Milwaukee Pilot Program Results

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Executive Summary

In 2008, Focus on Energy launched *Together We Save*, a community-based pilot project to increase energy-efficiency investments in Milwaukee homes. The objective of *Together We Save* was to test a more aggressive approach to reducing the barriers that prevent homeowners from making energy-efficiency investments in their homes. The program provided substantially larger incentives with financing options, integrated behavioral savings opportunities with shell measures and equipment, and hired “case managers” to help households overcome the various hassles and barriers associated with home improvements.

This report is based on a billing analysis of the 91 homes that completed the program. 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 program successfully recruited participants from the targeted neighborhoods and moved them through completion of the program.
- The median savings of treated homes was 182 therms per year, which represents about 23 percent of total natural gas consumption. With 91 completed homes during the study period, first-year program savings are estimated to be 16,562 therms.
- Savings were obtained at $3.02 per therm.
- The average impact of the program on electricity usage was neutral. Most homes did not have central air conditioning and participants overall did not seem to experience much change in their electricity usage.
- Changes to the program design could result in some cost savings and reduce the cost per therm of the program.
- Homeowners encounter many barriers to energy-efficiency investments. This program successfully reduced those barriers.
- Future programs based on the *Together We Save* pilot design should include a second round of analysis, ideally with a control group of homes, to confirm the savings results and the impact of any program design changes.

Introduction[1]

Together We Save used a community-based approach to increase energy efficiency investments in Milwaukee homes. The program targeted homeowners in two neighborhoods within the City of Milwaukee. High concentrations of both homeownership and moderate to low-income households were represented in the target neighborhoods.

The primary objectives for the pilot were to:

- Utilize the community by forming partnerships with neighborhood leaders, neighborhood groups, and city/utility/government agencies
- Test various outreach/marketing and ongoing communication techniques to ensure broad reach and pilot clarity, maximum participation, and well-informed homeowners
- Deliver optimal building science practices/products (based on experience with weatherization and home performance programs) to ensure energy efficiency standards are met
- Guide/redirect home energy-efficiency attitudes/behaviors toward sustainability

Homeowners who participated in the pilot were eligible for sizable incentives on products and services (such as insulation, air sealing and mechanical equipment) that increased the efficiency and comfort of their homes. In addition to financial incentives, homeowners received support throughout the process from a program representative (an energy advocate). This energy advocate offered services, such as walking the homeowner through the application and energy audit process, scheduling service consultants and contractors, sharing information on home electronics and appliance optimal energy efficiency settings, and educating homeowners on sustainable energy practices/behaviors.

A priority of this pilot was to get deep energy savings among a limited number of participants, rather than a shallow level of savings among a large number of participants. In designing the *Together We Save* pilot, the program presumed that various barriers have prevented these households from participating

[1] Much of the background information on the Milwaukee Pilot is summarized from:
Schauer, Laura & Kraft, Jeremy. (2010, February). Key Findings from In-depth Interviews with Together We Save Program Staff and Database Analysis. Available online:
http://www.focusonenergy.com/files/Document_Management_System/Evaluation/togetherwesaveidianddbmemo_evaluationreport.pdf and
Van de Grift, Sara & Schauer, Laura. (2010, August). A Hand to Hold: A Holistic Approach to Addressing Barriers in the Home Retrofit Model. Paper presented at the ACEEE 16th biennial Summer Study on Energy Efficiency in Buildings, Asilomar, CA.

in past programs, making it reasonable to assume that unfinished measures are unlikely to be pursued through standard efficiency programs.[2]

Program Description

Target Neighborhoods

Two Milwaukee neighborhoods, both of which have at least 50 percent home ownership rates, were targeted for the pilot.

Figure 1 Neighborhood Maps

Source: Van de Grift and Schauer (2010).

North side: Capitol Dr. (south) to Villard Ave. (north); 84th St. (west) to 60th St. (east)

South side: Lincoln Ave. (south) to Pierce St. (north); 43rd & 38th Sts. (west) to Layton Blvd (east)

Each neighborhood was comprised of older housing stock. The south side homes were, on average, 50 or more years old and predominantly Cape Cods. The north side homes were, on average, 30-50 years

[2] Van de Grift and Schauer present a thorough examination of the barriers that seem to prohibit homeowners from participating in retrofit programs and how the Together We Save program was designed to overcome those barriers

old, with a greater mix of styles including bungalow, Cape Cod and ranch. On average, residents of both neighborhoods were well below Wisconsin's median income of $70,700.

Program Processes

The program consisted of five stages. Each stage was designed to build upon the previous one with a community-based energy advocate as a common thread throughout the program experience. These stages are described below. The number in parentheses shows the number of participants at each stage.

> **Application.** Potential participant first completed a program application. Then, Focus on Energy, Wisconsin utilities' statewide program for energy efficiency and renewable energy, verified applicant's eligibility to participate in the program. The home had to be within the targeted neighborhood and the program required that all buildings be owned by the applicant. Rental properties were eligible, but landlords had to apply for the program. (159)
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> **Walk through audit.** Focus assigned an energy advocate who set up an appointment with the homeowner to complete the audit. During this appointment, the energy advocate recorded prior efficiency improvements, did an inventory of appliances and electronics, and distributed compact fluorescent light bulbs (CFLs), low flow showerheads, and faucet aerators. The energy advocate also recommended energy-saving behavior changes. He or she then promoted the next phase of the program, the pre-assessment and installation. (137)
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> **Pre-assessment.** A Focus consultant provided a technical walk-through of the home. This more in-depth energy assessment included blower door testing, combustion safety testing, and a technical analysis of the equipment in the home. The assessment resulted in written recommendations and estimated costs as well as costs covered by the pilot program. Table 1 details the portion of costs covered by the program based on homeowner income level. (123)
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> **Participant sign off.** After receiving the recommendations and cost information, the participant decided whether or not to proceed with the retrofits. The energy advocate provided the participants with financing options if they were not able to pay their portion of the co-payment. (106)
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> **Installation of efficiency improvements.** Next, the pre-selected contractors made all the energy efficiency improvements included in the work order. Contractors were chosen through a competitive request for proposal (RFP) process. The homeowner had no responsibility for hiring or managing consultants or contractors. Once the work was completed by the contractor, the consultant did a final inspection of the home to ensure the recommended improvements were made. (91)

Table 1. Income and Participant Co-Pay

Income	% of Total Cost Paid by Program
At or below 200% Federal Poverty Level	100% or referred to state Weatherization Assistance Program
201%–250% Federal Poverty Level	90%
251%–300% Federal Poverty Level	75%
Over 300% Federal Poverty Level	50%

Data Collection

As a condition of participation, homeowners agreed to release their energy consumption data to Focus. The signed release forms were provided to the customers' electricity and natural gas utility, We Energies. We Energies authorized their third-party data platform vendor, DataRaker, to provide participant data to Focus staff from 2008 through 2010. The data provided included monthly electricity and natural gas usage and some characteristics of the homes. These data were used to calculate the change in energy consumption from a one-year period (or longer) before the work was completed to a one-year period (or longer) after the work was completed.

In addition to the data supplied by the utility, the contractors completing the work also recorded the pre and post air-leakage rate as measured in cubic feet per minute at a pressure differential of 50 Pascals (CFM50). CFM50 indicates the leakiness of the building envelope—a higher value indicates a home with more air leakage.

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.[3] 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 10-year time period.

[3] Fels, M., K. Kissock, M. Marean, C. Reynolds. PRISM (Advanced Version 1.0) Users' Guide. January 1995.

The model produces three physical parameters for a 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 base load 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, called normalized annual savings.

Meter Data

Monthly meter data (both electricity and natural gas) were collected from the data platform vendor for the electric and natural gas utility serving the participants in the *Together We Save* pilot.

Weather Data

Average daily temperatures for Milwaukee for the period January 1, 1991 through December 31, 2010 were obtained online from the Wisconsin Department of Administration[4].

Data set

Ideally, only participants with at least a full year of data before and after retrofit work would be analyzed and the month during which the retrofit work occurred would be excluded. However, the *Together We Save* pilot included several touch points over the course of a few months which resulted in potential energy savings for the participant. The walk-through audit included installation of CFLs and water-saving measures. Air sealing, insulation, and installation of new equipment sometimes took place over a span of several months. The timing of the available data did not allow all the months during which work was ongoing to be excluded and still maintain 12 months of pre- and post-treatment data.

To make best use of the data available, the models were run on two datasets: (1) The small sub-group with 12 months of pre- and post-treatment data after the treatment date was defined as the earliest date in which air sealing, insulation, or equipment installation took place. (2) All participants in which 2008 and 2009 were defined as the pre-treatment period for all participants and 2010 was defined as the post-treatment period. Both approaches have limitations, which are discussed in more detail below.

[4] http://www.doa.state.wi.us/degreedays/

Results

Participant Characteristics

The most common time periods for the construction of participant homes were pre-1925 and 1951-1960. Participant homes tended to be older than homes in Wisconsin overall. The homes were smaller than a typical new home and 75 percent of homes were smaller than 2050 square feet. Generally, the homes were poorly sealed before program participation with a median air leakage rate of nearly 3,300 CFM50. Participant homes generally started off leakier and ended leakier than the typical participant in the statewide Focus on Energy Home Performance with ENERGY STAR® (HPES) program, but experienced a greater percentage of improvement than homes in the HPES program. Nearly all participants completed air sealing and insulation of their homes while more than half also installed new HVAC equipment and made improvements to water heating or exhaust fans. Rates of installation were higher among *Together We Save* pilot participating homes than homes in HPES

Table 2. Age of Participant Homes

Year Built	% of Participants	% of WI* Homes
Pre-1925	42%	31%
1925-1950	12%	
1951-1960	24%	13%
1961-1977	6%	29% (1961-1979)
1980-2000		44%
Unknown	17%	

***Source: 2000 US Census**

Table 3. Size of Participant Homes

Home Size (ft^2)	% of Participants
Less than 1071	21%
1072-1598	39%
1599-2051	17%
2052 or larger	8%
Unknown	17%

Table 4. Frequency of Meaures

Type of Measure	% of Participants Installing	% of 2009 HPES Homes
Air Sealing	93%	87%
Insulation	96%	87%
Equipment	81%	3%
Water Heating	68%	10%
Exhaust Fans	54%	36%

Table 5. Pre- and Post Air Leakage

	Pre-Retrofit Air Leakage (CFM50)	Post-Retrofit Air Leakage (CFM50)	Change in Air Leakage (CFM50 Change)
Mean	3663	2402	-1261
Median	3298	2351	-1048
Std. Deviation	1690	1171	968
Median 2009 HPES Homes	2339	1511	-660

Natural Gas Usage Results

The first set of data modeled using PRISM was the subset of participants with a full year of pre- and post-participation meter data based on the best estimates of participation dates. For these 29 homes, the median of the normalized annual savings was 209 therms with a standard error of +/- 66 therms for median savings of 23.3 percent (+/- 6.6 percent) of total natural gas usage. The statistical models used to calculate the savings for each home fit the data moderately well, with a median R^2 of 68 percent.[5]

To verify these results, the models were also run on all 91 homes with 2008 and 2009 defined as the pre-period and 2010 defined as the post-period. The median of the normalized annual savings across these homes was 182 therms with a standard error of +/- 29 therms for median savings of 22.6 percent (+/- 2.3 percent) of total natural gas usage. The statistical models used to calculate the savings for each home fitted the data moderately well, with a median R^2 of 67 percent.

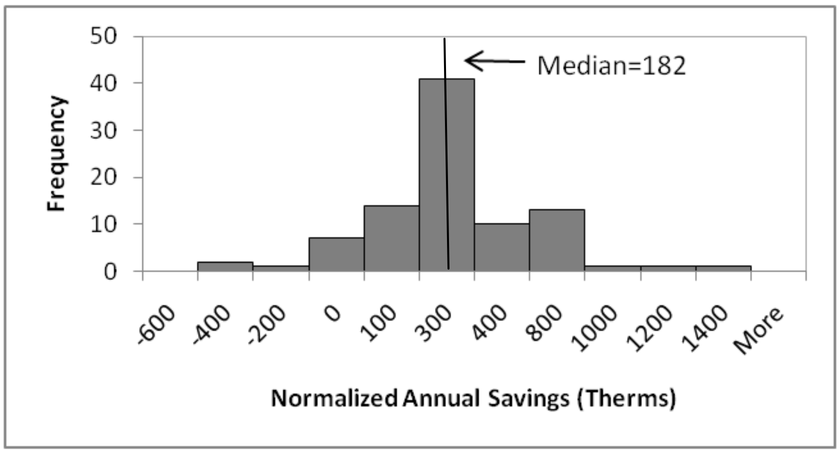
Both approaches have limitations. Since there is no one date on which energy-efficiency improvements took place in each home, the first approach of using the earliest date in which insulation or equipment

[5] R^2 is a common statistical measure of how well a statistical model fits actual data. It can be understand as the amount of the variation in the data that is explained by the model.

was installed means that the post-period is not fully "post" and will not reflect the full benefit of all improvements. Defining all of 2008 as the pre-period and all of 2010 as the post-period likely contaminates both periods for different houses, but allows all homes to be included in the analysis. The similarity in the results of the two approaches lends credibility to the accuracy of the results.

We should acknowledge, however, that the PRISM model only controls for changes in weather and does not control for any other non-weather, non-program changes that may impact energy usage. These factors may include changes in number of occupants, work schedules, other appliance purchases, and/or other societal factors that may influence energy usage. An ideal study would have included a control group of homes to help separate out these other factors, but the timing and budget of this pilot did not allow for a control group. The size of the full group of homes does help mitigate the effects on the overall results of individual household changes outside the program.

Figure 2. Distribution of Normalized Annual Therm Savings



Electricity Usage Results
Electricity usage is most weather-dependent in homes with central air conditioning. Central air conditioners respond to changes in outside temperatures, while electricity use in homes with room air conditioners is typically not as weather dependent.[6] Occupants tend to turn the units on and leave them on regardless of hourly or daily fluctuations or tend to not turn them on at all. Few homes in the *Together We Save* pilot had central air conditioners and as a result the PRISM models had a poor fit with electricity meter data. The median R^2 for homes with a full year of pre- and post-retrofit electricity usage (based on estimated completion date) was only 7 percent for the pre-period and 36 percent for the post-period. Using 2008 as the pre-period and 2010 as the post-period had similar results with a median R^2 of 15 percent for the pre-period and 33 percent for the post-period.

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[6] Wayne DeForest, personal communication, March 2011.

Since electricity usage in these homes does not appear to be weather-dependent, homes can be compared on pre- and post-usage. In the 29-home subset, post-retrofit usage is, on average, 59 kWh per month higher than pre-retrofit usage. However, with a standard error of +/-33 kWh, this does not pass statistical tests of significance. Analyzing all 91 homes with 2008/2010 as the pre/post periods, results in an average increase in monthly electricity use of 63 kWh. With a standard error of +/-24.9, this increase is statistically significant.

With less-than-ideal data and conflicting results, the impact of the *Together We Save* pilot on electricity usage warrants more investigation. It appears that at-best the net impact on electricity usage was neutral despite the inclusion of electricity-saving measures. It's possible that participants uninstalled CFLs or water saving measures. Other research has shown that when homeowners have installed energy-efficiency measures, they may feel comfortable with using more energy in other ways such as leaving lights on longer.[7] In addition, research has shown that overall households are adding to their plug load over time.[8]

Program Costs Compared to Energy Savings

Expenses for the *Together We Save* pilot totaled $950,331 or about $10,330 per completed home. Applying average home savings of 209 therms per year and amortizing at a 20-year lifetime, the levelized resource cost was $3.02 per therm[9].

Conclusions and Recommendations

The *Together We Save* pilot successfully recruited participants from two low-to-moderate income neighborhoods to participate in a program to improve the energy efficiency of their homes. Ninety-one homes completed all steps of the program. Controlling for weather, we estimate the homes achieved an average therm savings of 209 therms per year, which is about 23 percent of normalized natural gas usage. These results are impressive: Other studies of low-income retrofit programs have estimated savings of about 18 percent of annual usage.[10] These savings were achieved, however, at a relatively high cost.[11]

Previous reports have recommended how to apply the lessons learned from the *Together We Save* pilot to future program designs and several of the recommendations address ways to lower the program

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[7] Grotton, Frank. (2002). "Energy Efficiency and the Rebound Effect:Does Increasing Efficiency Decrease Demand?" in *Energy Efficiency: Issues and Trends*. Nova Science Publishers: New York.

[8] Roth, K. & McKenney, K. (2007, January). Energy Consumption by Consumer Electronics in U.S. Residences. Final Report to the Consumer Electronics Association. Available online: http://www.ce.org

[9] This calculation uses a 2% discount rate, as stipulated by the Public Service Commission.

[10] Wayne DeForest, personal communication, March 2010.

[11] For comparison, a very rough calculation of a levelized resource cost for the entire 2009 Focus on Energy Home Performance with ENERGY STAR yields about $0.35 per therm.

costs.[12] These recommendations include: (1) Rethink the necessity of the turnkey contractor program in the context of the cost of the program; (2) Revisit the incentive structure, as there is some evidence that the incentives may be slightly too high; (3) Weigh the value of including the lowest income category and/or targeted neighborhood in future program design. These reports strongly recommended continuing the energy advocate role in similar programs.

The impact of the pilot on electricity usage needs further study. At best, it seems the pilot had no impact on usage, and it is possible usage may have actually gone up. Future programs could also consider additional emphasis on electricity usage through the energy advocate.

[12] See Schauer & Kraft and Van de Grift & Schauer referenced earlier.