

# Assessing and Comparing the Energy Impacts of Three Weatherization Programs in Ohio and Kentucky

*Johna Roth, TecMarket Works, Oregon, WI*

*Nick Hall, TecMarket Works, Oregon, WI*

*Kathy Schroder, Cinergy, Cincinnati, OH*

*Rick Morgan, Morgan Marketing Partners, Madison, WI*

## ABSTRACT

This paper examines the energy impacts of three different weatherization programs that use three slightly different targeting and/or implementation strategies. All three of the weatherization programs are in the Cinergy service territory in southern Ohio and northern Kentucky (separated by the Ohio river, but located in the same heating/cooling-degree zone). Each program has been provided to low-income customers, using a common approach for selecting and installing measures (NEAT-type energy audit), but targeting customers in a slightly different way or by offering different program services in addition to the weatherization measures. One group had an educational component, and two provided services based on a tier approach. We also look at the energy impacts of furnaces and insulation and the cost of the saved therms. While the sample sizes for the group with the educational component were too small to support any conclusions regarding specific impacts, preliminary results suggest that an energy education component in a weatherization program may substantially increase energy savings. Further research should be conducted on that approach.

## Program Descriptions and Participation

In the Ohio and Kentucky weatherization programs, participants were weatherized between July and December of 2003. In the Payment Plus program, participants were provided with educational workshops in June and July of 2003, and weatherized between July and December of 2003.

**Ohio Weatherization:** Cinergy's weatherization program offered in southern Ohio is structured so that the amount of services received is determined by the type of heating fuel (electric or gas). Gas heated homes can receive up to \$4000 in weatherization services, including new furnaces, refrigerators and both minor and major envelope upgrades (exceptions are made as required). The mean investment for Tier 1 was \$459, \$967 for Tier 2, and \$1,096 for Tier 3), not including the refrigerator, in which the funding came from a different source and was not determined by tier level. Electric heated homes could receive refrigerators and both minor and major envelope upgrades. Program services are delivered in a two-tiered approach: the energy consumption tier in which the home is placed determines the eligible measures. The tier structure is based on the energy use per square foot for the home, which determines the extent of the energy efficiency services available for that home.

New furnaces and/or insulation was offered to participants if their tier level allowed the program to replace the unit, if the energy audit (NEAT) indicated the replacement was needed, and if the replacement would be cost effective (according to the audit results). There were 499 participants in the Ohio program that had pre- and post-participation meter readings and whose consumption patterns survived a PRISM sort using a  $R^2$  value of .7 or more. 123 of these customers received insulation services, and another 84 received a new furnace. Only 16 customers received both a new furnace and insulation.

**Kentucky Weatherization:** The Kentucky weatherization program used an approach identical to Ohio's program in its delivery and tier structure. However, the Kentucky program targeted only gas customers. The tiered structure meant that furnaces and major measures were only offered to homes that needed the measure, as recommended by the NEAT-type audit and if they had consumption levels that allowed that measure to be installed. As a result, new furnaces and/or insulation were offered to some of the participants. Of the 111 participants that had pre- and post-consumption meter reads to support the PRISM assessment, 107 received "general" weatherization services consisting of low-cost measures and minor envelope upgrades. Of these 107 participants, 12 received new furnaces, and 5 received major insulation upgrades.

**Payment Plus:** Cinergy's Payment Plus (PP) Pilot Program, offered in northern Kentucky in the same area as the Kentucky weatherization program, employed a three-step approach to helping low-income customers reduce consumption and manage household finances. The three steps include:

1. An energy education workshop focusing on ways to reduce energy consumption through behavior modifications,
2. A household financing and budgeting workshop focusing on teaching participants how to live within one's household income, and
3. The installation of weatherization measures that made the home more energy efficient. These measures included both low-cost and major weatherization measures including insulation, furnaces, and refrigerator replacements.

While weatherization services appeal to many low-income households, classroom style educational programs often suffer from poor attendance. To encourage program enrollment and participation, the PP program offers an incentive to customers who completed one or more of the program components. The incentive was applied to the customer's account in the form of a bill credit applied to their arrearage balance, directly reducing the total cost of the utility bill.

The PP program is funded by Cinergy utilizing demand-side management funds and was implemented by the Northern Kentucky Community Action Commission (NKCAC) and People Working Cooperatively (PWC), two low-income service agencies. NKCAC managed and administered the program and provided the participant training services. PWC provided the weatherization services as part of a broader weatherization program, after the participants completed the training component(s). Participants had to complete the energy education training component to qualify for the bill credits.

The primary purpose of the pilot program was to determine if the combination of the three components of the program helped low-income customers with high arrearage and payment problems obtain the information and learn the skills needed to control their consumption, reduce their utility bills, and manage their accounts in a way that resulted in lower arrearage levels.

## **Evaluation Methodology**

**All Groups:** The analysis conducted for each of these programs employed the use of a pre- and post-program test and control group. The control groups were selected to match the program participants associated with each comparison. The control group for the Ohio weatherization program consisted of LIHEAP customers who had not had their home weatherized and who, as a group, had pre-program energy consumption levels that matched the participant groups to a level of plus or minus 10% each month. The control group was selected by zip code and also to match the pre-program period.

This process allowed the Ohio participant and control groups to have similar geographic, economic, and energy consumption profiles. An additional control selection procedure was used for the Kentucky Weatherization and the Pilot Program. In addition to the income classification and the pre-program energy comparison, the control group also had to have pre-program arrearage levels that matched the pre-program arrearage levels of the Payment Plus participant group. In this case, the control group had to have a pre-program arrearage level of \$500 or more. Once the control groups were “matched”, the monthly-metered data over a period of up to twenty-four months pre-program and up to twenty-four months post-program was cleaned and readied for the PRISM analysis. Then, the control groups were randomly assigned a month in which they were switched from “PRE” to “POST” weatherization status consistent with the period of time in which the participants were weatherized. All three test groups were assigned POST status the month following their weatherization, with the month of weatherization removed from the analysis.

The analysis approach used in this study is based on the use of Princeton University’s energy impact analysis “scorekeeping” software called PRISM™. All three groups used the same weather data and weather normalization period. The weather data was provided by Cinergy and was taken from the weather station located at the Cincinnati area regional airport located in northern Kentucky.

The natural gas analysis was conducted using PRISM’s reliability criteria in which the coefficient of variance was set at 7.0%, and the  $R^2$  was equal to 0.7. Homes that met these criteria are included in the analysis. The electric results are based on data that passed reliability criteria of CV of 7.0%. All results are control-adjusted, which in all cases increased the energy savings of the participants due to the control group slightly increasing their energy usage over the period of time analyzed.

**Ohio Weatherization Program:** To conduct the analysis, Cinergy provided energy usage data, weatherization dates, and weatherization service details (new furnace installation, insulation services, and tier level) for 876 participants with natural gas heat and 106 participants with electric heat. The control group consisted of 2,457 LIHEAP customers in the same geographic area that have not, to the best of our knowledge, received weatherization services (although we did not have data about their participation in state-funded weatherization). The control group was broken down into three “ranks” based on the number of years they had received LIHEAP assistance payments over the course of the energy usage data we obtained. Rank 1 consists of 203 customers. These customers had received LIHEAP payments for all four years in which data was provided. Rank 2 consists of 703 customers. This group received LIHEAP payments three out of the four years in which data was provided. Rank 3, consisting of 1,637 customers, received LIHEAP payments for two of the four years. Some of the control group customers had received a LIHEAP payment for one year. The control group used in this analysis consisted of the Rank 1 and Rank 2 customers to best match those that received weatherization, yielding a control of 906 customers. Given that state weatherization data was not available for this study, it is likely that some of these customers in the control group were weatherized through the state of Ohio. This unknown number of weatherized homes in this control group would likely lower the energy savings attributed to the weatherization of the participants in the Ohio Weatherization Program.

**Kentucky Weatherization:** For the Kentucky program, Cinergy provided energy usage data for 120 participants, along with information on customers who received new furnaces and major insulation services. The control group used for this analysis is the same control group used for the Payment Plus assessment (described below).

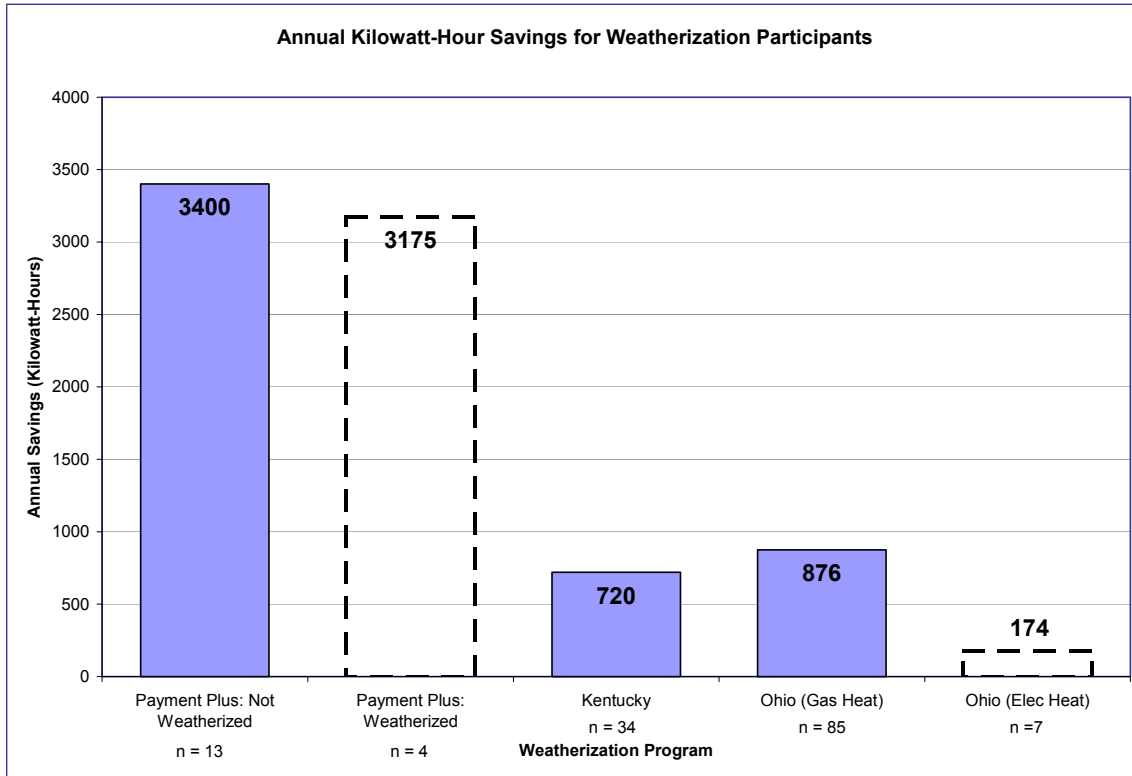
**Payment Plus:** The Payment Plus control group consisted of 182 customers. The candidates for the control group consisted of all of Cinergy’s area-eligible (northern Kentucky) customers who were

also income-eligible for participation in the Payment Plus program and had matching energy consumption and arrearage profiles. As discussed earlier, this population consisted of LIHEAP customers (income-qualified) who also had high enough arrearage levels that they would have been eligible to participate. Following this “filtering”, the control group was then matched to have the same energy consumption characteristics as the participant group. Once the control group was selected, the pre- and post-program consumption of the test group was compared to the consumption of the control group to normalize the test group’s consumption to reflect what would have happened to the test group if they would not have participated. Again, PRISM™ was used to conduct the assessment.

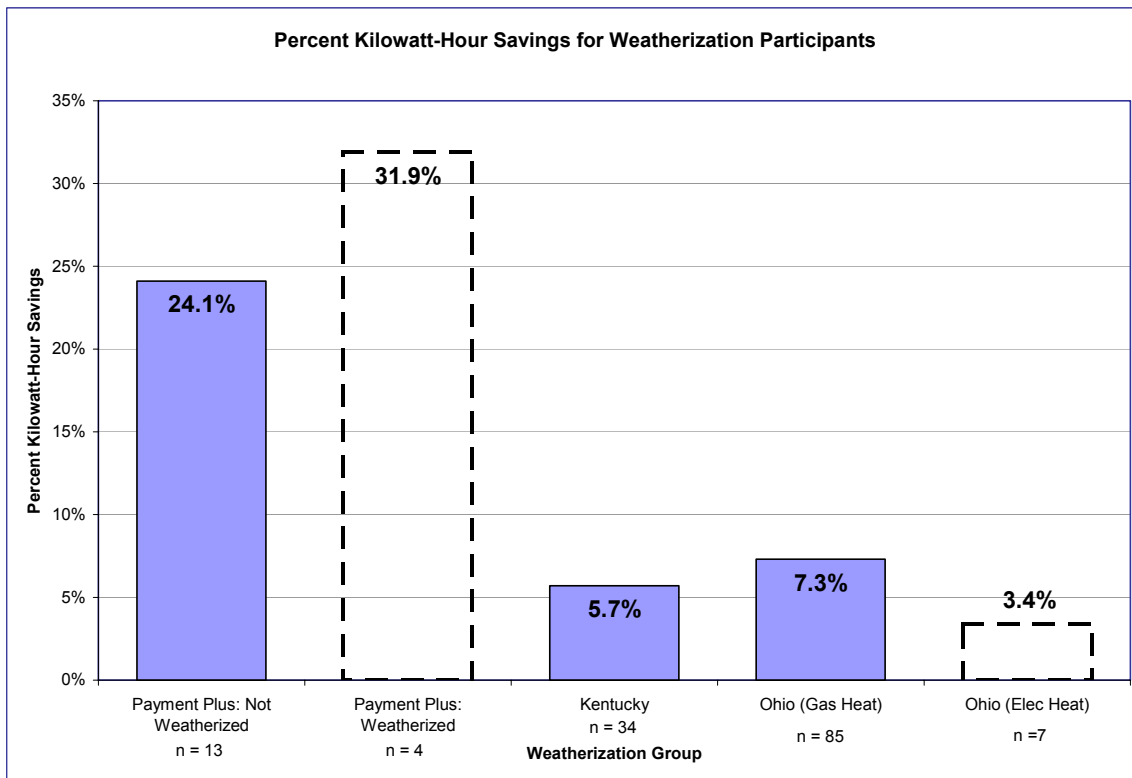
## **Overall Energy Impacts Due to Weatherization and Education**

In this section of the paper, the results of the energy impact assessments and a comparison across the three programs is presented. In presenting this information, we want to note that the number of Payment Plus participants whose pre- and post-program meter data met the PRISM reliability criteria is low. Only 20 homes are included in this assessment. For this reason we provide the Payment Plus savings information only as an initial indicator of the possible energy savings associated with this program. Additional analysis will be conducted on a larger group of Payment Plus participants from 2004 once enough time has passed to allow the evaluation to proceed. We expect these findings to be available in late 2005 or early 2006.

**Electricity Savings:** Payment Plus participants, regardless of weatherization, were able to achieve substantial annual kilowatt-hour savings from weatherization and their participation in the educational workshop designed to assist participants with reducing their energy consumption. They were able to achieve almost four times the level of savings realized by the Ohio weatherization group heated by natural gas, and over four times as much as the Kentucky weatherization group and the Ohio group with electric heat. The mean kilowatt-hour savings is shown in Figure 1, and the annual percent savings over the course of the energy data provided are shown in Figure 2. Again, we remind the reader that the Payment Plus savings are from 17 participants and should be considered as a rough savings indicator until substantially more participants are assessed in 2005 or early 2006. However, this data does indicate that electric savings are substantial compared to the weatherization programs offered in the same area during the same period of time, with all the participants from the three groups receiving an average of three CFLs per home. The significantly higher savings of the group that received the education in addition to the weatherization work bears close watching to see if the savings reported here remain consistent over a longer period and with added participants from the more current 2004 program. At this time, it is too early to say if the savings are reflective of the savings that we can expect from a larger assessment. The same data are presented in Figure 2 as a percent of total household consumption.



**Figure 1 Annual Kilowatt-Hour Savings for Weatherization Participants**

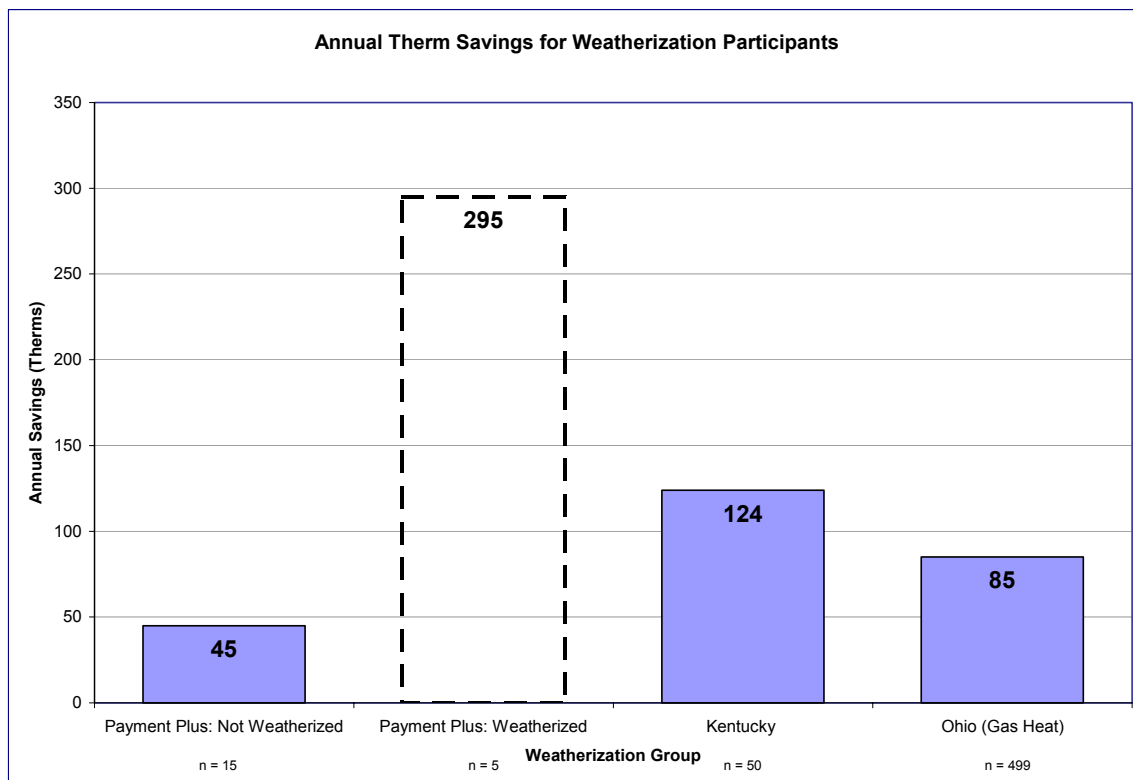


**Figure 2 Percent Kilowatt-Hour Savings**

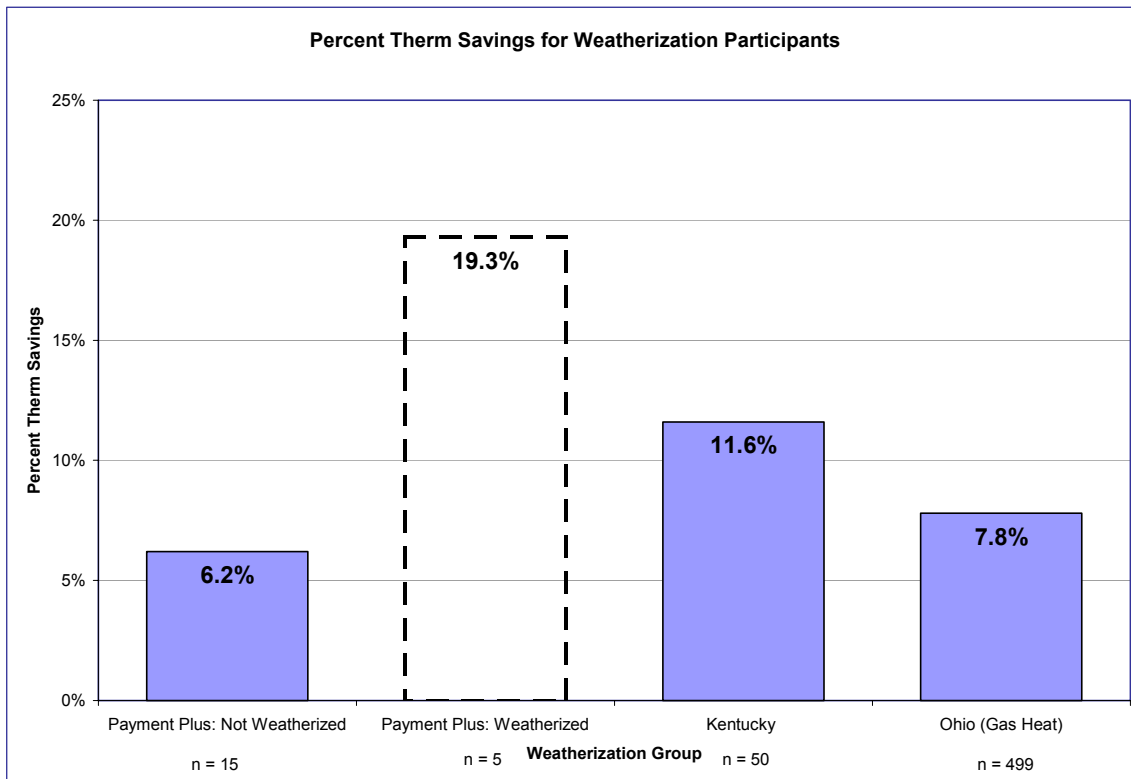
**Natural Gas Savings:** The results presented in Figure 3 illustrate that Payment Plus participants were able to achieve very substantial gas savings after participating in the energy education workshop and having their homes weatherized. However, again, the test group for the Payment Plus program is very small. Only 5 participants are included in this analysis after the PRISM reliability criteria is applied (from an original 18 in the group). For that reason, we caution that no conclusions can be drawn about the effect of this program from this limited data set. (Payment Plus participants who were not weatherized were still able to decrease their consumption, but only slightly.)

The savings realized by the Kentucky weatherization group (124 therms per year) are based on the energy usage data of 50 participants, and the Ohio weatherization group’s results (85 therms per year) are based on 499 participants, thereby providing a more reliable comparison. These analyses all utilize the PRISM reliability criteria.

In Figure 4 the savings are presented as a percent of total gas consumption for these four groups. This data indicates that the Kentucky weatherization program participants saved an average of 11.6%, while the Ohio weatherization participants saved 7.8%.



**Figure 3 Annual Therm Savings for Weatherization Participants**



**Figure 4 Percent Therm Savings**

Given the low number of participants for the Payment Plus Pilot Program, it is too early to draw conclusions about the relative influence of the educational workshop program component on the total energy savings. During program year 2004, an additional 75 participants took part in the program. This group of participants will be added to the assessment in late 2005 or early 2006. In 2005, the Kentucky Collaborative authorized the continuation of the program in 2005, permitting a more rigorous assessment of impacts in 2006 or 2007. The small group of Payment Plus participants that did not receive weatherization does provide an early indicator of what the savings from the educational component may be, but further analysis of more customers is needed.

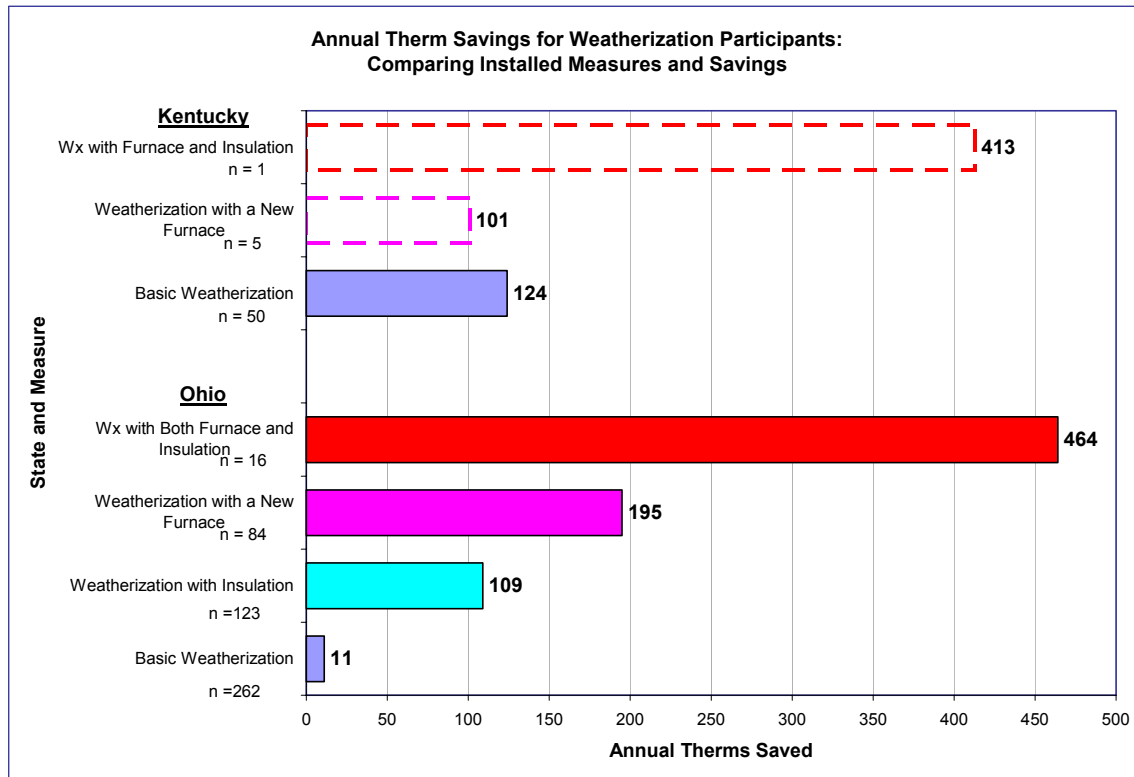
One additional factor to keep in mind in viewing the relatively low percent savings obtained for the Kentucky and Ohio test groups is that, as described earlier, a relatively small fraction of the program participants sampled in this study had received a “major” weatherization measure (new furnace or major insulation). Most participants in each group (approximately 60% in Ohio and 85% in Kentucky) had only received low-cost measures and minor envelope tightening.

### **Energy Impacts of New Furnaces and Insulation**

Both the Kentucky and Ohio weatherization groups have participants that had new furnaces installed, and participants across both programs had major insulation services provided to their homes. We were able to obtain program records for participants that had new high efficiency furnaces installed and for those that had major insulation installations. In this section of the paper, the differences across the program that are related to furnace installations and major insulation upgrades are presented.

The savings associated with new furnaces and insulation are substantially higher than the savings of the customers who received basic weatherization. Few of the Kentucky customers had data that

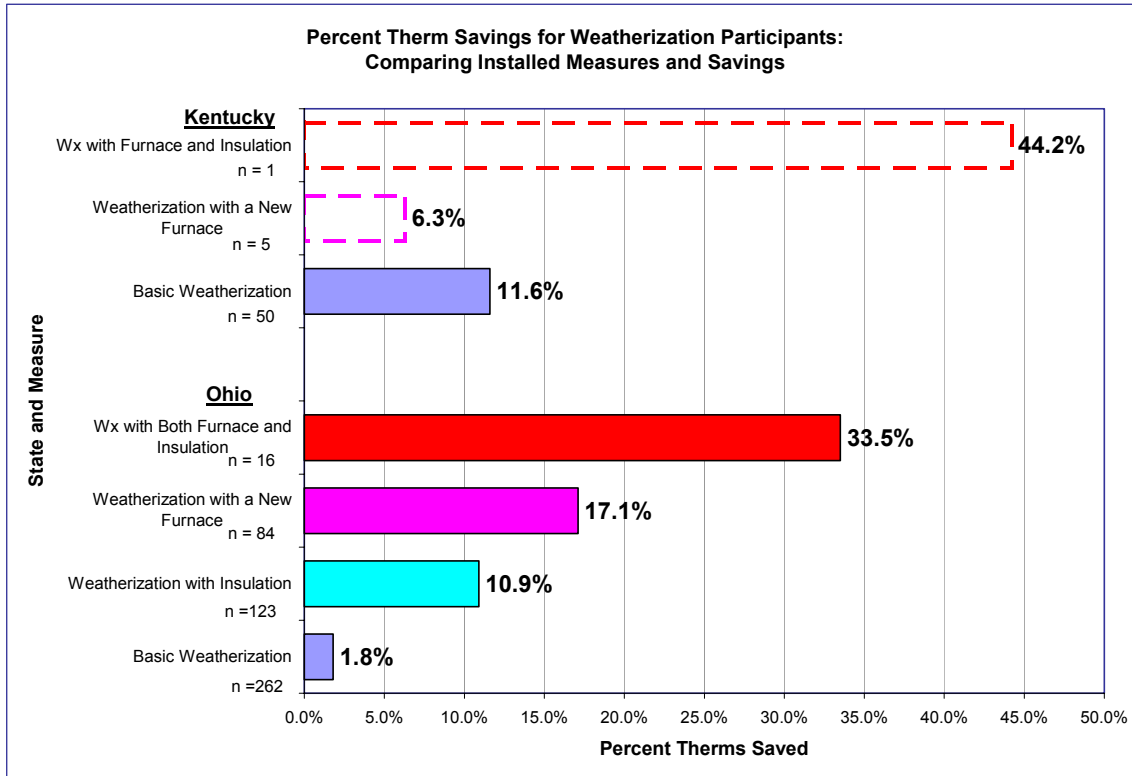
passed the reliability criteria, so those numbers serve only as indicators of energy savings potential. However, Ohio customers were able to achieve more than double the energy savings, 464 therms, with the addition of insulation, over those receiving weatherization and a new furnace (195 therms). (See Figure 5.)



**Figure 5 Annual Therm Savings for Weatherization Participants: Comparing Measures**

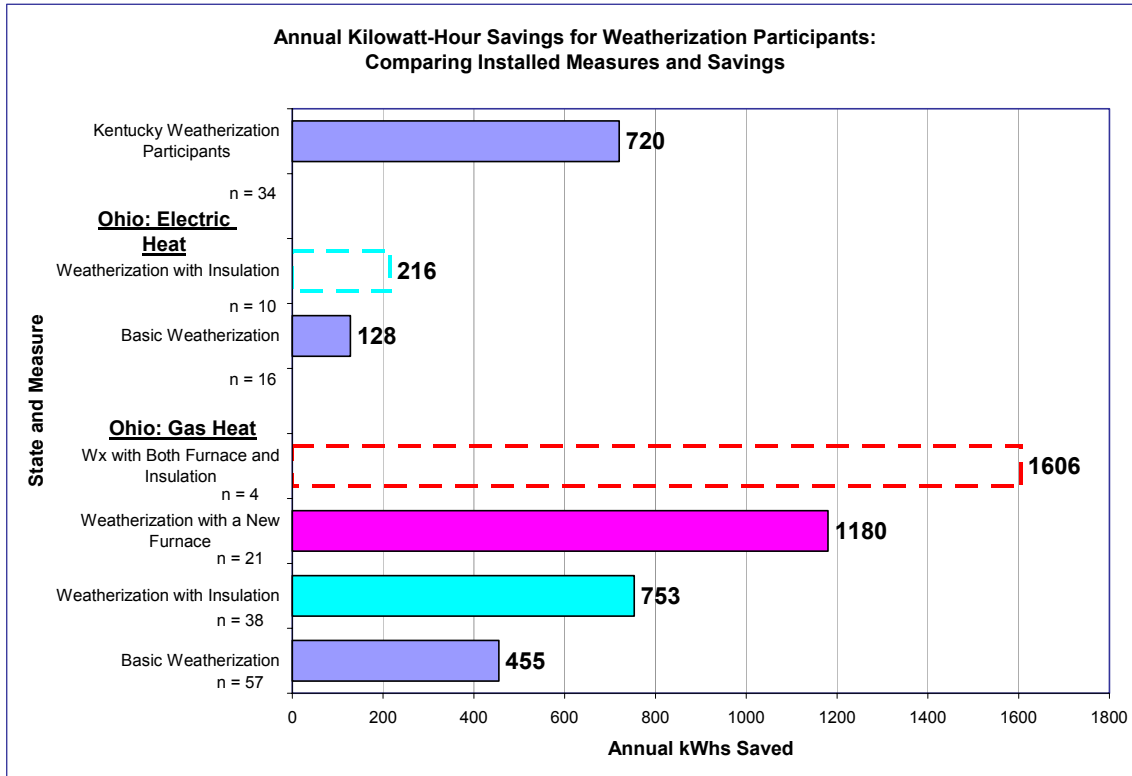
In Figure 6, the percent of therm savings as a result of weatherization, new furnaces, and insulation services is reported. Ohio customers that received both a new furnace and insulation services were able to cut their natural gas consumption by 33.5%, about twice the savings of those customers only receiving a new furnace (17.1%), and three times as much as those receiving only insulation services (10.9%). Those receiving basic weatherization services were able to decrease their natural gas consumption by only 1.8%. However, Kentucky participants receiving basic weatherization were able to decrease their consumption by 11.6%.



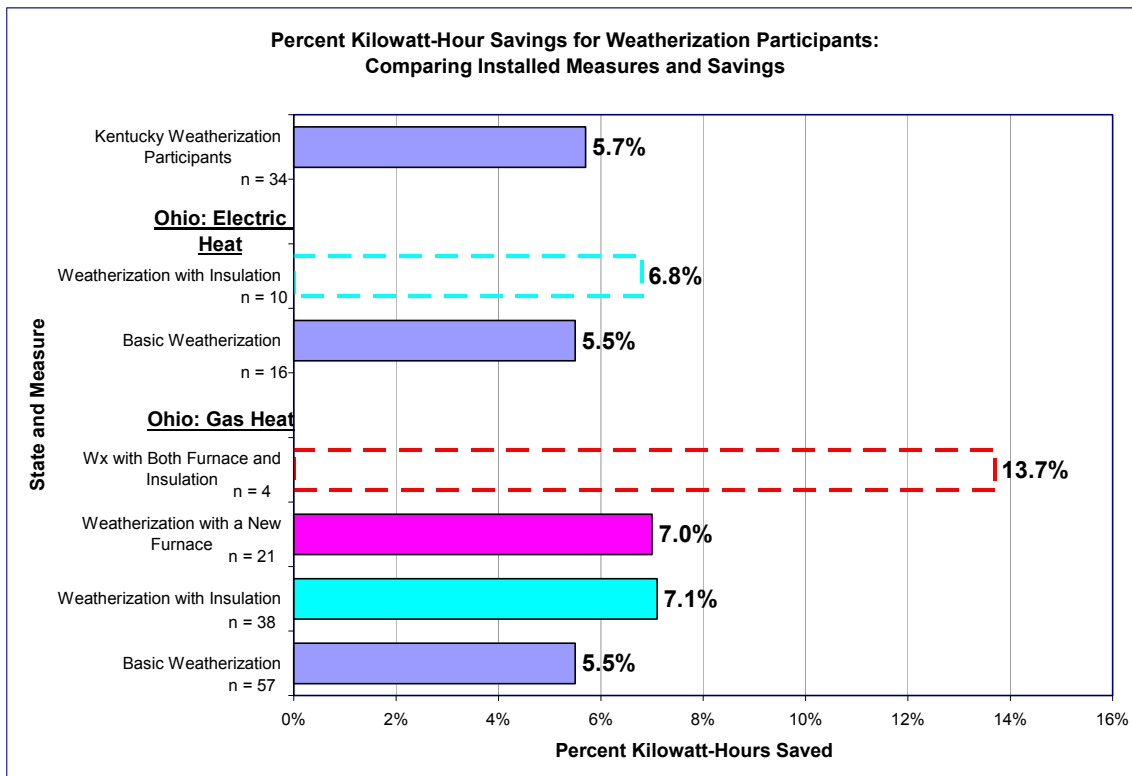


**Figure 6 Percent Therm Savings for Weatherization Participants: Comparing Measures**

Kilowatt-hour savings were not as substantial, but savings were achieved as a result of the weatherization and the new furnaces and insulation services. Ohio customers with electric heat did not have substantial savings through basic weatherization, saving only 128 kilowatt-hours per year, or 5.5% (Figure 7 and Figure 8). Insulation services did not increase these savings by any significant amount, customers that had insulation installed only saved 216 kilowatt-hours per year, or 6.8% overall. Surprisingly, Ohio customers with gas heat had larger kilowatt-hour savings with weatherization services, furnaces, and insulation. With basic weatherization, gas heating customers saved 455 kilowatt-hours per year, compared to 128 kilowatt-hours for those with electric heat.



**Figure 7 Annual Kilowatt-Hour Savings for Weatherization Participants: Comparing Measures**



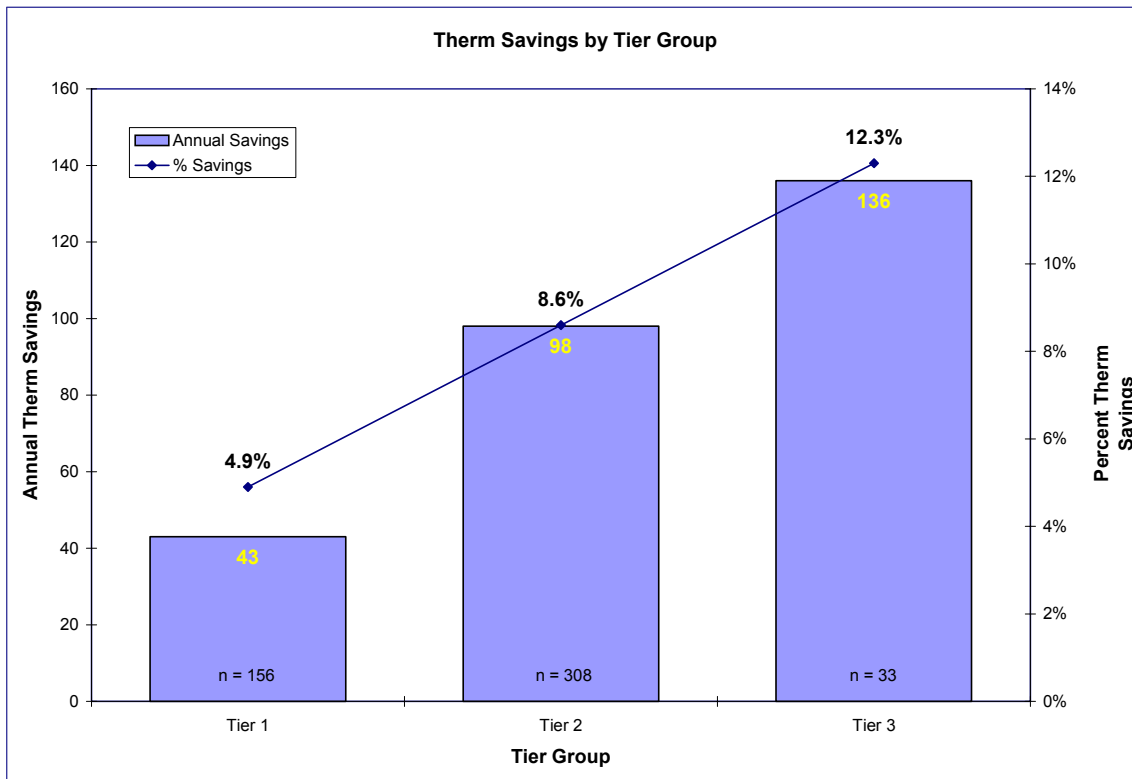
**Figure 8 Percent Kilowatt-Hour Savings for Weatherization Participants: Comparing Measures**

## Energy Impacts and the Tier Approach

All three of these programs employed a two-tier approach for selecting measures to install in the homes. In the two-tier approach, homes were classified as normal consumers or high consumers. (Ohio originally had three tiers, as shown in Figure 9. In 2003, Tiers 2 and 3 were combined.) The average level of measure funding was determined by the tier in which the home was placed (\$459 for Tier 1, \$967 for Tier 2, and \$1,096 for Tier 3), however measure selection was impacted by program funding levels, which varied by program. If a gas heated home used more than 1 therm per square foot it was placed in tier two and provided with additional measures (and supportive budgets); if it was below 1 therm per square foot it was placed in tier one and provided with a set of lower cost measures. The same approach applied to the electric heated homes. That is, if a home consumed more than 7 kilowatt-hours per square foot it was placed in tier two and more measures were provided.

Energy savings of Ohio customers are greater for customers placed in higher tier groups, since the customers are eligible to receive more services. Therm savings are more substantial, with the savings in Tier 3 over three times the savings of Tier 1 customers ( Figure 9). The dollars spent per therm saved decreases slightly in higher tiers. The energy savings include all customers, regardless of whether a furnace was installed.

Tier 1: \$1.07 spent per therm saved over 10 years with and without furnace installations  
\$2.34 spent per therm saved over 10 years with furnace installations  
Tier 2: \$0.99 spent per therm saved over 10 years with and without furnace installations  
\$2.17 spent per therm saved over 10 years with furnace installations  
Tier 3: \$0.81 spent per therm saved over 10 years with and without furnace installations  
\$1.78 spent per therm saved over 10 years with furnace installations



**Figure 9 Therm Savings by Tier Group, Ohio Weatherization Services**

## Conclusions

Weatherization, with or without a new furnace installation or insulation services, will likely result in relatively low kilowatt-hour savings for the weatherization customer. Therm savings are significant, and are the highest when a furnace is installed and insulation services are provided, which is expected. These findings confirm that the more aggressive the measures installed, the higher the savings, but it also confirms that the more aggressive measures lower the cost of energy saved.

Due to the low numbers of customers in the Payment Plus Pilot Program sample, the effects of the educational component program are uncertain, but the limited results of this analysis suggest that the workshops may result in behavior modification in the customers' homes, particularly with electricity usage. There will be further analysis in the spring of 2006 using a greater number of participants to better determine the effects of the educational component by adding a third round of participants in the Payment Plus Pilot Program. That will also provide two years of post-program data to analyze. Given the encouraging but highly uncertain results for the Payment Plus approach in this limited study, it will be important to conduct further research on this program approach.