | 0.014 |
| 6 | 1556 | 0.018 | 0.305 | 0.008 |
| 7 | 1800 | (0.027) | 0.289 | 0.007 |
| 8 | 1551 | (0.006) | 0.209 | 0.005 |
| 9 | 1828 | (0.005) | 0.205 | 0.005 |
| 10 | 1445 | (0.026) | 0.211 | 0.006 |
| 11 | 1778 | 0.001 | 0.351 | 0.008 |
| 12 | 1469 | (0.375) | 0.783 | 0.020 |

The sample size for non-participants is smaller than the sample size for participants, but still large enough to present a meaningful representation of usage profiles for baseline (i.e. non-program periods) in this analysis.

***Statistical Description and Summary of the NGas Regression Analysis***

The regression results presented in tables 15 through 17 reveal an impact estimate that has the correct sign indicating that natural gas use among program participants fell by an average of 1.44% following roll-out of the HECR program in the spring of 2011. The t-statistic rejects the (null) hypothesis that the program impact is not statistically different from zero, albeit the savings estimate on a percentage basis, is quite small. The range estimates indicate that the true, population savings parameter lies somewhere between 1.1 % and 1.7% with a 90% level of confidence.

### Table 15. Regression Analysis Data Summary

| Data Summary | Value: |
|---|---|
| Number of Observations | 48838 |
| Mean of Log_Ratio_Post_to_Pre | -0.08993 |
| Sum of Log_Ratio_Post_to_Pre | -4391.9 |

### Table 16. Regression Analysis Fit Statistics

| | |
|---|---|
| R-square | 0.1826 |
| Root MSE | 0.2595 |
| Denominator DF | 48837 |

### Table 17. Estimated Regression Coefficients

| Parameter | Estimate | STD Error | T Value | 90% Confidence Interval | |
|---|---|---|---|---|---|
| HECR_Part_Indicator | (0.0144) | 0.002 | (8.010) | (0.0173) | (0.0114) |
| Delta_Avg_Daily_HDD | 0.0363 | 0.000 | 95.470 | 0.0357 | 0.0370 |

***Weather-Normalized Estimates of Calendar Year Savings for NGas***

A PRISM-based weather-normalization procedure was applied to obtain weather-normalized therm use on a calendar year basis for each participant customer during the pre-treatment year (NACs), to which our model-based savings parameter estimate was applied, to obtain estimates of total therm savings, and average therms saved, per Opower customer, per year. The table below illustrates the same set of calculations for natural gas, as was applied to electricity.

| Savings Estimate: | Model-Based Savings Est. (*Avg. %/Year*): | PRISM W-N Population Sample (N=): | Total Weather-Normalized Therm/Year: | Estimated Opower W-N Therm Savings/Yr: | Avg W-N Therm Savings per Customer /Year: |
|---|---|---|---|---|---|
| Lower Range Estimate: | 1.14% | 5,029 | 4,009,801 | 45,712 | 9.09 |
| Base Savings Estimate: | 1.44% | | | 57,741 | 11.48 |
| Upper Range Estimate: | 1.73% | | | 69,370 | 13.79 |

These calculations are based on a sample of participants (N=5,029), so one possible approach to extending these results to the population of Opower (NGas) participants, would be to work with the customer savings estimate (=11.48 therms per customer, per calendar year) in applying it to the (sub-) population of program participants, assuming they meet certain, minimal attributes.[20]

[20] Key attributes would include the number of months of Opower customers took natural gas service: Customers taking service for less than 1 calendar year would have their savings estimates adjusted accordingly.

# Appendix IV. Net-to-Gross Observations

## Net-to-Gross Methodology

Between April and June of 2013, AEG conducted a survey of Central Hudson customers who participated in the HECR program. The survey results are based on the responses from a stratified random sample of program participants and have a margin of error of +/- 10 percent at a 90 percent level of confidence.

The survey results provide insights into the motivations and behaviors of participants. The survey included several questions that were designed to estimate free ridership and spillover. However, the net-to-gross observations presented in this appendix are separate from the statistical billing analysis and may not be applied to the program results overall. The statistical billing analysis was designed to estimate the net impacts of the program without the use of a NTG ratio.

## Free Ridership

Free ridership estimates the amount of savings that would have been achieved without the influence of the HECR program. A free rider is a program participant who would have engaged in energy savings behavior without the influence of the HECR program. First, respondents were asked if they were planning on taking actions before receiving the report. Each response was assigned a free ridership probability. The following tables present the free ridership probabilities for the free ridership survey questions.

### Free Ridership Question 1

*A18. Were you planning to take the energy savings actions prior to receiving the Home Energy Comparison Report?*

| Q1 Response | Min | Max | Est. |
|---|---|---|---|
| Yes | 0% | 50% | 25% |
| No | 0% | 0% | 0% |

### Free Ridership Question 2

*A20. How likely is it that you would have taken the energy savings action had you not received the Home Energy Comparison Report?*

| Q2 Response | Min | Max | Est. |
|---|---|---|---|
| Very Unlikely | 0% | 0% | 0% |
| Somewhat Unlikely | 10% | 30% | 20% |
| Neither Likely or Unlikely | 30% | 50% | 40% |
| Somewhat Likely | 50% | 70% | 60% |
| Very Likely | 70% | 90% | 80% |

The free ridership estimate for each response ranges from zero to 90 percent. For example, respondents who answered “yes” to Question 1 were assigned a 25 percent probability that they would have reduced energy use without receiving the bi-monthly report. Similarly, in Question 2 the probability of free ridership increases with the likelihood that the participant would have reduced energy use without receiving the bi-monthly report.

and  show how the free ridership estimates were determined using the survey results. The free ridership estimate reflects the free ridership probability weighted by the proportion of responses for each appliance category.

**Table 23. Free Ridership Results, Question 1**

| Response | FR Probability | Count | Weight | FR Estimate |
|---|---|---|---|---|
| Yes | 25% | 26 | 0.70 | 18% |
| No | 0% | 11 | 0.30 | 0% |
| *Question 1 Total* | | | | *18%* |

**Table 24. Free Ridership Results, Question 2**

| Response | FR Probability | Count | Weight | FR Estimate |
|---|---|---|---|---|
| Very Unlikely | 0% | 4 | 0.11 | 0% |
| Somewhat Unlikely | 20% | 7 | 0.19 | 4% |
| Neither Likely nor Unlikely | 40% | 5 | 0.14 | 5% |
| Somewhat Likely | 60% | 13 | 0.35 | 21% |
| Very Likely | 80% | 8 | 0.22 | 17% |
| *Question 2 Total* | | | | *48%* |

The free ridership estimates from both questions were averaged to get a total estimate for the overall program. Table 25 shows the overall free ridership estimate for the program as approximately 33 percent.

**Table 25. Total Free Ridership Estimate**

| FR Q1 | FR Q2 | Total FR |
|---|---|---|
| 18% | 48% | 33% |

## Spillover

Spillover represents the estimated portion of additional energy savings that occurred as a result of the Home Energy Comparison Report Program that the program participant undertook outside of the program. In the context of behavior change programs such as HECR, spillover refers to the savings that are achieved by participants in response to the energy reports. The survey questions were designed to capture only participant spillover, non-participant spillover was not included in the analysis.

Spillover Question 1 asked participants if they had taken any energy efficiency actions in the past two years. If they answered “yes,” they were asked a series of questions for more details about the actions as well as their motivation for engaging in the behavior.  Table 26 shows that approximately 65 percent of survey respondents indicated that they had taken energy efficient actions in the previous two years.

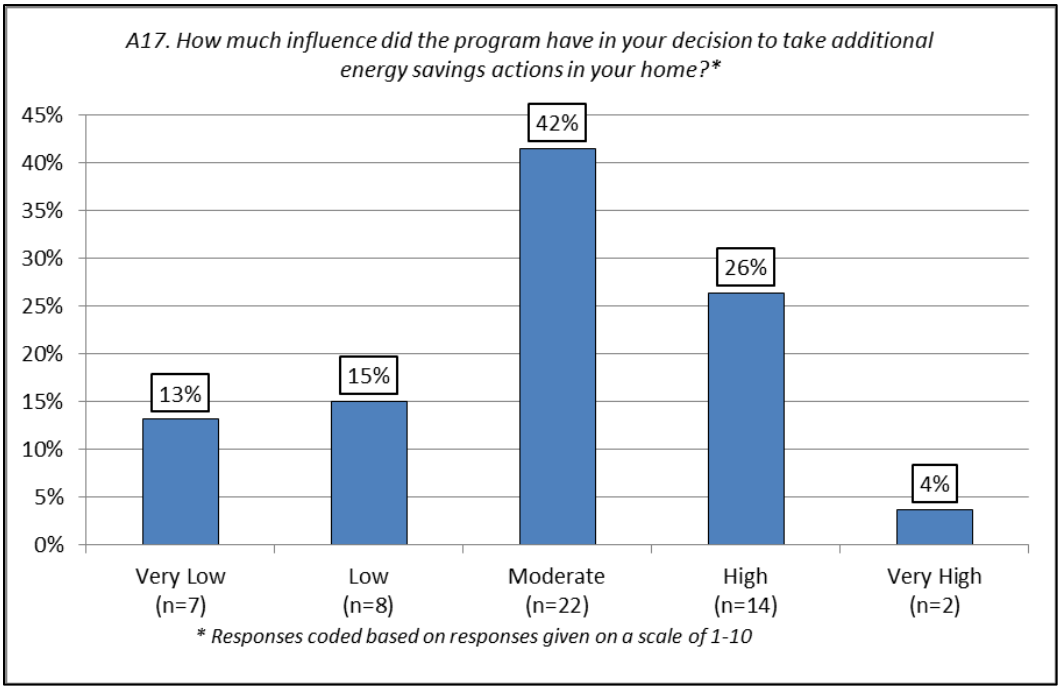
### Table 26 Spillover Participant Responses

| Response | Count | Percent |
|---|---|---|
| Yes | 53 | 65% |
| No | 26 | 32% |
| Total | 81 | 100% |

Next, Spillover Question 2 asked respondents about the specific actions taken: installed efficient lighting, HVAC systems, appliances, etc. AEG calculated the energy savings associated with each action using algorithms in the *2010 New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs* ("Tech Manual").[21]

HECR participants engaged in a variety of spillover energy savings actions. AEG combined the electric and gas savings associated with the actions by converting all values to British Thermal Units (BTUs) using conversion factors found in the Tech Manual. Respondents who reported participating in other Central Hudson programs such as Appliance Recycling or Residential HVAC were assigned a savings value based on the average Ex Ante participant savings for that program, which was determined by AEG in other evaluations.

### Figure 5. HECR Influence on Spillover Actions




Spillover Question 3 asked respondents about how much the program influenced the decision to engage in the spillover actions. The figure above shows how influential the HECR program was in motivating survey respondents to engage in spillover energy savings actions. A plurality of respondents reported that the bi-monthly reports had a moderate influence on their energy saving decision.

[21] *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs*, Prepared for New York Department of Public Service by TecMarket Works, October 15, 2010. The Tech Manual is a public document that is designed to provide a standardized, fair and transparent approach for measuring program energy savings.

The following series of equations were used to derive the net spillover savings attributable to the program. Net spillover refers to the sum of each participant's spillover savings multiplied by that participant's spillover score. First, the spillover score reported by each respondent was translated into a spillover score using the equation below.

**Equation 2. Weighted Spillover Score**

$$Weighted\ Spillover\ Score = \frac{Spillover\ Question\ 3}{10}$$

Next, AEG applied each participant's weighted spillover score to their total spillover savings to derive their net spillover savings attributable to the program, as shown in Equation 3. .

**Equation 3. Spillover Measure Savings**

$$Spillover\ Measure\ Savings_{(participant\ i, measure\ j)} = Tech\ Manual\ kWh\ Savings_{(measure\ j)} \times Weighted\ Spillover\ Score_{(participant\ i, measure\ j)}$$

Finally, Equation 4 shows how AEG derived the spillover factor adjustment for the HECR program. The spillover factor adjustment is expressed as the percentage of net spillover savings for all respondents to the gross savings from all survey respondents. The total savings for all survey respondents includes the gross spillover savings plus the average participant savings from the HECR program.

**Equation 4. Spillover Factor Adjustment**

$$Spillover\ Factor\ Adjustment = \frac{\sum Spillover\ Measure\ Savings_{(participant\ i, measure\ j)}}{\sum Total\ Savings\ for\ All\ Survey\ Respondents}$$

The table below shows the data used to determine the spillover factor adjustment. The table shows each line for the 88 respondents showing those that engaged in spillover actions and those that did not. The gross spillover savings (Column 3) for each respondent includes the total spillover savings reported by the respondent. Spillover participants engaged in a variety of activities according to the survey results, including efficient lighting, HVAC, and appliances. The savings for each measure were calculated using the Tech Manual.

The table includes the spillover score (1-10) reported by each respondent (Column 4) as the influence the HECR program had in motivating the respondent to engage in the spillover actions. The net spillover savings (Column 5) is calculated as the product of the spillover score and the gross spillover savings. The total EE savings (Column 6) equals the gross spillover savings plus the average participant savings attributable to the HECR program.

### Table 27 Spillover Factor Calculation Data

| Respondent ID | Spillover Respondent | Gross SO Savings | SO Score | Net SO Savings | Total EE Savings |
|---|---|---|---|---|---|
| 1 | Yes | 63.55 | 10% | 6.36 | 65.4 |
| 2 | Yes | 26.98 | 10% | 2.7 | 28.83 |
| 3 | Yes | 1.7 | 10% | 0.17 | 3.55 |
| 4 | Yes | 11.33 | 10% | 1.13 | 13.18 |
| 5 | Yes | 0.45 | 10% | 0.05 | 2.3 |
| 6 | Yes | 0 | 10% | 0 | 1.85 |
| 7 | Yes | 48.94 | 20% | 9.79 | 50.79 |
| 8 | Yes | 68.65 | 20% | 13.73 | 70.5 |
| 9 | Yes | 15.5 | 20% | 3.1 | 17.35 |
| 10 | Yes | 0 | 20% | 0 | 1.85 |
| 11 | Yes | 0.35 | 30% | 0.1 | 2.19 |
| 12 | Yes | 13.72 | 30% | 4.11 | 15.56 |
| 13 | Yes | 1.55 | 30% | 0.47 | 3.4 |
| 14 | Yes | 42.95 | 40% | 17.18 | 44.8 |
| 15 | Yes | 0.17 | 50% | 0.09 | 2.02 |
| 16 | Yes | 0.29 | 50% | 0.15 | 2.14 |
| 17 | Yes | 6.36 | 50% | 3.18 | 8.21 |
| 18 | Yes | 0.83 | 50% | 0.41 | 2.67 |
| 19 | Yes | 0.7 | 50% | 0.35 | 2.54 |
| 20 | Yes | 27.62 | 50% | 13.81 | 29.47 |
| 21 | Yes | 0.32 | 50% | 0.16 | 2.17 |
| 22 | Yes | 0 | 50% | 0 | 1.85 |
| 23 | Yes | 0.16 | 50% | 0.08 | 2 |
| 24 | Yes | 0.58 | 60% | 0.35 | 2.43 |
| 25 | Yes | 2.04 | 60% | 1.22 | 3.88 |
| 26 | Yes | 0.45 | 60% | 0.27 | 2.29 |
| 27 | Yes | 0 | 60% | 0 | 1.85 |
| 28 | Yes | 30.64 | 70% | 21.44 | 32.48 |
| 29 | Yes | 56.37 | 70% | 39.46 | 58.22 |
| 30 | Yes | 27.91 | 70% | 19.54 | 29.76 |
| 31 | Yes | 11.19 | 70% | 7.83 | 13.04 |
| 32 | Yes | 0.54 | 70% | 0.38 | 2.39 |
| 33 | Yes | 14.3 | 80% | 11.44 | 16.14 |
| 34 | Yes | 0.55 | 80% | 0.44 | 2.4 |
| 35 | Yes | 0.35 | 80% | 0.28 | 2.19 |
| 36 | Yes | 0.7 | 80% | 0.56 | 2.54 |
| 37 | Yes | 0.08 | 80% | 0.07 | 1.93 |
| 38 | Yes | 0.76 | 100% | 0.76 | 2.61 |
| 39 | Yes | 11.19 | 100% | 11.19 | 13.04 |
| 40 | Yes | 0.23 | 50% | 0.12 | 2.08 |
| 41 | Yes | 6.06 | 50% | 3.03 | 7.9 |
| 42 | Yes | 0.23 | 50% | 0.12 | 2.08 |
| 43 | Yes | 6.07 | 50% | 3.04 | 7.92 |
| 44 | Yes | 0.82 | 50% | 0.41 | 2.67 |
| 45 | Yes | 0.41 | 50% | 0.2 | 2.25 |
| 46 | Yes | 0.58 | 50% | 0.29 | 2.43 |
| 47 | Yes | 17.06 | 50% | 8.53 | 18.91 |
| 48 | Yes | 14.59 | 50% | 7.3 | 16.44 |
| 49 | Yes | 0.62 | 50% | 0.31 | 2.47 |
| 50 | Yes | 0 | 50% | 0 | 1.85 |
| 51 | Yes | 0 | 50% | 0 | 1.85 |
| 52 | Yes | 0 | 50% | 0 | 1.85 |
| 53 | Yes | 0 | 10% | 0 | 1.85 |
| 54 | No | 0 | 0 | 0 | 1.85 |
| 55 | No | 0 | 0 | 0 | 1.85 |
| 56 | No | 0 | 0 | 0 | 1.85 |
| 57 | No | 0 | 0 | 0 | 1.85 |
| 58 | No | 0 | 0 | 0 | 1.85 |
| 59 | No | 0 | 0 | 0 | 1.85 |
| 60 | No | 0 | 0 | 0 | 1.85 |
| 61 | No | 0 | 0 | 0 | 1.85 |
| 62 | No | 0 | 0 | 0 | 1.85 |
| 63 | No | 0 | 0 | 0 | 1.85 |
| 64 | No | 0 | 0 | 0 | 1.85 |

| Respondent ID | Spillover Respondent | Gross SO Savings | SO Score | Net SO Savings | Total EE Savings |
|---|---|---|---|---|---|
| 65 | No | 0 | 0 | 0 | 1.85 |
| 66 | No | 0 | 0 | 0 | 1.85 |
| 67 | No | 0 | 0 | 0 | 1.85 |
| 68 | No | 0 | 0 | 0 | 1.85 |
| 69 | No | 0 | 0 | 0 | 1.85 |
| 70 | No | 0 | 0 | 0 | 1.85 |
| 71 | No | 0 | 0 | 0 | 1.85 |
| 72 | No | 0 | 0 | 0 | 1.85 |
| 73 | No | 0 | 0 | 0 | 1.85 |
| 74 | No | 0 | 0 | 0 | 1.85 |
| 75 | No | 0 | 0 | 0 | 1.85 |
| 76 | No | 0 | 0 | 0 | 1.85 |
| 77 | No | 0 | 0 | 0 | 1.85 |

| Respondent ID | Spillover Respondent | Gross SO Savings | SO Score | Net SO Savings | Total EE Savings |
|---|---|---|---|---|---|
| 78 | No | 0 | 0 | 0 | 1.85 |
| 79 | No | 0 | 0 | 0 | 1.85 |
| 80 | No | 0 | 0 | 0 | 1.85 |
| 81 | No | 0 | 0 | 0 | 1.85 |
| 82 | No | 0 | 0 | 0 | 1.85 |
| 83 | No | 0 | 0 | 0 | 1.85 |
| 84 | No | 0 | 0 | 0 | 1.85 |
| 85 | No | 0 | 0 | 0 | 1.85 |
| 86 | No | 0 | 0 | 0 | 1.85 |
| 87 | No | 0 | 0 | 0 | 1.85 |
| 88 | No | 0 | 0 | 0 | 1.85 |
| **Grand Total** | | | | **216** | **699** |

The table below shows the simplified values used to determine the spillover factor adjustment. Electric and natural gas savings were converted to mmBTUs using the conversion factors in the Tech Manual in order to account for both therm and kWh savings.

**Table 28. Spillover Factor Adjustment**

| Line | Variable | Value |
|---|---|---|
| A | Total Respondents | 88 |
| B | Program Savings per Participant | 1.85 |
| C | Program Savings of Sample (A x B) | 162 |
| D | Gross Spillover Savings of Sample | 536 |
| E | Total Sample Savings (C + D) | 699 |
| F | Net Spillover Savings | 216 |
| G | Spillover Score (F ÷ E) | 31% |

As shown in the gross spillover savings of the sample was approximately 536 mmBTUs. This value is referred to as "gross spillover" because it does not account for programmatic influences. The "net spillover savings" is the sum product of each participant's the spillover score and spillover savings. Therefore, the net spillover savings was about 216 mmBTUs. The overall spillover score reflects the ratio of net spillover savings to the total sample savings (both gross spillover and program savings) of 699 mmBTUs. As a result, the spillover score is 31 percent.

## Net-to-Gross Results

As described in , the NTG ratio combines the influences of free ridership and spillover. Free ridership refers to the amount of savings that would have occurred without any influence associated with the HECR program. Likewise, spillover represents the amount of additional savings that occurred as a result of program participation, but was not directly incentivized.

**Equation 5. Net-to-Gross Ratio**

$$NTG\ Ratio = 1 - Free\ Ridership + Spillover$$

Using the free ridership and spillover estimates described above, the overall NTG factor for the Home Energy Comparison Report Program is 98 percent, as summarized in the table below.

**Table 29. HECR Net-to-Gross Factor**

| Free Ridership | Spillover | Net-to-Gross |
|---|---|---|
| 33% | 31% | 98% |

The net-to-gross factor presented in the table above may not be applied to the net savings determined by the statistical billing analysis.