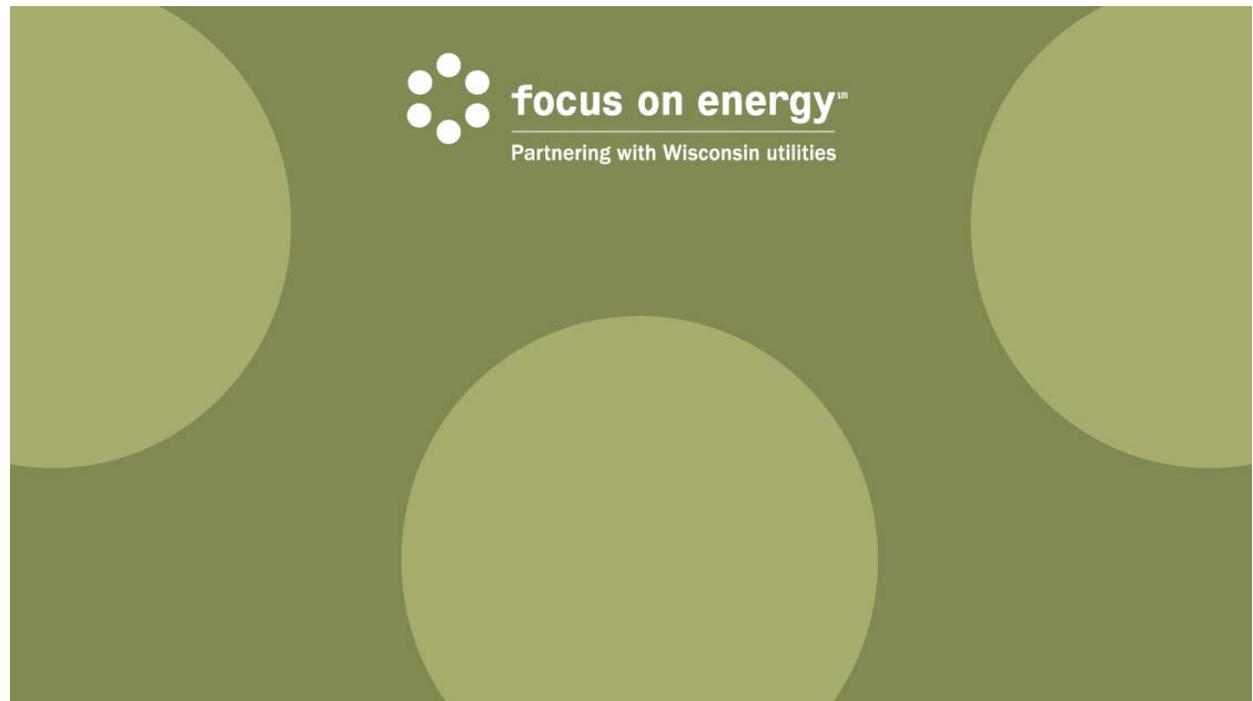




**Focus on Energy Mobile Home Duct Sealing Pilot:  
Results from 2008-2009**  
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## Executive Summary

In 2008 Focus on Energy launched a pilot project to perform very select weatherization measures on mobile homes. The objective of the Mobile Homes Duct Sealing Pilot was to explore opportunities to provide this hard-to-reach, underserved market with a program offering that would address both air sealing and direct install measures. While the initial intent was to focus on those homes that were electrically heated and/or had central air conditioning units, the pilot was expanded to cover all eligible customers (gas and electric) once it was determined that it was too difficult to target only those types of units. The program took a blitz approach, making the offer available to a park for a limited period of time in order to maximize the savings opportunity and minimize delivery costs. The program focused on retrofits that could be identified and implemented quickly so that diagnosis, work, and testing were completed in one session and at no cost to the homeowner.

This report is based on a billing analysis of 99 homes out of 192 homes with retrofit work completed prior to June 2009. The Princeton Scorekeeping Method (PRISM) was used which factors in changes in the weather in order to normalize the consumption data and calculate changes in consumption.

The major conclusions from this study include:

- The median savings of treated homes is 28 therms per year which represents about 4% of total natural gas consumption. With 192 completed homes during the study period, program savings are estimated to be 5,376 therms.
- Savings were obtained at \$0.75 per therm.
- An insufficient number of homes had central air conditioning units to calculate savings due to reduced cooling needs. As a group, the homes had a median reduction in electricity usage of 220 kWh. However, these results should be treated cautiously and revisited with additional data.
- The therm savings are comparable to savings in another pilot, but less than expected. This is partially due to the participating homes which were newer and in better condition than expected.
- Opportunities exist in these units; the energy savings potential appears to warrant development of a larger scale program offering.
- Mobile homes are a hard-to-reach market. While savings were less than forecasted, the approach generated sufficient value to continue to deliver the program, although results may warrant a review of the “free” delivery approach and the contractor’s cost for delivery. These types of adjustments may increase cost effectiveness and make it possible to increase the size and scale of the program.

- If expanded, another round of analysis should be conducted to confirm the savings results and the impact of any program design changes.

## Introduction

In 2008 Focus on Energy launched a pilot project to weatherize mobile homes. The Mobile Homes Duct Sealing Pilot focused on retrofits that could be identified and implemented quickly so that diagnosis, work, and testing were completed in one session and at no cost to the homeowner. The limited range of retrofits included duct sealing, combustion safety testing as applicable, and air-sealing of large leakage sites. To be eligible, the mobile home could not have a basement and must have both electric and natural gas utilities that participate in Focus on Energy. Participants signed a release enabling Focus on Energy to collect their energy consumption data (pre- and post-retrofits) from their electricity and natural gas utilities. This data was collected in June 2010 and billing analysis was completed for homes participating in the program up through June 2009.

## Program Description

The Mobile Homes Duct Sealing Pilot issued a request for proposal to find contractors to complete the diagnostics, duct sealing and other retrofit work, and follow-up testing all in one session; four contractors were selected. To generate leads for the project, letters were sent to mobile home owners in targeted areas. Home owners were asked to sign an agreement allowing the testing and work to be done as well as allowing Focus on Energy to collect their energy usage data from their electricity and natural gas utilities.

Contractors were required to test for duct leakages and seal leaks with Butyl tape, mesh, and mastic, often by working underneath the unit by penetrating and re-sealing the road barrier and the ductwork itself. They were also required to conduct combustion safety testing for atmospherically vented water heaters. Where indicated and practical, contractors thermally isolated water heaters, sealed exterior leaks in the furnace closet, maximized air flow through the closet door and furnace, gave dwellers instructions regarding proper maintenance, replaced poorly performing clothes dryer ductwork, disabled and re-routed systems that used the belly cavity as the return air system, and other low-cost measures such as shell air-leakage, excessive water temperature, unattended heat tape, and other items identified by the contractor.

The budget for the program including fixed and variable marketing, direct and indirect costs, subcontractors, and overhead was \$89,000 for the first year for 150 completed units and \$170,000 if 300 units were completed.

## Data Collection

As a condition of participation, homeowners agreed to release their energy consumption data to Focus on Energy staff. The signed release forms were provided to customers' electricity and natural gas utilities. The utilities collated and submitted monthly consumption data from each participant covering the period of January 2007 through June 2010. These data were used to calculate the change in energy consumption from a one-year period before the work was completed and compared it to a one-year (or longer) period after the work was completed.

In addition to the data supplied by the utilities, the contractors that completed the work also recorded the age of the mobile home, whether or not the home had central air conditioning, the pre- and post air-leakage rate as measured in CFM50 (cubic feet per minute at a pressure differential of 50 Pascals), and the pre- and post- duct leakage as measured in cumulative Pascals at 50 Pa. depressurization. CFM50 indicates the leakiness of the building envelope—a higher value indicates a home with more air leakage. Total duct leakage is a qualitative measure; the higher the number, the greater the leakage. Three Pa. total duct leakage @50 Pa. was used as the target leakage rate.

## Data Analysis Methodology

### Princeton Scorekeeping Method (PRISM)

Studies of energy consumption frequently use the Princeton Scorekeeping Method (PRISM) to control for changes in weather across the study period.<sup>1</sup> PRISM is a statistical procedure that corrects for the effects of differences in weather before and after treatment that could influence energy consumption. The procedure requires meter readings for one year or more in both the pre- and post-treatment periods and local average outdoor temperature data for ideally a ten-year time period.

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<sup>1</sup> Fels, M., K. Kissock, M. Marean, C. Reynolds. PRISM (Advanced Version 1.0) Users' Guide. January 1995.

The model produces three physical parameters for the house: base level consumption, reference temperature, and heating (or cooling) slope. Base level consumption represents energy usage independent of heating or cooling which is typically appliance and lighting usage. The reference temperature is the temperature at which a house's heating or cooling system is engaged. This is allowed to vary by home and may depend on the thermal integrity of the home, the preferred thermostat setting of the occupants, and other behavioral factors. The heating (or cooling) slope is the house's effective heat (or cooling) loss rate.

PRISM uses regression to calculate the baseload and weather-dependent components of energy use for each home. The sum of these components is the typical total annual consumption during a "normal" weather year called the Normal Annual Consumption (NAC). The difference between the NAC for a home before and after treatment is the savings due to the program.

### **Meter Data**

Meter data were collected from the electric and natural gas utilities serving the participants in the Mobile Homes Duct Sealing Pilot. Utilities provided the meter reading date and the kWh and/or therms consumed during the meter reading period. These data were inspected for missing or estimated values. As recommended by the PRISM manual, estimated values were combined with the nearest actual reading.<sup>2</sup> Missing values were coded to -1. A few participants appeared to have no service during the summer months and were excluded from the analysis.

### **Weather Data**

Average daily temperatures for three weather stations in Wisconsin for the period of January 1, 1991 through December 31, 2009 were obtained online from the Wisconsin Department of Administration.<sup>3</sup> The three weather stations were located in Madison, Green Bay, and Eau Claire, and each participant was matched to a weather station based on proximity.

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<sup>2</sup> Ibid.

<sup>3</sup> <http://www.doa.state.wi.us/degreedays/>

## Data set

Only participants with at least a full year of data before and after the treatment were included in the analysis. The initial list of participants that was submitted to utilities included homes that were treated after June 2009. These homes would not have had a full year of post-treatment data when data was collected in June 2010. Participants may also have lacked a full year of data if they moved into or out of their home within a year of participating in the pilot. Participants with several months of missing data were also eliminated and a few participants did not have a valid release form on file. Figure 1 shows the number of valid participants at each stage of filtering.

**Figure 1: Number of participants used in analysis**

Filtering criteria	Number of participants with Gas/Electric data
1. Total number of participants November 2007 through December 2009.	415
2. Total number of participants November 2007 through June 2009.	192
3. Subset of participants with eligible data for November 2007 through June 2009.	137
4. Subset of participants with full year of pre- and post-treatment.	102/95
5. Subset of participants with full year pre- and post-treatment and minimal missing data.	99/92

Because most of the homes in the Green Bay area were treated more recently, the final analysis set included only homes in the Madison and Eau Claire areas. The Green Bay area homes should be analyzed at a future date along with the more recent homes from other parts of the state.

## Results

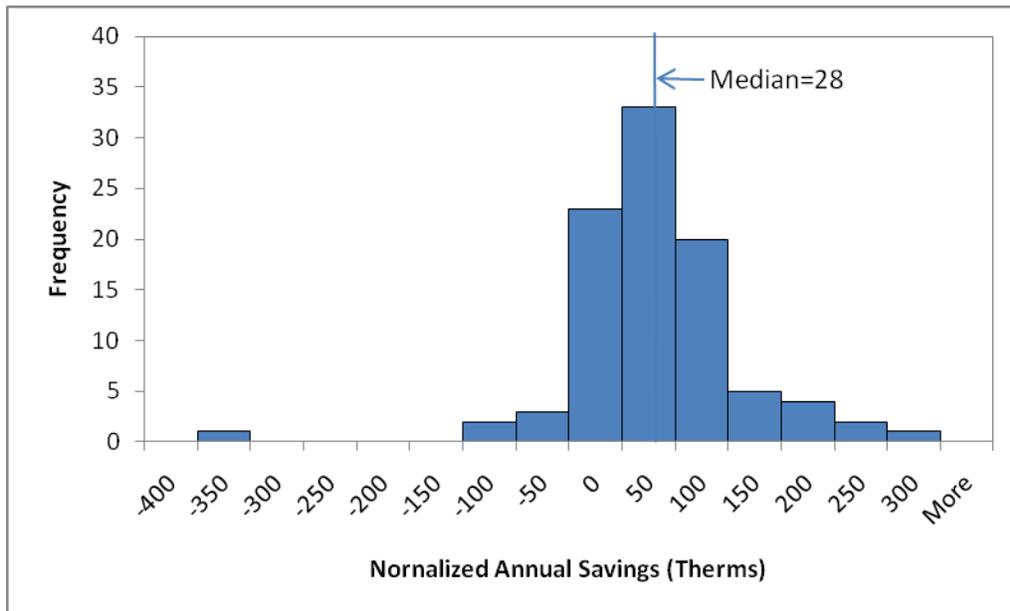
Overall, the homes participating in this pilot are newer and in better shape than expected. Half of the homes were constructed in 1985 or later. Less than 25% were built prior to 1979 despite the fact that

these older homes were given priority. The median CFM50 for homes before work was completed was 1735 and the median total duct leakage was 13.9 Pa.

## Natural Gas Usage Results

The median of the normalized annual savings across the 99 buildings with reliable models is 28 therms saved with a standard error of +/- 8 therms. This is a median savings of 3.9% (+/- 1.2%) of total natural gas usage. The statistical models used to calculate the savings for each home fit the data quite well, with a median  $R^2$  of 99%. The percentage savings (3.9%) is comparable to savings reported by a duct sealing program in Oregon.<sup>4</sup> With 192 participants through June 2009, overall first year program savings are estimated to be 5,376 therms.

**Figure 2: Distribution of normalized annual therm savings**



<sup>4</sup> Robinson, David. Manufactured Home Duct Sealing Pilot Program Draft Impact Evaluation for Energy Trust of Oregon. March 19, 2004. Summary available online: [www.cee1.org/eval/db\\_pdf\\_es/418es.pdf](http://www.cee1.org/eval/db_pdf_es/418es.pdf)

The savings illustrated above are lower than initially predicted by the program.<sup>5</sup> There is limited research on retrofits in mobile homes and the initial savings used by the program were based on a study conducted in Oregon. The participating homes in the Oregon study were generally older (about 70% were built pre-1980) and had electric heat only.

The results reported should be viewed as just the start of the evaluation of this pilot. There are over 200 additional homes that will have adequate data for analysis within the next six months. In addition, future programs could consider stricter targeting based on age of home and energy use. This would require more emphasis (and attendant costs) on recruitment, but could yield larger savings.

## Electricity Usage Results

The initial plan for the pilot included an emphasis on recruiting homes with central air conditioning so that the bulk of electricity savings would come from reduced cooling needs in the summer months. Most of the actual participants, however, resided in homes without central air conditioning. As a result, only 23 homes had both central air conditioning and adequate data for analysis in this first round of data collection. These 23 homes did not have a statistically meaningful change in electricity usage.

Combining all homes in the analysis provides a larger sample and more statistical precision; however, we would expect the savings to be much lower since the savings for most homes is coming from lower furnace fan run-time. Overall, the median of the normalized annual savings across the 92 buildings is 220 kWh with a standard error of +/- 145 kWh. This is a median savings of 3.2% (+/- 1.7%) of total electricity usage. These results are promising, but should be re-examined with a larger group of homes that have central air conditioning. The models used on the whole sample do not fit the data quite as well as the gas models. Median R<sup>2</sup> for the electric models is only 40%.

## Program Costs Compared to Energy Savings

The bulk of the program expenses come from payments for time and materials to contractors completing the retrofits. From the beginning of the pilot through June 2009, payments to contractors

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<sup>5</sup> Internal Report: Residential FY08 Program Summary, November 16, 2007.

totaled \$66,010 or about \$344 per home. Amortized at a 20-year lifetime, the costs and savings calculate to a levelized resource cost of \$0.75 per therm.<sup>6</sup>

## Conclusion

The Mobile Homes Duct Sealing Pilot shows promise and deserves continued analysis of homes that participated after June 2009. Finding savings through analysis of billing data can be tricky at best as many other factors (e.g. change in family size, travel, change in habits, etc.) can impact energy usage. Those influences are somewhat mitigated by the size of this pilot, giving us an initial reliable estimate of therm savings of 3.9% of usage. Revisiting the analysis in six months will include many more homes and enable a more robust analysis of electricity savings.

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<sup>6</sup> This calculation uses a 2% discount rate, as stipulated by the Public Service Commission.