STATEWIDE IMPACT EVALUATION

OF THE

2003 RESIDENTIAL RETROFIT PROGRAM

(HOME ENERGY SOLUTIONS PROGRAM)

Prepared for:
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EXECUTIVE SUMMARY

Introduction

The New Hampshire CORE Electric Utilities contracted with Summit Blue Consulting to conduct an impact evaluation of the 2003 Statewide Residential Retrofit Program (Home Energy Solutions). This evaluation was conducted to determine the energy and demand savings realized by this program

We evaluated the Home Energy Solutions Program across New Hampshire including the service territories of Public Service of New Hampshire (PSNH), Unitil Energy Systems, Inc. (Unitil), New Hampshire Electric Cooperative Inc. (NHEC) and Granite State Electric Company (GSEC).

There are six main objectives to this impact evaluation:

1. Determine total energy savings from the program.
2. Explain the reasons for discrepancies between each utility's tracked and verified savings.
3. Review the systems and methodology currently employed.
4. Review and verify electric and non-electric program savings estimates.
5. Differentiate evaluated savings by utility service area.
6. Identify other opportunities.

Program Description

The Retrofit Program is marketed under the name Home Energy Solutions. This program focuses on upgrading the existing housing stock in New Hampshire by assisting with improvements to the energy efficiency of their homes. Basic services include insulation, weatherization, and cost effective appliance and lighting upgrades. In 2003 participating customers could receive up to $2,500 in program services. Co-payments are required and determined based on the measures installed. The program also has a strong educational component designed to help customers better understand their home and the factors that effect energy use.

The program is open to both single and multi-family households. Marketing efforts are first targeted to customers with electric heat and then to those with high electric use. NH Utility personnel administer the program and contract for the delivery of program services.

Method

An econometric analysis was conducted using billing data, weather data, and program tracking data to compute program impacts. A monthly fixed-effects panel data specification was used for the analysis. Separate savings estimates for electric space heating customers and non-electric customers were developed since the program impacts were expected to vary substantially between the two groups. The model was estimated over the entire population of participants who had usable billing data. No non-participants were used. Therefore, the results of the statistical analysis are gross of freeridership.

Results

Exhibit S.1 presents the estimated regression model for both electric and nonelectric/multi fuel use single-family participants. For this analysis, the dependent variable in the model was monthly energy consumption for the house. Since meaningful engineering estimates were not available for these participants, we used a binary participation variable.[1] The specification of the model also helped to control for the effects of weather on the magnitude of energy consumption over the analysis period through the inclusion of yearly variables. For brevity, these non-program control variables are not included in Table S.1. They can be found in the full report.

Exhibit S.1: Impacts Model – dependent variable is monthly kWh usage

Utility Space Heating Fuel	Annual Estimated Savings (kWh)	t-value[2]
Granite State Electric Company		
Electric	3,486	4.4
Non-Electric	1,318	0.3
New Hampshire Electric Co-op		
Electric	3,547	11.2
Non-Electric	N/A[3]	
Public Service of New Hampshire	3,539	17.1
Electric	1,514	9.4
Multi-Fuel Use		
Unitil		
Electric	4,259	11.8
Non-Electric	2,760	9.8
Sample Size	17,730 observation (1,588 homes)	
R-Squared[4]		
Total	67.6%	
Ignoring individual constants	21.8%	

[1] In most impact evaluations, the use of a customer specific prior savings estimate (such as an engineering estimate) is preferred over a binary participation variable because the prior estimate contains information about the type and extent of measures installed, and thus helps to differentiate across customers. In this analysis, the binary participation model was used because the engineering estimates where questionable because the model was not benchmarked to actual consumption for the particular household. This issue is discussed further in the report.

[2] The t-value is the coefficient divided by its standard error, and is used to determine if the coefficient is statistically different from zero. If the t-value is greater than 1.64 in absolute value, then the coefficient is considered statistically significant at the 90% confidence level. The larger the absolute t-value is, the more precise is the estimate (i.e., the narrower the confidence interval).

[3] Since NHEC did not use TREAT/OTTER in 2003, we were unable to differentiate between electric and non-electrically heated homes.

[4] The R-squared is the percentage of the variation of the dependent variable (in this case monthly kWh usage) explained by the model. The total R-squared includes the individual constant terms, while the partial R-squared is the percentage of variation in the dependent variable explained by all the variables *except* the individual constant terms.

Exhibit S.2: Average Annual Estimated kWh Savings per Participant (2003)

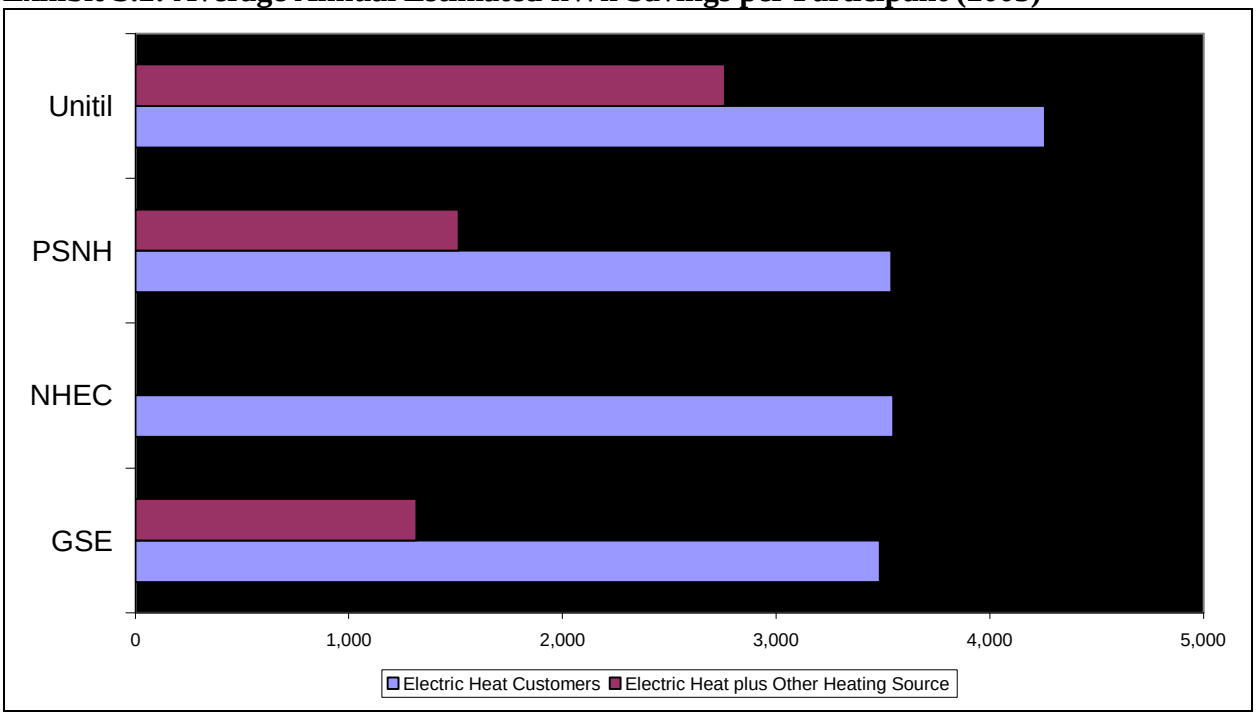

Exhibit S.3 presents the annual savings and the 90% confidence interval for each of the savings categories based on the model results.

Exhibit S.3: Impacts Model – 90% Confidence Intervals

Utility Space Heating Fuel	Lower Bound	Upper Bound
Granite State Electric Company		
Electric	2,179	4,792
Non-Electric	-4,962	7,598
New Hampshire Electric Co-op		
Electric	3,027	4,066
Non-Electric	N/A	N/A
Public Service of New Hampshire		
Electric	3,198	3,879
Multi Fuel Use	1,247	1,779
Unitil		
Electric	3,667	4,850
Non-Electric	2,297	3,223

Energy Savings Calculation Review

While the focus of this evaluation is the calculation of the gross participant savings presented in the Exhibits above, we have included program review efforts beyond the typical impact analysis, including:

- ? Review of the current savings estimation procedures
- ? Review of the software used in the savings estimation calculations
- ? Review of the program tracking system, and
- ? Comparison of the program savings to similar programs in New England.

Review of the Process

A deployment flowchart was created to better understand the program flow. In reviewing this chart it was determined that the process flow for the *HES* program appears to be efficient. There are no major feedback loops that encompass several steps. Use of the Online Tracking Tool for Energy Retrofits (OTTER) to communicate between the program staff and the contractors helps to keep the projects on track.

An examination of the tracking data in OTTER determined that single family retrofits take on average over twice as long as multi-family retrofits (Table S.4). PSNH projects, both single and multi family, take longer to complete than the projects for the other utilities.

Exhibit S.4 - Average Length of Process (days)

Dwelling Type	NHEC	GSECO	UNITIL	PSNH	Average
Single family	48.90	65.62	118.70	158.98	133.13
Multi-family	19.02		26.86	68.47	56.10
Average	30.16	65.62	51.28	91.43	77.86

In trying to understand why the PSNH projects are taking longer to complete, we examined the installed measure mix for each of the utilities. As a percent of measures installed, PSNH is installing more windows than the other utilities and more refrigerators than NHEC and UNITIL. Since windows take longer to install than most measures and refrigerators have to be purchased and installed by the customer using a rebate voucher, these measure may explain the longer project completion times.

Our review of the HES process was preliminary. A more detailed process review can help the utilities better understand the average length of process and identify areas for improvement. Based on this review, we suggest examining the "Lead-to-Work Order" stage. It is notable that this stage of the process is taking longer than the selected measure installation stage.

More accurate dates and possibly more tracking dates would help to better understand the efficiency of the *HES* delivery process. Not all utilities take advantage of all of the date fields in OTTER. This may be a result of using a separate tracker tool and then uploading the projects to OTTER. Part of the quality assurance should be to check that the tracking dates are being captured by OTTER.

Review of Software

As part of this impact evaluation, we also examined the software (TREAT and REM-Rate™) and data tracking system (OTTER) that were being used by the NH electric utilities to calculate and track the energy savings in 2003.

TREAT's development has been sponsored by the New York State Energy Research and Development Authority (NYSERDA) in cooperation with the US Department of Energy (DOE) National Renewable Energy Laboratory (NREL). NYSERDA is currently integrating TREAT as the required auditing tool for their Home Performance with ENERGY STAR® Programs. TREAT has been extensively tested and is pre-approved by DOE for use in the Low-Income Weatherization Assistance Program. TREAT has passed the Tier 1 and Tier 2 BESTEST requirements and has the capability to provide home energy ratings in accordance with the national Home Energy Rating System (HERS) standard. Treat uses TM2 weather to simulate hourly energy usage using the SUNREL computer model developed at NREL.

REM/Rate™ is a residential energy analysis, code compliance and rating software developed specifically for the needs of HERS providers. The software calculates heating, cooling, hot water, lighting, and appliance energy loads, consumption and costs for new and existing single and multi-family homes. The software uses local climate data. REM/Rate™ meets the following requirements:

- ? Calculates energy loads, consumption and costs as well as sizes mechanical equipment and performs automatic CABO Model Energy Code, ASHRAE 90.2 and International Energy Conservation Code compliance analysis.
- ? Complies with National Home Energy Rating Standards as promulgated by Residential Energy Services Network (RESNET).

Since TREAT and REM-Rate™ are currently meeting industry standards for energy use calculations, we did not undertake a review of the TREAT energy use calculations. However, as with any simulation software the accuracy of the results are dictated by the accuracy of the inputs.

Although both software packages allows the users to “true up” the estimated energy use against actual fuel bills, this step in the savings calculations was not required during the 2003 program year. As a result, the project specific savings captured in the simulation and uploaded to OTTER are not considered as accurate as they could have been had the energy savings estimates been validated against actual billing data. The calculation procedures were changed for the 2004 program year to require that the simulation models be calibrated to actual energy use (i.e., monthly utility kWh billing data).

Both the TREAT and REM-Rate software packages will provide good estimates of weather-dependent measure savings. Calibration of the models to actual billing history will greatly improve the accuracy of the savings and has already been incorporated into the 2004 program procedures.

Review of Tracking System

The Online Tracking Tools for Energy Retrofits (OTTER) provides comprehensive project management services for energy efficiency programs. OTTER is used to track work scopes and savings, report demographics and support quality assurance inspections for the HES program. OTTER allows program managers and rating providers to supervise contractors and raters online while protecting the confidentiality of the contractor-customer relationship. Program managers are able to allow users to see only the data they are given permission to see and to change only

the data they are given permission to change. OTTER helps automate the process of rating, reporting and quality assurance.

Initially, data for this impact evaluation was pulled directly from the OTTER web interface. Upon comparing the OTTER data with a similar query done by PSNH, it was discovered that the datasets did not match. The program staff has discovered that the reason for this discrepancy is that the OTTER reports truncate the data set, i.e. doesn't include all the records. As a result, the PSNH staff uses MS Access to query the back-end OTTER database, which resides at the PSNH facility, without using the web interface. This query method is complex and requires a good database background. Therefore all requests for program data and reports had to go through PSNH, defeating the idea of the central program database that all utilities can access.

Additionally the OTTER tracking system does not capture the primary and secondary fuel types from the simulation software. Currently there is no way to differential homes that are 100% electrically heated from homes that are 30% electric and 70% gas.

It is strongly recommend that program team finds a solution to the OTTER reporting problems. Reliable data is the key to tracking a program, evaluating a program and improving a program. If the program staff doesn't believe the data in the reports, then they are not getting the information that they need to manage the program. It is also recommended that primary and secondary fuel types be added to the OTTER tracking system.

Comparison of savings

Another important review of the HES tracking system is a comparison of the estimated savings from the engineering software to the savings reported by other similar programs in New England. There are several retrofit programs in the region, but few offer the full range of services as those provided by *HES*. Two organizations, Efficiency Vermont and NYSERDA, have begun offering many of the same services. Efficiency Vermont's "Home Performance" service began in early 2004. NYSERDA's Home Performance with ENERGY STAR® started in late 1999. Both of these programs only serve the single family market.

Based on this comparison, we find that overall, the savings estimates are reasonable given that the simulation models were not calibrated. Calibrating the models to actual billing data will help improve the savings estimates. NYSERDA's Home Performance program calibrates to billing data. In 2004 the *HES* program also began requiring that all models be calibrated to billing data.

Summary of On-site Measure Verification

We conducted 24 single-family and 13 multi-family on-site investigations of participants in the *HES* program to gain insights into actual program performance, both relative to existing program design and to the potential for further program benefits. Sample site investigations provide critical insights into the extent of other opportunities, installation quality, accuracy of data collection, and likelihood of persistence. Other opportunities are potential measures or installations that that were not complete at the site, either as a result of contractor oversight or customer refusal of the measure. Post- project on-site investigations can not accurately differentiate the cause of other opportunities, only direct observation can determine the source of

the other opportunity. A blower door test to determine air infiltration rates was not performed. The on-site investigations were used to support this evaluation and were not designed to be statistically precise.

To maximize the potential for gaining useful insights from these site investigations the following procedures were followed:

- Consumption histories of the sites scheduled for a visit were analyzed to provide pre-visit estimates of base load and seasonal energy consumption. The visits focused on understanding the particular usage pattern and magnitude of the site usage and assessing the potential for cost-effective savings, particularly in regard to other opportunities.

- The participants in these investigations received a $50 incentive for allowing the on-site investigation. This incentive helped to optimize the scheduling process and to minimize site selection biases (e.g., to prevent visiting only participants who are not employed during the day).

The on-site investigations found that the contractors for the most part are doing a good job recommending and installing measures that are appropriate for the situation. Unprompted by the auditors, several of the Customers expressed satisfaction with the program and their level of savings. The auditors did not find that Contractors had completely missed opportunities for *HES* program measures. The quality of the air sealing and insulation installation was for the most part thorough and professional.

The on-site investigations did note some areas on the program delivery that may be improved. The following issues were observed at multiple sites:

1) Although the auditors/contractors may have reviewed how to program the thermostats with the customers, the facility manager or customer should be shown exactly how to do it as well. And each thermostat should be programmed according to the occupant's schedule. Perhaps a schedule should be completed by the tenant prior to installation. A simple instruction sheet should be left behind to explain to the customer how to change for daylight savings time and/or changes in sleep/wake schedule.
2) Possible other air sealing and insulation opportunities were noted; however, the cause of these other opportunities was not readily identified. Infiltration areas may have been left to allow for proper ventilation levels as determined by the final blower door test. The *HES* program requires that contractors are HERS certified and undergo annual training. This advanced certification and annual training will help to mitigate possible missed air sealing and insulation opportunities.
3) Although not specifically addressed by HES program, the auditors noted possible additional opportunities for energy savings in the common area lighting in multi-family buildings. It may be possible to include common area lighting retrofits in multi-family buildings:
    a) as part of the *HES* program, or
    b) establish a procedure for passing the lead off to the appropriate commercial program, similar to PSNH's procedure for handling common area lighting.
4) The program has done a good job replacing incandescent bulbs with CFLs, however there may be an issue regarding the persistence of savings. On several occasions, the auditors

noted that the CFLs were at the site, but not installed. This may be a result of Customer dissatisfaction with the CFLs or the Contractor not installing the CFLs. The Contractors may need to be reminded that they need to determine the high-use lighting locations and actually install the CFLs in these locations.