



Department of  
Development  
Office of Community Services

# Electric Partnership Program

# Impact Evaluation

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## Executive Summary

This report presents the findings from the fourth energy savings impact evaluation of the Ohio Electric Partnership Program (EPP). EPP was created under Senate Bill 3 the Ohio Electric Restructuring Act, as passed in July 1999. The program was designed by the Ohio Office of Energy Efficiency to reduce the electric consumption of customers in the Ohio Percentage of Income Payment Plan (PIPP) in order to reduce the long term costs of PIPP to ratepayers and the customers. EPP is now administered by the Ohio Office of Community Services.

EPP serves electric PIPP and PIPP eligible customers throughout Ohio using a network of local providers composed of non-profit agencies, community action organizations, and one for-profit company. The program has three component programs:

- the High Use Baseload program is targeted toward PIPP customers with high electric baseload (i.e., not heating or cooling) usage, defined as greater than 6,000 kWh/yr., and includes extensive lighting retrofits, replacement of inefficient refrigerators and freezers, electric hot water reduction measures, and energy education;
- the Moderate Use Baseload program is targeted toward PIPP customers with annual baseload usage of between 4,000 and 6,000 kWh and includes the same measures as the High Use program, but allows for a more streamlined energy audit process;
- the Targeted Energy Efficiency (TEE) program is targeted toward PIPP customers with moderate or high electric heating and cooling loads (defined as greater than 6,000 kWh/yr in heating or cooling) that, in addition to the baseload measures, provides weatherization of the building shell including insulation and air sealing.

EPP began treating homes in late 2001 and production ramped up from 4,000 homes in 2002 to more than 8,000 homes in 2003 to about 12,000 homes per year in 2005, 2006, and 2007. In 2008, production increased to nearly 16,000 homes. The program has served a total of more than 75,000 PIPP customers through the end of 2008. The High Use program served about three quarters of all participants, the Moderate Use program about 21%, and TEE served about 4%. The High Use program was selected by the American Council for an Energy Efficient Economy (ACEEE) as an exemplary low income program.

EPP program managers have worked to improve the cost effectiveness of EPP and have included frequent energy impact evaluations as a key part in that effort. This study is the fourth energy savings evaluation of EPP. The prior evaluations found that EPP has been a cost-effective use of ratepayer funds for reducing the costs of PIPP. Additional evaluation findings have included:

- The High Use program has been the most cost-effective program element -- providing bill reductions worth 35%-50% more than the program costs. Net savings per participant appear to have declined some over time – from 1,775 kWh in the first evaluation to 1,615 kWh in the last evaluation. This reduction is most likely related to more careful measure selection criteria, which reduced costs, but may also be related to the program having already served many of the homes with the highest savings potential.

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- The Moderate Use program has not been quite cost-effective in the past two evaluations with program costs exceeding the value of bill reductions by about 15%. Program management has attempted to enhance cost-effectiveness primarily through reducing program costs. The net participant electric savings averaged 772 kWh in the second evaluation and 697 kWh in the third evaluation.
  - The TEE program is much smaller than the others – with just a few hundred participants per year. Its cost-effectiveness has been difficult to assess because many of the participants have been treated jointly with other weatherization programs. Energy savings averaged 2,913 kWh in the second evaluation and 3,151 kWh in the third evaluation – about 11% of pre-treatment usage. These savings compare well to other electric heating weatherization efforts around the nation.

### *Methodology and Data Collection*

In this evaluation, the impacts of the three program components were assessed for participants served in PY 2006, which spanned from September 2006 through March 2008. PY 2006 was extended in order to synchronize the program year with other programs. Comparison groups for statistical analysis were formed from customers who participated in EPP after March 2008.

The evaluation involved collecting usage data histories for program participants, program tracking system data, and weather data. Net program savings were calculated as the average weather-adjusted energy savings for participants minus the change in a comparison group.

### *Program Production and Participation*

In PY 2006, EPP served 17,842 PIPP customers – 12,956 High Use, 4,279 Moderate Use, and 607 TEE. About two thirds of participants lived in single family site built homes, 9% lived in mobile homes, and 17% lived in apartments. TEE treated more mobile homes (49%) while the Moderate Use program served the greatest proportion of apartments (28%). 55% of EPP customers were homeowners

Among High Use participants, 46% had separate freezers, 18% had secondary refrigerators, 26% had electric hot water, 33% had central air conditioning, 45% used electric space heaters, 13% had central electric heat (but their heating usage was too low for TEE), and 84% had electric dryers. The saturation of appliances varied along urban/rural and North/South lines.

### *Program Treatments*

The major program treatments included replacement of inefficient refrigerators and freezers, installation of compact fluorescent light bulbs, and energy education. The High Use program replaced an average of 15 light bulbs, 0.61 refrigerators and 0.21 freezers per home. The Moderate Use program replaced an average of 9.4 light bulbs, 0.57 refrigerators, and 0.15 freezers per participant. The program has had greater success in convincing participants with secondary refrigerators and freezers to give up these appliances with removal rates increasing to 14% for refrigerators and 4% for freezers. The local provider CHN appears to have had the most success in obtaining customer agreement for this measure and their methods may be worth trying to replicate with other providers.

Direct program costs averaged \$975 per High Use participant and \$758 per Moderate Use participant which are both a little higher than the last evaluation. Refrigerator costs appear to have increased while lighting costs declined. The High Use program now includes clothes dryer fuel switching from electric to gas as a frequent measure for two providers, also contributing to increased costs. TEE spending appears to have declined some to \$1,817 per home, but a significant fraction of TEE participants received treatments from other funding sources as well.

Data collected in the program tracking system indicated that lighting and refrigerator loads represent about 28% of total household consumption, limiting the potential overall program savings from the major two measures to at most 20% of usage. Energy education efforts are the primary means for addressing the remaining 72% of the load.

### *Electric Impacts*

Electric Usage impact results are summarized in Table 1.

**Table 1. Electric Usage Impact Summary (kWh/yr. per participant)**

<b>Program</b>	<b># homes</b>	<b>Pre-use</b>	<b>Net Savings (sample)</b>	<b>Net % Savings</b>	<b>Program Net Savings</b>
<b>High Use Program</b>	7,305	13,300	<b>1,559</b>	11.7%	<b>1,556</b>
<b>Moderate Use Program</b>	2,257	6,252	<b>566</b>	9.0%	<b>579</b>
<b>TEE</b>	328	28,615	<b>3,995</b>	14.0%	<b>3,995</b>

The High Use program produced average annual net savings of 1,559 kWh in the 7,305 homes in the analysis, equal to about 12% of pre-treatment usage. The overall program savings are estimated at 1,556 kWh due to small differences in the frequency of measure installations between the sample and the population. These savings are a little lower than the 1,615 kWh found in the last evaluation. The Moderate Use program produced average annual net savings of 566 kWh, equal to 9% of pre-treatment usage. These savings are a noticeable smaller than the 697 kWh found in the last study. The TEE program produced average net savings of 3,995 kWh, equal to about 14% of pre-treatment usage and considerable larger than the 3,151 kWh found in the last study.

The overall savings in the High Use program were equal to about 69% of the savings projected from the energy audit data. A statistical analysis of the relationship between measured and projected savings found:

- Refrigerator and freezer replacement savings are equal to about 76% of the savings expected based on the audit's short-term metering. This result is a little lower than the prior study but similar to earlier studies. Total refrigeration-related savings averaged about 600 kWh per home.
- Lighting savings were about 60% of the savings projected based on reported wattages and hours of use and averaged 51 kWh per bulb installed and 749 kWh per home (based on 14.7 bulbs). This result is higher than prior studies which typically found about 40-45

kWh savings per bulb. The higher savings could reflect more selective installation of bulbs to avoid rarely used fixtures.

The Moderate Use program analysis found overall savings equal to 41% of audit projections -- 56% of projected for refrigerators and perhaps 28% of projected for lighting and other measures. Low savings relative to predictions have been common through all prior evaluations of the Moderate Use program. There was considerable uncertainty in the Moderate Use program results due to issues with the comparison group.

### *Cost Effectiveness, Environmental, and Aggregate Impacts*

Blasnik and Associates assessed program cost-effectiveness using a life cycle cost analysis approach and calculated the environmental impacts using emission factors for Ohio electric utilities. Table 2 summarizes the results of these analyses along with a summary of all major impacts on a per participant and per program basis

**Table 2. EPP Aggregate Impact Summary PY 2006**

	High Use		Moderate Use		TEE		Total Program
	Per Home	Program	Per Home	Program	Per Home	Program	
<b># Participants</b>		12,956		4,279		607	17,842
<b>Program Cost</b>	\$975	\$12,632,100	\$758	\$3,243,482	\$1,817	\$1,102,919	\$16,978,501
<b>Electric Savings: kWh/yr</b>	1556	20,159,536	579	2,477,541	3995	2,424,965	25,062,042
<b>Annual Retail Bill Reduction</b>	\$155	\$2,011,922	\$62	\$264,849	\$340	\$206,365	\$2,483,135
<b>Lifetime Bill Reductions PV</b>	\$1,243	\$16,100,608	\$546	\$2,335,720	\$3,755	\$2,279,017	\$20,715,346
<b>Net Savings \$</b>	\$268	\$3,468,508	-\$212	-\$907,762	\$1,938	\$1,176,098	\$3,736,845
<b>Savings to investment Ratio</b>	1.27	1.27	0.72	0.72	2.07	2.07	1.22
<b>Annual Emission Impacts:</b>							
<b>CO2 (tons/yr.)</b>	1.63	21,168	0.61	2,601	4.19	2,546	26,315
<b>NOx (lbs./yr.)</b>	9.1	117,611	3.4	14,454	23.3	14,147	146,212
<b>SOx (lbs./yr.)</b>	29.3	379,201	10.9	46,603	75.1	45,614	471,417
<b>PM-10 (lbs./yr.)</b>	0.37	4,758	0.14	585	0.94	572	5,915

Overall, for the 17,842 participants in EPP in PY06, the present value of the energy savings are worth \$20.7 million, which is 22% greater than the \$17.0 million total program costs.

The High Use and TEE programs appear to be cost-effective uses of ratepayers funds -- the present value of the lifetime energy savings exceeds the program costs. For the High Use program, the net benefits are \$3.5 million and the savings to investment ratio (SIR) is 1.27. For TEE, the SIR is 2.07, but this figure is overstated due to some costs being absorbed by other programs (e.g., HWAP). The Moderate Use program does not appear to be cost-effective with an SIR of 0.72 – a decline from the 0.87 and 0.85 in the prior two studies. The program produced \$2.3 million in bill reductions at a cost of \$3.2 million.

The above calculations do not place any value on other program benefits such as environmental emission reductions or local job creation. The estimated pollutant emission reductions from the

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program are substantial. Annual reductions are estimated at 26,000 tons of CO<sub>2</sub>, more than 146,000 pounds of NO<sub>x</sub> and more than 471,000 pounds of SO<sub>x</sub>. These reductions are equivalent to 4,600 average cars of CO<sub>2</sub> emissions and 3,800 cars of NO<sub>x</sub> emissions annually. In addition to these benefits, EPP provides additional economic benefits to the State by shifting resources from electricity production to the more labor intensive program operations of EPP. These economic impacts have been assessed previously in a separate study.

Overall, EPP continues to produce substantial electricity savings in thousands of PIPP and PIPP eligible households each year. The High Use program continues to be an exemplary program that cost-effectively invests ratepayer funds in reducing the long term costs of PIPP. However, the Moderate Use program is still not cost-effective and will likely need substantial revision to become cost-effective. In the alternative, the moderate program could be dropped and the resources re-deployed to the more cost-effective High Use program.

## I. Introduction

This report presents the findings from the 4<sup>th</sup> impact evaluation of the Electric Partnership Program. The analysis focused on quantifying the electric savings and payment impacts for EPP customers treated in program year 2006 which extended from September 2006 through March 2008.

### *A. Background*

EPP was created under Senate Bill 3 the Ohio Electric Restructuring Act, as passed in July 1999. The program was designed by the Ohio Office of Energy Efficiency to reduce the electric consumption of customers in the Ohio Percentage of Income Payment Plan (PIPP) in order to reduce the long term costs of PIPP to ratepayers and the customers. EPP is paid for by funds collected by the Universal Service Fund rider on the bills of investor-owned electric utility (American Electric Power (AEP), Cleveland Illuminating Company (CEI), Duke Energy Ohio (Duke), Dayton Power and Light (DP&L), Ohio Edison (OE) and Toledo Edison (TE)) customers. The program began in late 2001 and has served more than 80,000 low income households since inception. EPP is now administered by the Office of Community Services (OCS).

### **Ohio PIPP**

PIPP is a special utility payment arrangement that allows low income (<150% of poverty) households to maintain their service if they pay a fixed proportion of their income. The rules for electric PIPP are changing in November 2010. The current electric PIPP customers pay a fixed percentage of income (3% to 15% depending on heating fuel and poverty level) for bills rendered from November 1 through April 15 but charges the full retail bill in the remainder of the year if it is larger than the PIPP amount. Beginning in November 2009, customers will pay a new fixed PIPP income percentage all year (6% or 10%). Under the existing PIPP rules, reductions in summer bills would accrue to the PIPP customer while reductions in winter bills would accrue to ratepayers. The new rules will make all bill reductions accrue to the ratepayers since PIPP customer bills will not be affected by their level of usage.

### *B. Electric Partnership Program Design*

EPP was designed to provide cost-effective usage reduction services to PIPP customers. EPP has three component programs:

- **High Use Baseload:** targeted toward PIPP customers with high electric baseload (not heating or cooling) usage, defined as greater than 6,000 kWh/yr. Measures include extensive lighting retrofits, replacement of inefficient refrigerators and freezers, electric hot water reduction measures, some other miscellaneous measures, and energy education;

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- Moderate Use Baseload: targeted toward PIPP customers with baseload usage between 4,000 and 6,000 kWh/yr., same measures as High Use program, but more streamlined audit process.
  - Targeted Energy Efficiency (TEE): targeted toward PIPP customers with moderate or high electric heating and/or cooling loads defined as greater than 6,000 kWh/yr. TEE provides the same measures as the baseload program and also provides weatherization of the building shell including insulation and air sealing.

Customers are selected and recruited based on an OCS analysis of PIPP customer electric usage data provided by the utilities to OCS.

## **EPP Providers**

EPP was designed to be implemented through a network of local providers throughout the State. In PY06 there were 7 main program providers: Cleveland Housing Network (CHN), Coalition for Ohio Appalachian Development (COAD), Honeywell Solutions (HWDMC), Mahoning Youngstown Community Action Partnership (MYCAP), Ohio Heartland Community Action Council (OHCAC), Portage Community Action (PORT) and People Working Cooperatively (PWC). Two of these providers acted as lead providers for a network of smaller local community action agencies and other low income energy service providers. A total of 28 different agencies delivered the program in PY 2006. One lead provider is a for profit company, Honeywell.

## **Treatment Approach**

EPP employs a computerized field audit called South Middlesex Opportunity Council~EnergyRS (SMOC~ERS). The program providers use the software at each home to identify and assess cost-effective electric savings opportunities. The software also serves as a program tracking system and provides administrative functions.

The overall treatment approach involves the following steps:

- Local providers recruit PIPP customers from target lists sent by OCS and schedule an appointment to perform the energy audit and treatments.
- At each High Use and TEE home, the auditor performs a detailed inventory of electric end uses and enters information about the wattage and hours of use for each into SMOC~ERS. Refrigerators and freezers are each metered for two hours (one hour in Moderate Use homes) and those results are also entered into SMOC~ERS.
- The software calculates the total projected electric use by season and overall for High Use and TEE homes and compares it to the actual usage data to help determine if the auditor has properly identified the electric usage of the home. This reconciliation may help identify missed end-uses and lead to revisions of the audit inputs.
- The data on each end use is used to estimate the cost-effectiveness of potential retrofits – primarily refrigerator and freezer replacements (or removals), lighting replacements, and electric hot water measures.
- In addition to lighting, refrigeration, and water heating, the program also provides mattress pads for waterbeds (whose heaters can cause high use), and can perform custom

measures (e.g., well pump repairs or replacements) and fuel switching of electric water heaters and dryers.

- Once measures have been identified, the auditor then installs lighting and electric hot water measures. Refrigerators and freezers are ordered as needed and the replacement is performed on a separate visit by a sub-contracted refrigerator provider.
- The data on each end use is also used to identify potential savings from actions that the customer could take. For example, using a clothes line in the summer or turning off televisions when no one is watching. The energy auditor identifies a few key actions in each home and secures customer agreement to do them.
- The SMOC~ERS analysis results of usage, measures, and potential customer actions are printed out in the home to provide the customer with information about the services performed and their commitments to energy saving actions.

The computerized approach seems to make sense but there have been many practical challenges. Early hardware and software problems have been mostly resolved, but the detailed end use analysis can be tedious and may shift the focus away from the energy education and major treatments. Over time the process has been streamlined to maximize the value of the software as a field tool.

### *C. Evaluation*

OCS has included regular program evaluations into EPP in order to assess cost-effectiveness and maximize the value of the programs to ratepayers and PIPP customers. This impact evaluation study is part of an on-going feedback loop being used to continuously assess and improve EPP.

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## II. Methodology and Data

This section briefly describes the evaluation methods employed in this study. More detailed information about the data and methods has been provided in prior evaluation reports.

### *A. Data Sources*

The evaluation relied on three primary sources of data: the SMOC~ERS computerized audit and program tracking system (for information on program participation and treatments); monthly utility usage data for each PIPP customer provided by the utilities to OCS each quarter; and weather data for six weather stations in Ohio from the National Weather Service.

### *B. Energy Impact Analysis*

The energy impact analysis starts with combining all of the usage data files from the utilities and creating a clean and continuous usage history for each PIPP customer. The meter readings are classified into pre-treatment and post-treatment periods and then analyzed with a weather normalization procedure that adjusts for heating and cooling degree day differences from a typical year. This analysis is performed for each home for the year before treatment and the year after treatment. Cases were excluded from the usage analysis if the available data did not contain usage from all seasons or the annual usage estimate was extremely large or small (<1,200 kWh or >70,000 kWh) or the change in usage was extreme (65% or more than an outlier threshold value statistically determined for each group).

The results from the usage data analysis were combined with the tracking system data and then statistically summarized to provide the energy impact estimates.

### **Comparison Groups**

In addition to analyzing the usage of participants, we also analyzed the usage over the same period for a comparison group composed of homes treated after September 2007. The comparison group is used to reflect trends in usage unrelated to the program such as households adding computers or other appliances as well to reflect any small biases in the weather adjustment. Net program energy savings are estimated as the average savings for the participants minus the average savings for the comparison group.

To provide for good matching overall and for analyses of sub-groups of interest, we used post-stratification techniques to match comparison group cases to the treatment group based on pre-treatment usage, geography, and housing type.

### **Statistical Analysis of Energy Impacts**

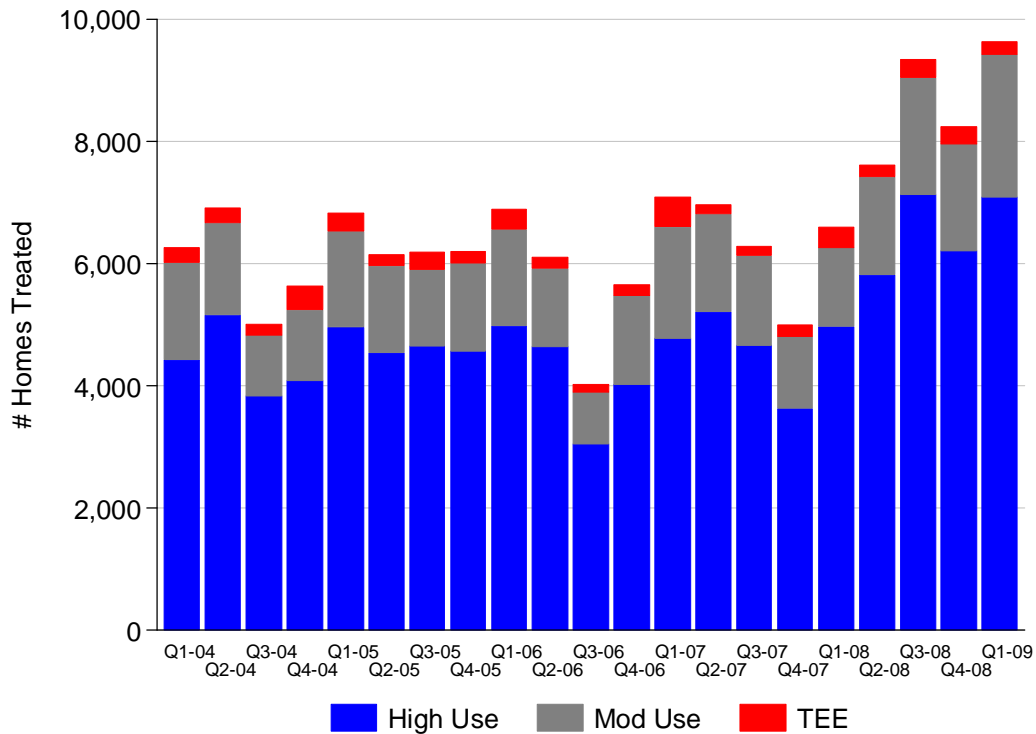
Overall average energy savings results from billing data analysis typically provide a useful but limited picture of program accomplishments and few insights into the causes of program performance or ways to effect improvements. To assess which factors are associated with savings, we summarized impacts among different groups of participants and also employed statistical analyses, including regression modeling, to estimate the impacts of specific measures and explore how housing and demographic characteristics may affect savings.

### III. Program Description and Characteristics

This section summarizes information about the program and its customers based on data from the tracking system and data on the PIPP population from OCS.

#### A. Program Production

Figure 1 shows the number of audits completed by quarter from 2004 through March 2009, broken out by program.



**Figure 1. EPP Program Production by quarter and program**

Total EPP production generally stayed in the range of about 6,000 homes per quarter from 2004 through 2007 with a noticeable dip in Q3-06 which signaled the end of the PY05 contract year. Production climbed in 2008 and is now more than 9,000 homes per quarter. The High Use program has always been the largest program by far while the TEE program has been small.

Table 3 shows EPP production by program component and utility service territory for the 17,842 homes treated in the evaluation target period of September 2006 through March 2008. There were six homes listed as served by Allegheny Power (five high use and one moderate use) which are not shown in the table but are included in the totals.

**Table 3. EPP Production by Program and Utility (September 2006 – March 2008)**

	<b>AEP</b>	<b>Duke</b>	<b>CEI</b>	<b>DP&amp;L</b>	<b>OE</b>	<b>TE</b>	<b>Total</b>
<b>High Use Baseload</b>	3,424	1,834	3,376	410	3,637	270	12,956
<b>TEE – Weatherization</b>	525	20	0	22	36	4	607
<b>Moderate Use</b>	591	342	1,713	155	1,376	101	4,279
<b>Total</b>	4,540	2,196	5,089	587	5,049	375	17,842

AEP, CEI, and OE each served about one quarter of the High Use participants while AEP served almost every TEE participant. Most Moderate Use participants were served by CEI or OE.

### *B. Participant Characteristics*

The SMOC~ERS program tracking system contains detailed information about the appliances and electrical end uses of program participants, but relatively few demographics. Table 4 summarizes key housing characteristics of all EPP customers treated from September 2006 through March 2008 along with some overall PIPP population data from 2008.

**Table 4. Housing Characteristics of EPP Customers and PIPP Population**

	<b>High Use</b>	<b>TEE</b>	<b>Mod. Use</b>	<b>EPP Total</b>	<b>PIPP Population</b>
<b># Units</b>	12,956	607	4,279	17,842	~230,000
<b>Housing Type:</b>					
<b>Single Family</b>	73%	48%	63%	70%	64%
<b>Mobile Home</b>	9%	49%	5%	9%	5%
<b>Multi Family</b>	14%	1%	28%	17%	31%
<b># Occupants</b>	3.3	3.2	2.3	3.0	2.6
<b>Homeowner</b>	57%	63%	49%	55%	

The table shows some clear differences between the EPP programs and between EPP and the PIPP population. EPP High Use customers mostly live in single family site-built homes while about half of the TEE customers live in mobile homes and 28% of Moderate Use customers live in multifamily buildings. The Moderate Use participants are most similar to the PIPP population in terms of type of housing and household size.

Table 5 provides a similar break out by utility service territory for High Use participants.

**Table 5. Demographics of EPP High Use Participants by Utility**

	<b>AEP</b>	<b>Duke</b>	<b>CEI</b>	<b>DP&amp;L</b>	<b>OE</b>	<b>TE</b>
<b># Units</b>	3,424	1,834	3,376	410	3,637	270
<b>Housing Type:</b>						
<b>Single Family</b>	62%	77%	74%	79%	78%	81%
<b>Mobile Home</b>	18%	8%	3%	10%	7%	8%
<b>Multi Family</b>	8%	14%	22%	10%	12%	11%
<b># Occupants</b>	3.2	3.1	3.5	2.8	3.3	3.2
<b>Homeowner</b>	56%	68%	53%	70%	54%	62%

CEI participants were most likely to be living in apartments and had the largest average household size while AEP served the most mobile homes. DP&L participants were the most likely to be homeowners living in site built homes and had the fewest occupants.

### Electric End Uses

The data from SMOC~ERS provides an inventory of electrical end uses for all High Use and TEE participants and more limited data for Moderate Use participants. The frequency of key electric end-uses for participants in each EPP program for September 2006 through March 2008 is summarized in Table 6.

**Table 6. Electric End Uses by Program and Utility**

<b>Program</b>	<b>Hot Water</b>	<b>Central A/C</b>	<b>Central Heat</b>	<b>Space Heater</b>	<b>Freezer</b>	<b>Extra Fridges</b>	<b>Dryer</b>	<b>Stove</b>
<b>High Use</b>								
<b>AEP</b>	52%	34%	19%	40%	39%	15%	88%	67%
<b>Duke</b>	23%	58%	12%	55%	46%	20%	82%	59%
<b>CEI</b>	6%	26%	7%	49%	51%	22%	88%	28%
<b>DP&amp;L</b>	35%	49%	16%	36%	43%	13%	87%	83%
<b>OE</b>	19%	25%	11%	41%	47%	17%	78%	42%
<b>TE</b>	25%	33%	8%	43%	46%	15%	69%	44%
<b>High Use - All</b>	<b>26%</b>	<b>33%</b>	<b>13%</b>	<b>45%</b>	<b>46%</b>	<b>18%</b>	<b>84%</b>	<b>49%</b>
<b>Moderate Use</b>	<b>8%</b>	<i>not always recorded</i>			<b>31%</b>	<b>8%</b>	<b>53%</b>	<b>22%</b>
<b>TEE</b>	<b>93%</b>	<b>23%</b>	<b>87%</b>	<b>32%</b>	<b>40%</b>	<b>10%</b>	<b>93%</b>	<b>93%</b>

The table shows that a quarter of the High Use program homes have electric hot water, a third have central air conditioning, nearly half have freezers, and many have electric space heaters or even installed electric heat. The proportion of homes with second refrigerators has grown to 18% from 12% in the prior study. In comparison to the High Use participants, Moderate Use participants have fewer freezers, secondary refrigerators, and electric dryers and rarely have

electric hot water. TEE participants mostly have “all electric” homes, but have slightly lower penetration of freezers and secondary refrigerators than High Use participants.

There are also some clear differences between utilities. Among High Use participants, CEI participants are much less likely to have electric water heating but are the most likely to have freezers and secondary refrigerators. CEI High Users qualify due to their greater penetration of freezers and secondary refrigerators, making them ideal candidates for the primary program treatments. In contrast, AEP High Use participants often have high usage due to water heating, which may not provide the same opportunity for savings as refrigeration or lighting. An electric water heater will make almost any house qualify for the High Use program even if other end uses are not high, generally providing less opportunity for savings at a given level of usage.

The SMOC~ERS database includes estimates of the electric usage for each end use in each home based on data entered by the auditor. Table 7 shows the average auditor-estimated loads broken into several end use categories subtotaled by utility company for the High Use baseload program (September 2006 through March 2008).

**Table 7. Auditor-Estimated kWh Usage by End Use: High Use Baseload Program**

	<b>AEP</b>	<b>Duke</b>	<b>CEI</b>	<b>DP&amp;L</b>	<b>OE</b>	<b>TE</b>	<b>All</b>	<b>% total</b>
<b># Participants</b>	3,424	1,834	3,376	410	3,637	270	12,956	
<b>Refrigerators</b>	1,326	1,335	1,441	1,460	1,341	1,496	1,369	10%
<b>Freezers</b>	335	378	407	337	373	431	372	3%
<b>Lighting</b>	2,107	2,390	1,919	1,429	1,812	1,805	1,987	15%
<b>Heating/Cooling</b>	5,492	6,315	4,139	5,246	4,510	4,467	4,950	37%
<b>-Air Conditioning</b>	1,761	2,564	1,166	2,015	1,288	1,777	1,595	12%
<b>-Space Heaters</b>	1,067	1,551	1,141	998	975	864	1,122	8%
<b>-Installed Heat</b>	1,525	1,065	504	864	808	456	949	7%
<b>-Other HVAC</b>	1,140	1,135	1,328	1,368	1,439	1,370	1,284	10%
<b>Laundry</b>	1,005	833	1,183	775	976	832	1,008	8%
<b>Stove/Oven</b>	770	652	364	883	474	462	561	4%
<b>Other Kitchen</b>	315	217	401	211	339	229	325	2%
<b>Televisions</b>	851	967	699	1,031	824	1,199	833	6%
<b>Computers</b>	434	496	255	378	400	474	386	3%
<b>Other Electronics</b>	472	546	272	400	420	497	414	3%
<b>Hot Water</b>	2,270	798	261	1,107	815	1,599	1,077	8%
<b>Other</b>	121	-155	28	90	22	-265	21	0%
<b>Total</b>	<b>15,499</b>	<b>14,772</b>	<b>11,368</b>	<b>13,348</b>	<b>12,305</b>	<b>13,226</b>	<b>13,304</b>	<b>100%</b>

Notes: “Other HVAC” includes furnace fans, other fans (whole house, ceiling, window, box), humidifiers, dehumidifiers, pumps (sump, boiler, and pool), electric blankets, heating pads, heat tape, aquariums, and other end uses related to heating or cooling. “Other Electronics” refers to stereos, VCRs, hair dryers and other smaller electronic devices. “Laundry” refers to electric dryers and motor power for all washers and dryers. “Other” refers to miscellaneous small plug loads (e.g., vacuums, cell phone chargers) as well as on-going power draw when appliances are off.

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Heating/Cooling was the largest end use category, comprising 37% of the total usage. Refrigeration and lighting are the two main loads targeted by program measures and were estimated to average 3,728 kWh/yr, equal to 28% of usage. Without substantial savings from behavior changes, it would be difficult to achieve program savings of more than about half of these loads, which would equal about 1,850 kWh/yr or 14% of the total load.

A closer examination of the individual load estimates found that:

- **Lighting:** the average estimated lighting load increased a little to 1,987 kWh/yr from the 1,817 kWh in the last evaluation. The auditors reported 4.0 hours per day of average use per light for the 21.7 average number of bulbs per home. These estimated hours of use and loads are higher than national averages, but these are high use homes. A conditional demand regression analysis of actual usage indicated that the true lighting loads are perhaps 5%-15% lower than these reported loads. As in prior studies, we also found that the reported hours of use varied systematically between auditors.
- **Hot water:** Electric hot water load estimates were identified as problematic in past evaluations and continue to be so – having greater variability than expected. The estimated annual water heating usage was outside the expected range of 2,000-7,000 kWh for 42% of water heating participants. This percentage is only slightly lower than the 47% found in the last evaluation. Average loads varied between provider with OHCAC having the most unusual estimate at 5,976 kWh.
- **Other End Uses:** Conditional demand regression modeling indicated that auditors seem to be doing a better job at estimating loads than in past evaluations. The end uses with the largest discrepancies tended to be in the rapidly changing entertainment related end uses of computers and “other electronics” (e.g., video games). The approaches for estimating wattages and daily use may need to be revisited.

### *C. Program Treatments*

EPP’s computerized audit system screens measures based on a site-specific cost/benefit analysis. The cost-effectiveness of the program depends on having sufficient net benefits at each house to cover the fixed costs of the program. EPP was designed to target higher usage customers to maximize the likelihood that the savings opportunities are large enough to produce overall net benefits. The major program treatments include:

- **Refrigerator Replacements:** Refrigerators are replaced with new efficient units if these refrigerators are deemed cost-effective to replace and the customer accepts the replacement. For the High Use and TEE programs, 2 hour metering is used to assess the existing unit. For the Moderate Use program, either one hour metering or a model lookup in a database of ratings can be used.
- **Freezer Replacements:** Freezers are assessed in the same manner as refrigerators and are also eligible to be replaced with a more efficient unit.
- **Refrigerator and Freezer Removals:** Secondary refrigerators and freezers are often under-utilized and can provide an excellent savings opportunity. It can be challenging to convince customers to allow the removal of appliances because many qualify for replacement and there is little incentive to give them up. Two-for-one swaps can be an

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incentive but require skill in “selling” this to the customer. Appliance removals have increased over time as program management has placed greater emphasis on this highly cost-effective treatment.

- **Compact Fluorescent Lights:** Light bulbs are replaced with energy efficient compact fluorescent bulbs in all fixtures deemed feasible and cost effective. Given the low cost of CFLs, many fixtures tend to qualify per home.
- **Electric Hot Water Usage Reduction:** Houses with electric hot water may receive low flow showerheads and aerators, tank wraps, pipe insulation, and tank temperature reductions. Some providers have funds from other program to pay for these measures and so it is not always clear whether a home received these measures or not.
- **Weatherization / Building Shell Measures:** For participants in the TEE program, EPP provides a full range of weatherization treatments such as attic and wall insulation, air sealing, duct sealing, and other building shell improvements. Many homes treated under TEE have additional treatments provided by HWAP or other utility funds, making it difficult to attribute savings to EPP unambiguously.
- **Occasional and Custom Measures:** EPP includes several additional measures that are rarely performed but can sometimes provide very large savings including water bed mattress pads and fuel switching – replacing electric water heaters or clothes dryers (and even heating systems) with gas units. EPP also allows for “custom” measures that can address any other savings opportunity not specifically covered elsewhere.
- **Energy Education** can play a key role in producing energy savings at a low cost. EPP provides energy education to every participant during the initial energy audit and can also provide follow-up education through phone calls and further site visits when warranted. Education opportunities are identified within the computerized audit system and potential actions are supposed to be prioritized to develop a list of a few actions that the occupants agree to undertake.

### Measure Installation Rates and Costs

Table 8 summarizes key measure installation rates and costs by program and by utility territory within the High Use baseload program. The table only includes units in the evaluation target sample – treated from September 2006 through March 2008.

**Table 8. Measure Installations and Costs by Program and Utility** (September 2006 – March 2008)

	High Use Baseload Program						All	Mod Use	TEE
	AEP	Duke	CEI	DP&L	OE	TE			
<b># Homes</b>	3,424	1,834	3,376	410	3,637	270	12,956	4,279	607
<b>Measures (per site)</b>									
-Refrigerators Replaced	0.49	0.58	0.71	0.49	0.65	0.68	0.61	0.57	0.48
-Freezers Replaced	0.14	0.25	0.26	0.12	0.22	0.21	0.21	0.15	0.09
-Fridge/Freezer Removals	0.05	0.03	0.05	0.01	0.04	0.04	0.04	0.02	0.02
-Light Bulbs	17.4	18.7	12.5	11.8	12.5	12.3	14.7	9.4	12.7
-Electric Hot Water: any	40%	13%	4%	29%	11%	20%	18%	5%	58%
<b>Measure Costs (per site):</b>									
-Refrigeration	\$362	\$463	\$567	\$444	\$476	\$659	\$471	\$395	\$311
-Lighting	\$214	\$267	\$160	\$148	\$166	\$157	\$191	\$125	\$156
-Other Measures	\$28	\$27	\$146	\$6	\$74	\$4	\$69	\$46	\$24
<b>Total Measure Cost /site</b>	<b>\$604</b>	<b>\$757</b>	<b>\$873</b>	<b>\$598</b>	<b>\$716</b>	<b>\$820</b>	<b>\$731</b>	<b>\$566</b>	<b>\$491</b>
<b>Audit/Education/Admin</b>	<b>\$225</b>	<b>\$225</b>	<b>\$224</b>	<b>\$224</b>	<b>\$225</b>	<b>\$226</b>	<b>\$225</b>	<b>\$174</b>	<b>\$324</b>
<b>Weatherization Cost*</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$998</b>
<b>Total Treatment Cost</b>	<b>\$844</b>	<b>\$1,000</b>	<b>\$1,124</b>	<b>\$833</b>	<b>\$959</b>	<b>\$1,062</b>	<b>\$975</b>	<b>\$758</b>	<b>\$1,817</b>

\* Weatherization costs for TEE jobs were zero for 37% of the TEE jobs, but may under-estimate total weatherization spending if other programs were used to fund measures. The average weatherization costs for jobs with any costs listed was \$2,139

The table shows that the High Use baseload program:

- replaced an average of 0.61 refrigerators and 0.21 freezers per home (vs. 0.58 and 0.20 in the previous study) – 64% of homes had one or more appliance replaced;
- installed 14.7 light bulbs per home (vs. 16.4 in the previous study);
- provided electric hot water measures in about one sixth of the homes;
- convinced 4% of the participants to have secondary refrigerators or freezers removed – twice as many as in the prior evaluation;
- spent an average of \$975 per home on program treatments (vs. \$879 in previous study) with about half of the spending paying for refrigerators and freezers, 20% for lighting, and 25% for audit, administrative, and education costs.

High Use program spending averaged \$96 more per home than in the previous study. The increase is due to \$63 more per home in “Other” measures -- almost entirely clothes dryer fuel switching as a custom measure by two providers – as well as slightly more refrigerator replacements and a higher cost per refrigerator or freezer. Lighting measure costs dropped by about \$80 per home as the cost per bulb and the number of bulbs per home both declined.

Refrigerator and freezer installation rates were highest for CEI participants, leading to the highest average measure spending. Duke and AEP participants received considerably more lighting retrofits per home than the other utilities. The average cost per bulb installed was about \$13 for the High Use program (vs. \$16 in the prior study).

The relatively low rate of secondary refrigerator and freezer removals has been identified in prior evaluations as a potential lost opportunity although the situation started improving in the last study. In the current analysis, secondary refrigerators were found in 18% of High Use participant homes and 14% of these units were removed. This removal rate compares well to the 10% in prior study and 6% in the study before that. For freezers, 49% of participants had separate freezers and 4% of those units were removed compared to 2% in the prior study and 1% in the study before that.

The appliance removal rates varied between providers and between auditors. CHN had the highest secondary refrigerator removal rate at 16.8% while PWC removed just 9%. For freezers, OHCAC removed fewer than 1% while CHN removed 5%. It appears that CHN has developed an appliance removal approach, especially with freezers, that may be worth trying to replicate with other providers.

The Moderate Use program costs stayed about the same as the last evaluation. The increase in refrigeration measure costs was offset by the decrease in lighting costs.

As in prior studies, the TEE program had lower rates of refrigerator replacements than the other programs. Also, the data on weatherization measure costs appears incomplete since zero costs were recorded in 40% of the cases. Part or all of the weatherization costs for TEE jobs were likely covered by other funding sources.

## IV. Electric Usage Impacts

### A. Sample Attrition

Table 9 tabulates the sources of attrition from the full treated population to the actual analysis sample for each program.

**Table 9. Electric Usage Analysis Sample Attrition by Program**

<b>Sample / Attrition Cause</b>	<b>High Use</b>	<b>Mod Use</b>	<b>TEE</b>
<b>Treated Population Units</b>	<b>12,956</b>	<b>4,279</b>	<b>607</b>
-No Usage match	1,275	-309	-74
-Insufficient Usage Data (total or seasonal)	-4,116	-1,314	-186
-Estimated Usage <1,200 or >70,000	-52	-30	-7
-Change in Usage >65%or 2.2 IQRs	-208	-94	-12
<b>=Analysis Sample Units</b>	<b>7,305</b>	<b>2,532</b>	<b>328</b>
Attrition %	44%	41%	46%

All three programs had similar attrition rates and all suffered from a lack of pre and/or post-treatment data in about 40% of cases. The attrition rates are a little higher than in the past evaluation. This increase may be related to the need for the program to identify newer PIPP customers for targeting who are therefore less likely to have sufficient pre-treatment usage data histories available. The potential bias from sample attrition is addressed later in the report. For the comparison group, attrition was about 65% due to the need for at least two years of pre-treatment data.

### B. High Use Baseload Program Electric Impacts

Table 10 summarizes the results of the savings analysis for the High Use baseload program.

**Table 10. High Use Baseload Program: Electric Savings Results**

<b>Group</b>	<b>Average Usage &amp; Gross Savings (kWh/yr)</b>				<b>Net Savings</b>	
	<b># units</b>	<b>Pre-use</b>	<b>Post-use</b>	<b>Savings</b>	<b>Net Savings</b>	<b>Net % Savings</b>
<b>All Participants</b>	<b>7,305</b>	<b>13,300</b>	11,780	<b>1,520</b>	<b>1,559 (±69)</b>	<b>11.7% (±0.5%)</b>
Comparison Group	6,631	12,981	13,065	-84		
<b>Weighted Comparison</b>	<b>6,410</b>	<b>13,230</b>	13,268	<b>-39</b>		

Notes: ± figures are 90% confidence intervals on the net savings. Net savings are based on a weighted comparison group matched to the participants on location (weather station), housing type, and usage patterns.

The participants' weather-adjusted annual electric usage declined by an average of 1,520 kWh. The raw comparison group's weather-adjusted usage increased by an average of 84 kWh. The analysis employed stratification methods to weight each comparison group case to better match the participants on factors including pre-treatment total and winter usage, geographic location, and housing type. The results of this weighted analysis are shown as the second comparison group line and were used to calculate net savings. Although this stratification and weighting approach only resulted in a 45 kWh adjustment in the overall comparison group, we used the approach for all group break-outs of savings where larger adjustments sometimes occurred.

The annual net electric savings averaged 1,559 kWh, equal to 11.7% of pre-treatment usage. These savings are a little smaller than the prior evaluation's savings of 1,650 kWh (12.2%). The EPP High Use program savings continue to compare quite favorably to similar programs that typically save 700 – 1,100 kWh/yr. The main reason for the difference is the targeting of high use households and associated high installation rates for refrigeration and lighting measures.

Table 11 shows the net savings calculated separately for each seasonal component of usage.

**Table 11. High Use Program: Heating, Cooling Baseload Savings**

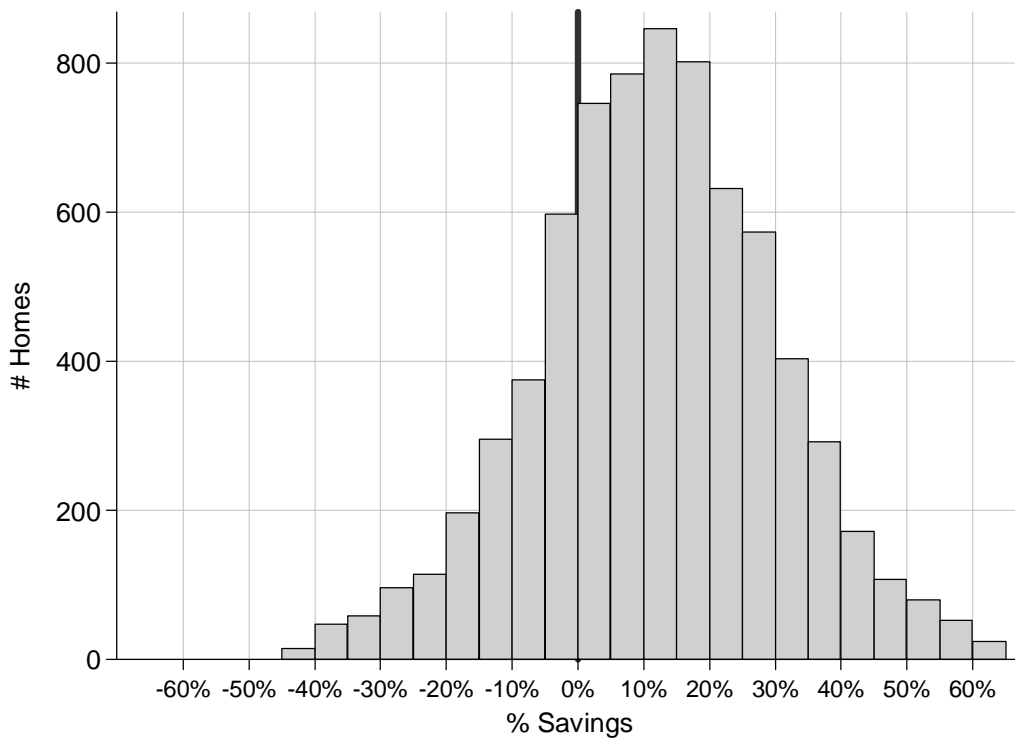
Load Components	Average Usage & Gross Savings (kWh/yr)			Net of Weighted Comparison Group	
	Pre-use	Post-use	Savings	Net Savings	Net % Savings
Baseload	9,216	7,603	1,613	<b>1,416</b>	15.4%
Winter/Heating	2,688	2,790	-102	<b>71</b>	2.6%
Summer/Cooling	1,396	1,387	8	<b>72</b>	5.2%

The seasonal break out of savings is similar to the prior evaluations -- nearly all of the savings occur in the baseload usage while winter and summer load changes were small.

### High Use Program: Usage and Savings Variations

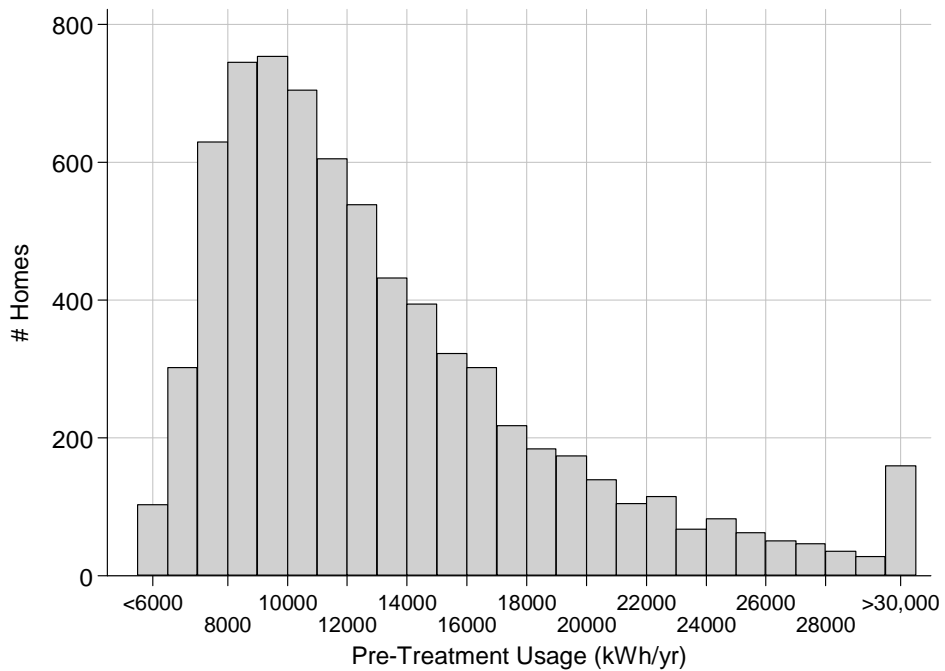
Usage and savings varied widely across participants and within the comparison group. Field visits during prior evaluation work found that many households experience significant changes in occupancy, end uses or circumstances from year to year. The more extreme changes in usage are often due to changes in such non-program factors.

Figure 2 shows the distribution of gross savings as a percent of pre-treatment usage for the High Use program. Overall, slightly more than half of the participants had gross savings between 0% and 25%, while one quarter saved more than 25% and nearly one quarter had an apparent increase in usage. In the comparison group, 53% of all homes had increased usage, 42% had apparent savings between 0% and 25%, and fewer than 5% had savings of more than 25%.



**Figure 2. Distribution of % Savings (gross): High Use Participants**

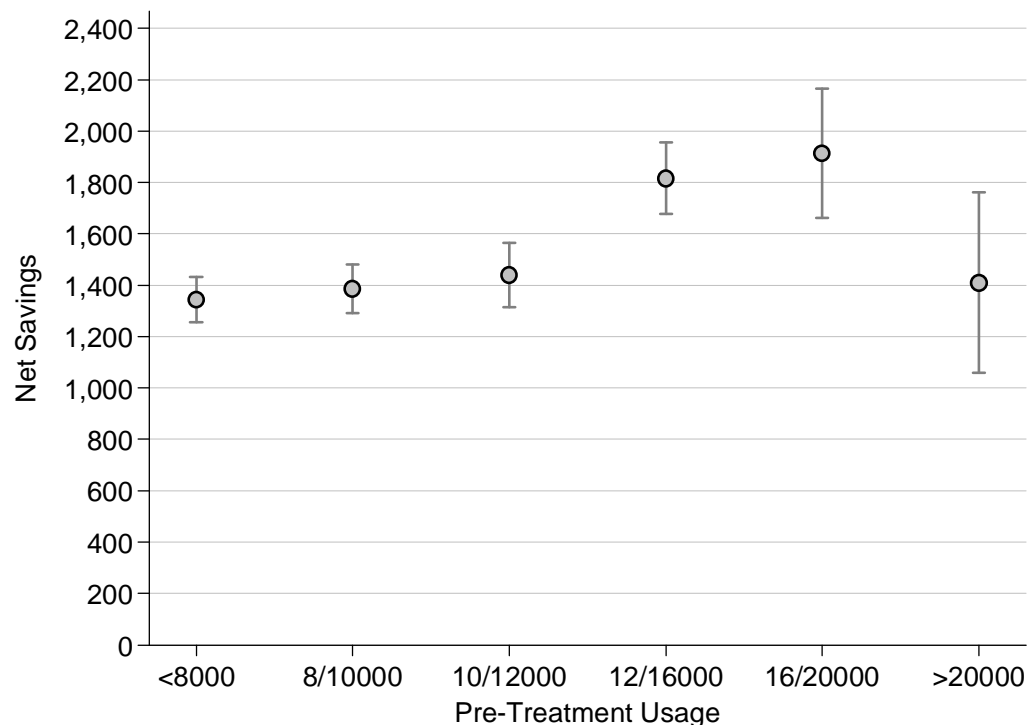
Pre-treatment usage is often related to energy savings. Figure 3 shows the distribution of pre-treatment annual electric usage for the High Use participants.



**Figure 3. Distribution of Pre-Treatment Usage: High Use Participants**

Pre-treatment usage averaged 13,300 kWh and the median usage was 11,699 kWh – similar values to the last evaluation. Half the participants used between 9,000 and 16,000 kWh, while 10% used more than 21,000 kWh. The frequency of electric water heating grows with increasing usage.

Figure 4 shows the net savings for participants by level of pre-treatment usage. For each usage bin, the average net savings is shown by the gray-filled circle and the capped line reflects the statistical uncertainty (i.e., the  $\pm 90\%$  confidence interval).



**Figure 4. Net Savings by Pre-Treatment Usage : High Use program**

note: Circle shows average (mean) savings, gray capped lines show  $\pm 90\%$  confidence interval. All figures in kWh/year

The graph is similar to prior years -- showing a changing relationship between usage and savings. Houses using more than 12,000 kWh generally have greater savings than those using less, but savings are fairly flat across lower usage bins and then peak at about 16,000 kWh and then decline at the highest usage bin. The reason for this pattern is that the High Use program primarily addresses refrigeration and lighting loads and those loads do not grow in direct proportion to total usage as electric water heating and HVAC loads become more prevalent with increasing usage. Therefore, although homes with usage below the High Use threshold tend to have smaller refrigerator and lighting savings opportunities, the opportunities do not grow in a linear fashion above that level. The graph also shows that the variation in savings increases at higher levels of pre-treatment use, indicated by the widening of the confidence intervals.

We explored variations in usage and net savings based on a variety of treatment and housing characteristics including refrigerator and freezer measures, dryer fuel switching, the presence of electric water heating, and housing type. We also calculated savings for each utility service territory. These comparisons are summarized in Table 12.

**Table 12. High Use Program: Savings Break-outs** (annual kWh with  $\pm 90\%$  confidence intervals)

Group	# Homes	Pre-use	Gross Savings	Net Savings	Net % Savings
<b>By Utility Service Territory</b>					
AEP	1,687	15,463	1,472	1,425 ( $\pm 129$ )	9.2% ( $\pm 0.8\%$ )
Duke	1,104	14,784	1,839	1,801 ( $\pm 220$ )	12.2% ( $\pm 1.5\%$ )
CEI	1,873	11,701	1,615	1,635 ( $\pm 118$ )	14.0% ( $\pm 1.0\%$ )
DP&L	251	13,918	1,154	1,349 ( $\pm 281$ )	9.7% ( $\pm 2.0\%$ )
OE	2,192	12,208	1,374	1,524 ( $\pm 89$ )	12.5% ( $\pm 0.7\%$ )
TE	197	13,059	1,344	1,278 ( $\pm 328$ )	9.8% ( $\pm 2.5\%$ )
<b>By Refrigerator Measures</b>					
Any Refrigeration Measure	<b>4,719</b>	<b>13,189</b>	<b>1,784</b>	<b>1,820 (<math>\pm 77</math>)</b>	<b>13.8% (<math>\pm 0.6\%</math>)</b>
- single refrigerator replaced	2,814	12,870	1,584	1,647 ( $\pm 87$ )	12.8% ( $\pm 0.7\%$ )
- single freezer replaced	459	13,492	1,623	1,618 ( $\pm 191$ )	12.0% ( $\pm 1.4\%$ )
- 2+ appliances replaced	1,443	13,720	2,221	2,218 ( $\pm 117$ )	16.2% ( $\pm 0.8\%$ )
No Refrigeration Measure	<b>2,409</b>	<b>13,478</b>	<b>1,004</b>	<b>1,054 (<math>\pm 92</math>)</b>	<b>7.8% (<math>\pm 0.7\%</math>)</b>
<b>By Dryer Fuel Switch</b>					
Dryer Switched to Gas	531	11,847	2,445	2,479 ( $\pm 155$ )	20.9% ( $\pm 1.3\%$ )
Dryer Not Switched	6,774	13,414	1,448	1,487 ( $\pm 71$ )	11.1% ( $\pm 0.5\%$ )
<b>By Electric Water Heating</b>					
Hot Water: no measures	544	17,925	1,230	1,414 ( $\pm 268$ )	7.9% ( $\pm 1.5\%$ )
Hot Water: with measures	1,231	18,234	1,063	1,293 ( $\pm 210$ )	7.1% ( $\pm 1.2\%$ )
Not Electric Hot Water	5,530	11,747	1,650	1,676 ( $\pm 70$ )	14.3% ( $\pm 0.6\%$ )
<b>By Housing Type</b>					
Single Family Home	5378	13,118	1,643	1,651 ( $\pm 80$ )	12.6% ( $\pm 0.6\%$ )
Mobile Home	582	16,135	845	1,114 ( $\pm 262$ )	6.9% ( $\pm 1.6\%$ )
Apartment	983	11,880	1,342	1,474 ( $\pm 165$ )	12.4% ( $\pm 1.4\%$ )

Net savings ranged moderately across utility service territories from a low of 1,278 kWh for customers served by Toledo Edison (TE) to a high of 1,801 kWh for Duke customers.

Refrigerator and freezer replacements clearly were a major driver of savings. Houses that did not receive any refrigeration measures achieved only a little more than half the savings of those

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that did – 1,054 kWh vs. 1,820 kWh. Dryer Fuel Switching also appears to provide substantial savings, although customers who received that measure were also more likely to get a refrigerator replacement.

Participants with electric hot water used about 50% more electricity on average than other participants but saved less in absolute, and especially percentage, terms. These differences are consistent with prior studies which found that electric water heating can qualify an otherwise moderate use home as high use, providing fewer opportunities for the main program measures.

Among homes with electric water heating, savings were actually slightly higher in homes that reportedly received no measures to address this end use. The prior evaluation found that other funding sources may have been used on some of these homes.

In terms of housing type, single family site-built homes had the highest savings and mobile homes had the lowest savings. Mobile homes had the highest usage due to their higher prevalence of electric heat and hot water but EPP treatment saved just 7% of this load.

### **High Use: Comparison to Projected Savings**

The overall net annual savings of 1,559 kWh are higher than the savings found for most low-income electric baseload programs -- the targeting of high use customers is continuing to succeed in identifying homes with cost-effective savings opportunities. However, the savings have declined by about 100 kWh/yr in each of the last two evaluations.

One way to assess the success of the program is to compare the measured savings to those expected from engineering-based calculations. This comparison can help put the measured savings in context, provide feedback on the accuracy of the field data and savings algorithms, and allow for a more detailed analysis of factors associated with savings.

We used the data in SMOC~ERS to calculate savings for each measure, generally following the same approaches used by SMOC~ERS, with some minor changes. We calculated projected lighting savings by using the auditor-recorded data on hours of use and the change in wattage for each bulb installed. For refrigerator replacements, we calculated the difference between the estimated usage of the existing unit as calculated by SMOC~ERS and the rated usage of the new unit. We estimated savings from electric hot water measures using either SMOC~ERS values (when available and reasonable) or relatively conservative default values. We used SMOC~ERS data for other miscellaneous measures, occasionally applying a maximum cut-off or modified default value.

Table 13 summarizes the results of these engineering-based calculations for the analysis sample and compares these savings to the savings measured from the usage data analysis.

**Table 13. High Use Baseload: Projected Savings by Utility (analysis sample)**

	Projected from engineering estimates (kWh/home/yr)					Measured from Usage Data Analysis	
	Refrigeration	Lighting	Hot Water	Other	Total	Net	Realized
<b>By Utility:</b>							
AEP	772	1,438	160	57	2,427	1,425	59%
Duke	740	1,552	48	46	2,387	1,801	75%
CEI	862	1,151	25	264	2,302	1,635	71%
DP&L	766	1,015	52	0	1,832	1,349	74%
OE	800	1,082	52	149	2,083	1,524	73%
TE	984	1,124	32	0	2,139	1,278	60%
<b>Overall</b>	<b>804</b>	<b>1,252</b>	<b>69</b>	<b>133</b>	<b>2,257</b>	<b>1,559</b>	<b>69%</b>

Note: “Measured” column shows net savings results. “Realized” is equal to the percent of projected savings measured. See section III for details on measure installation rates by utility.

The projected annual savings averaged 2,257 kWh per home and the measured net savings were 1,559 kWh, equal to 69% of projected (referred to as the realization rate). Measured realization rates ranged from 59% for customers in the AEP service territory to 75% for the Duke customers.

In the prior evaluation, the projected savings were a little smaller at 2,141 kWh but the realization rate was 77%, yielding higher overall savings. One area with consistent over-estimation of savings has been for lighting retrofits. In the first three EPP evaluations, the projected savings per bulb dropped from 96 kWh to 84 kWh to 76 kWh as evaluation results showed that measured savings fell short of projected. In this study, there has been a reversal in this trend – projected lighting savings averaged 86 kWh per bulb. This change might make some sense as the program is installing fewer bulbs per home and could be targeting higher use fixtures. However, the measured savings have always been far lower than the projections.

A second change from past studies is the greater projected savings from “Other” measures which averaged just 12 kWh in the prior evaluation. About half the increase is due to dryer fuel switching from electric to gas.

The savings projections and realization rates in the table do not include any savings estimated from energy education or customer actions. To the extent that education savings are projected to add to the total, the realization rate would decline commensurately.

### Measure Savings Analysis

The prior impact evaluations found that most of the shortfall between projected and measured savings could be attributed to lighting measures where measured savings have been about 40 kWh – 45 kWh per bulb while projections have been about double that. The lighting savings shortfall was investigated in more detail and led to the conclusion that about half of the lighting savings shortfall was due to over-estimated hours of use and half was due to installation problems (premature burn-out, bulb removals, and installations in fixtures where the existing bulb was burned out or non-existent).

Savings from refrigerator and freezer replacements have also been a little less than projected – by about 10%-20%.

In this study, we again used regression analysis to assess measure-specific savings, employing an “errors-in-variables” approach to reflect random variations in the projected savings due to short-term metering fluctuations and random components to the error is estimated lighting hours (we estimated projection reliability at 75% for both, indicating 25% random variation). The model also included a 0/1 indicator variable to reflect the savings from dryer fuel switching since projected dryer savings was often listed near zero (perhaps in watts and not kWh/year). The regression modeling found:

- Refrigeration measures saved about 76% of projected and were well correlated with measured savings. This result is closer to the 77% and 79% found in the first two evaluations than to the 89% found in the last evaluation.
- Lighting retrofits are estimated to save 60% of the projected savings, equal to 50 kWh per bulb – somewhat larger than the 41 kWh in the last study and the 43 kWh from the first study. The realization rate was fairly well determined with a 90% confidence interval ranging from 52% to 68% but the nature of the errors in variables model implies a greater uncertainty than reported.
- Clothes dryer fuel switching was estimated to save 944 kWh per dryer with a 90% confidence interval of  $\pm 189$  kWh. This value is consistent with the expected usage of a dryer used frequently. Given these electric savings, one might expect gas usage to increase by 30-45 therms per year.

We used these realization rates and savings estimates to calculate the measure impacts per installation and estimate the overall program savings by using population treatment installation rates. The differences between the analysis sample and full population were minor and resulted in a 3 kWh reduction in the net program savings to 1,556 kWh. Table 14 summarizes the results of this analysis.

**Table 14. High Use Program: Measure Savings and Adjusted Program Savings**

Measure	Realization Rate	Savings: kWh/Install		#/home	Savings per home
		Projected	Realized		
- Refrigerator Replacement	76%	1033	783	0.61	475
- Freezer Replacement	76%	715	542	0.21	114
<b>Refrigeration total</b>	76%	1,235	937	0.64	<b>597</b>
<b>Lighting</b>	60%	86/bulb	51	14.7	<b>749</b>
<b>Dryer Fuel Switch</b>	n/a	n/a	944	.08	<b>77</b>
<b>Other Measures + Education</b>				1	<b>133</b>
<b>Total</b>	69%				<b>1,556</b>

Refrigeration measures are estimated to save about 600 kWh per home – about 100 kWh less than the last study -- and lighting retrofits are estimated to save about 750 kWh per home – about 75 kWh more than the last study. Dryer fuel switching adds 77 kWh more savings per home while all other measures (including hot water and education) are estimated to save 133 kWh. Based on the participant population installation rates, we estimate that **the High Use program provided average annual savings of 1,556 kWh per participant**. This value is similar to the 1,615 kWh found in the prior evaluation.

### *C. Moderate Use Baseload Program Electric Impacts*

For the Moderate Use program, preliminary results revealed a problem with the planned evaluation approach. A fairly large proportion of comparison group customers had usage outside the target range of 4,000-6,000 kWh of baseload in their “pre-treatment” year, which was actually two years prior to treatment. Customers with low baseload usage two years prior to treatment almost certainly increased their usage or else they would not have qualified for the program. Similarly, those with high usage two years prior to treatment showed a sharp decline in the following year. In prior evaluations, this problem had more limited impact on results because it involved a smaller proportion of customers and the biases tended to cancel out in both directions. The current analysis suffered from a larger proportion of such customers with an overall bias toward savings (i.e., lower net savings). We addressed this problem by restricting the analysis to customers with pre-treatment annual baseload usage between 2,500 and 7,500 kWh (1,500 kWh wider in each direction than the target thresholds). These values were selected to avoid making the analysis sample too small and potentially unrepresentative while maintaining similar net savings to the more restrictive criteria of 4,000-6,000.

Table 15 shows the results of the usage analysis for the Moderate use baseload program using both the original planned analysis and with the restricted sample..

**Table 15. Moderate Use Baseload Program: Electric Savings Results**

Group	Average Usage & Gross Savings (kWh/yr)				Net of Weighted Comparison Group	
	# units	Pre-use	Post-use	Savings	Net Savings	Net % Savings
All Participants	2,532	6,588	5,943	644	423 (±73)	6.4% (±1.1%)
<b>Participants: restricted</b>	<b>2,257</b>	<b>6,252</b>	<b>5,641</b>	<b>611</b>	<b>566</b> <b>(±64)</b>	<b>9.0%</b> <b>(±1.0%)</b>
Comparison Group	1,965	5,876	5,909	-33		
Weighted Comparison	1,965	6,421	6,200	221		
Wtd. Comparison: restricted	1,785	6,076	6,031	45		

Note: “restricted” groups are limited to homes with pre-treatment annual baseload usage between 2,500 and 7,500 kWh. All ± figures are 90% statistical confidence intervals on the net savings. Weighted comparison group is matched on geography, building type, and pre-treatment usage categorized into 3 levels.

The restricted analysis sample shows average net savings of 566 kWh/yr for the Moderate Use program, equal to about 9% of pre-treatment usage. These savings represent a noticeable decline from the 697 kWh (11%) found in the last evaluation. The net savings using the original comparison group approach would have been just 423 kWh due to a large apparent savings in the comparison group due to targeting bias.

The current savings estimate of 566 kWh may still suffer from some of this bias because savings tends to be larger for customers with higher usage but many of these are removed from the analysis due to the need to reduce the comparison group bias. Another alternative analysis was attempted using a subset of later High Use program participants as the comparison group. This approach found net savings of 896 kWh, but most likely suffers from an opposite bias due to High Use program targeting. Essentially, we have been unable to identify a sound comparison group for higher use customers served by the Moderate Use program and so net savings estimates may be biased. The approach taken and presented here represents a best estimate.

Table 16 shows savings by usage component -- baseload, winter, and summer.

**Table 16. Moderate Use Program: Heating, Cooling, Baseload Savings**

Load Components	Average Usage & Gross Savings (kWh/yr)			Net of Weighted Comparison Group	
	Pre-use	Post-use	Savings	Net Savings	Net % Savings
Baseload	4,547	3,882	664	<b>440</b>	9.7%
Winter/Heating	1005	1047	-42	<b>56</b>	5.6%
Summer/Cooling	700	711	-11	<b>69</b>	9.9%

The majority of savings occurred in baseload and a fairly large baseload comparison group adjustment reduced savings considerably. Winter and summer usage both showed some small net savings due to comparison group adjustments.

### **Moderate Use Program: Usage and Savings Variations**

Similarly to the analysis of High Use participants, we explored the Moderate Use program savings based on a variety of treatment and housing characteristics including refrigerator and freezer measures and housing type. We also calculated savings for each utility service territory. These comparisons are summarized in Table 17.

**Table 17. Moderate Use Program: Savings Break-outs** (annual kWh with  $\pm 90\%$  conf. intervals)

Group	# Homes	Pre-use	Gross Savings	Net Savings	Net % Savings
<b>By Utility Territory:</b>					
AEP	237	6,685	480	337 ( $\pm 157$ )	5.0% ( $\pm 2.3\%$ )
Duke	168	6,872	719	492 ( $\pm 340$ )	7.2% ( $\pm 4.9\%$ )
CEI	878	6,068	656	617 ( $\pm 98$ )	10.2% ( $\pm 1.6\%$ )
DP&L	94	6,596	773	746 ( $\pm 235$ )	11.3% ( $\pm 3.6\%$ )
OE	816	6,173	531	535 ( $\pm 83$ )	8.7% ( $\pm 1.4\%$ )
TE	63	6,057	997	1,041 ( $\pm 267$ )	17.2% ( $\pm 4.4\%$ )
<b>By Refrigerator Measures:</b>					
Any Refrigeration Measure	1,384	6,229	796	869 ( $\pm 71$ )	12.0% ( $\pm 1.1\%$ )
- single refrigerator replaced	985	6,154	739	723 ( $\pm 91$ )	11.7% ( $\pm 1.5\%$ )
- single freezer replaced	132	6,371	721	596 ( $\pm 214$ )	9.4% ( $\pm 3.4\%$ )
- 2+ appliances replaced	267	6,435	1,045	913 ( $\pm 157$ )	14.2% ( $\pm 2.4\%$ )
No Refrigeration Measure	784	6,277	306	279 ( $\pm 102$ )	4.4% ( $\pm 1.6\%$ )
<b>By Housing Type:</b>					
Single Family Home	1,474	6,283	620	544 ( $\pm 94$ )	8.7% ( $\pm 1.5\%$ )
Mobile Home	110	6,539	461	484 ( $\pm 369$ )	7.4% ( $\pm 5.6\%$ )
Apartment	602	6,139	636	677 ( $\pm 151$ )	11.0% ( $\pm 2.5\%$ )

Most of the Moderate Use participants were in the Cleveland Electric Illuminating (CEI) and Ohio Edison (OE) service territories. Savings appeared to be largest in the Toledo Edison (TE) territory and lowest in the AEP territory. Homes that received refrigeration measures saved much more than those that did not. The 279 kWh net savings for the 784 homes that did not receive refrigeration measures seems fairly low considering that these homes received an average of 9.7 light bulbs each. In the previous evaluation, the no-refrigerator group had similar net savings of 342 kWh. This lower savings per bulb than found in the High Use program makes sense since customers with lower usage can be expected to have fewer high use lights. In terms of housing type, apartments had the highest net savings, as found in the prior evaluation.

### Moderate Use: Projected Savings & Measure Savings Analysis

The net electric savings of 566 kWh equal 41% of the average 1,368 kWh projected for those customers. This realization rate is slightly lower than the 46% found in the last study. Refrigeration savings were projected at 604 kWh and lighting savings at 691 kWh with all other savings totaling 73 kWh. If the savings realization rate were the same as the High Use program - 76% for refrigerators and 60% for lighting -- then net savings from lighting and refrigeration alone should have totaled 874 kWh. As in prior evaluations, the realization rates for one or both measures are lower in the Moderate Use program.

A regression analysis estimated a 56% realization rate for refrigerator savings (vs. 61% in the prior study and 76% in the current High Use analysis) and a poorly determined 17% realization rate for lighting. If the refrigerator savings realization rate is 56%, then 339 kWh of the total 566 kWh net savings in the analysis sample is attributable to refrigeration measures, leaving 217 kWh for lighting and all other measures (including education), or a 28% realization rate for the remaining savings.

In order to estimate savings for the full population of 4,279 participants served by the Moderate Use program in PY06, we used the 56% realization rate for refrigeration measures and this 28% rate for lighting and other measures. The results of this analysis are shown in Table 18.

**Table 18. Moderate Use Program: Measure Savings and Adjusted Program Savings**

Measure	Realization Rate	Savings: kWh/Install		#/home	Avg. kWh per home
		Projected	Realized		
<b>Refrigeration Measures</b>	56%	1012	568	0.61	<b>347</b>
<b>Lighting</b>	28%	77/bulb	22	9.4	<b>208</b>
<b>Other Measures + Education</b>	28%	87	24	1	<b>24</b>
<b>Total</b>	41%				<b>579</b>

Based on installation data for the Moderate Use program PY06 population, **the net program savings are estimated at 579 kWh per participant.** These savings are slightly larger than the analysis sample savings because the analysis sample participants received slightly fewer measures. This result is considered the best estimate of program savings.

#### *D. TEE Program Electric Impacts*

The TEE program completed 607 units in PY06. There was sufficient usage data to evaluate 328 of these units. A large proportion of the units (43%) did not have any weatherization treatments listed in the tracking system.

Table 19 shows the results of the usage analysis for the TEE program.

**Table 19. TEE Program: Electric Savings Results**

Group	Average Usage & Gross Savings (kWh/yr)				Net of Weighted Comparison Group	
	# units	Pre-use	Post-use	Savings	Net Savings	Net % Savings
<b>Participants</b>	<b>328</b>	<b>28,615</b>	25,235	<b>3,380</b>	<b>3,995</b> <b>(±653)</b>	<b>14.0%</b> <b>(±2.3%)</b>
Comparison Group	257	29,539	29,899	-360		
<b>Weighted Comparison</b>	<b>204</b>	<b>30,045</b>	<b>30,660</b>	<b>-615</b>		

Notes: ± figures are 90% confidence intervals on the net savings. Net savings are based on a weighted comparison group matched to the participant sample on 3 factors: location (weather station), housing type (site built, mobile home or multifamily), and pre-treatment total usage (in 5 bins).

TEE is estimated to provide net savings of 3,995 kWh/yr, equal to 14% of pre-treatment usage. These savings are noticeably larger than the 3,151 kWh and 11% found in the previous evaluation although a substantial portion of the difference is related to the comparison group adjustment reflecting about a 2% increase in usage. The savings compare well to the limited weatherization evaluations of electrically heated homes available. Table 20 shows a break-out of the savings for the baseload, winter, and summer components of usage.

**Table 20. TEE Program: Heating, Cooling, Baseload Savings**

Load Components	Average Usage & Gross Savings (kWh/yr)			Net of Weighted Comparison Group	
	Pre-use	Post-use	Savings	Net Savings	Net % Savings
Baseload	12,700	11,849	850	<b>1,512</b>	11.9%
Winter/Heating	14,476	12,199	2,277	<b>2,312</b>	16.0%
Summer/Cooling	1,440	1,187	253	<b>171</b>	11.8%

The winter/heating savings are estimated at 2,312 kWh equal to 16% of pre-treatment use. These results are substantially greater than the 1,782 kWh and 12% savings found in the prior evaluation.

The TEE analysis sample is too small to provide many useful break-outs. But we managed to identify a few useful findings:

- “no weatherization” TEE homes : savings for the 142 homes with no listed weatherization measures averaged 3,488 kWh total and 2,218 kWh in winter/heating load, implying that the homes did in fact receive weatherization but the services were most likely provided by another funding source (e.g., HWAP or a utility program).
- Two providers served all of the homes in the analysis: COAD treated 297 units and HWDMC treated 31. Unlike prior evaluations, the savings appear to be substantially greater for COAD, but the HWDMC sample size is very small.

- **Housing Type:** Net savings were about the same in site built and mobile homes with mobile homes actually saving slightly more – 4,178 kWh (14.8%) vs. 3,748 (12.9%) for site built. Mobile home savings increased substantially from the last study where savings were just 2,505 kWh and 9% .

Given the likelihood that program treatments were provided by other funding sources and not recorded in the program tracking system, we were unable to explore the savings in any greater detail or develop any way to adjust for installation differences between the population and the analysis sample.

### *E. EPP Savings Results by Provider*

Electricity savings varied between providers for the High Use and Moderate Use programs. Differences in average savings between providers do not necessarily reflect differences in the quality of the treatments or education but will also be related to differences in the opportunities available in the local housing stock. Homes with high refrigeration and lighting loads often provide greater savings opportunities while houses that only qualify as high usage due to the presence of electric water heating tend to provide lower savings.

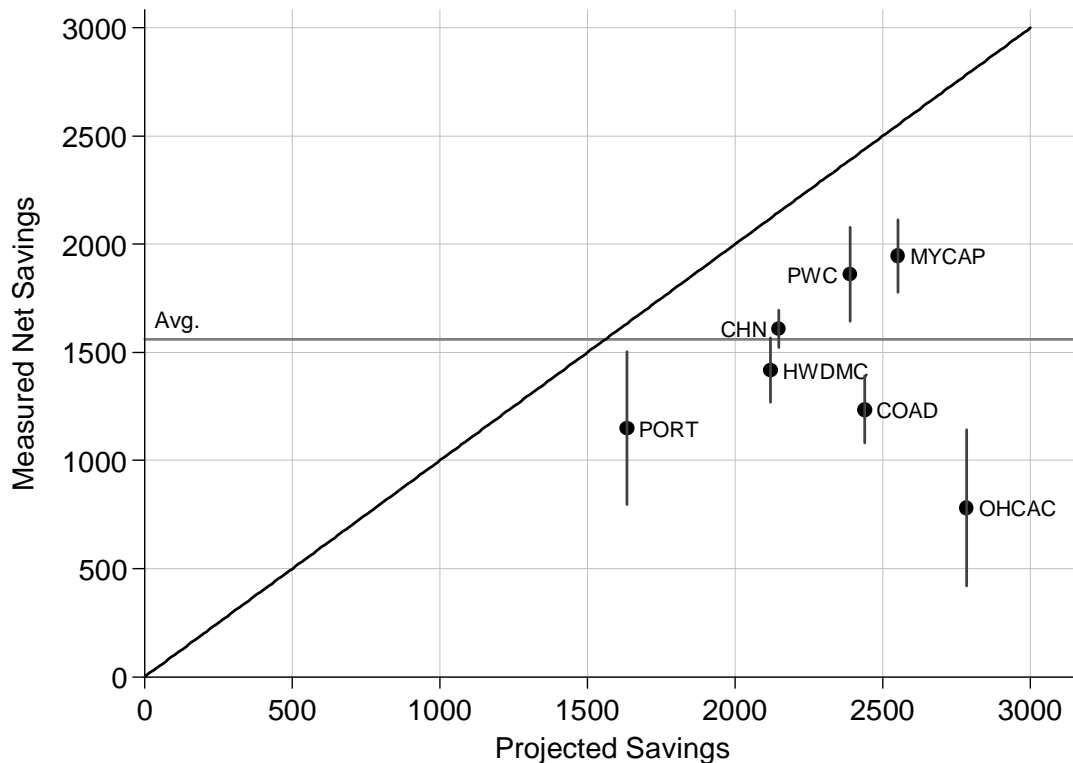
Table 21 shows the savings results by provider for the High Use program along with information on spending per home and a rough measure of cost effectiveness expressed as kWh saved per dollar spent.

**Table 21. High Use Program: Results by Provider**

<b>Provider</b>	<b># Homes</b>	<b>Pre-use</b>	<b>Gross Savings</b>	<b>Net Savings</b>	<b>Net % Savings</b>	<b>Cost \$/home</b>	<b>Annual kWh per \$ spent</b>
CHN	3,431	11,929	1,531	1,608 (±87)	13.5% (±0.7%)	\$1,019	1.58
COAD	1,250	16,065	1,311	1,236 (±156)	7.7% (±1.0%)	\$801	1.54
HWDMC	859	14,004	1,377	1,418 (±148)	10.1% (±1.1%)	\$999	1.42
MYCAP	440	11,403	1,762	1,947 (±168)	17.1% (±1.5%)	\$1,026	1.90
OHCAC	125	12,888	736	782 (±360)	6.1% (±2.8%)	\$1,018	0.77
PORT	119	14,018	1,063	1,149 (±353)	8.2% (±2.5%)	\$731	1.57
PWC	1,079	14,646	1,883	1,862 (±217)	12.7% (±1.5%)	\$1,020	1.82

Among High Use program providers, MYCAP had the highest average savings at 1,947 kWh/yr with PWC close by at 1,862 kWh. The lowest savings were 782 kWh/yr for OHCAC although the sample size is fairly small. Program costs did not vary as widely as in past evaluations and ranged from \$731 to \$1,026 per home. The last column in the table shows that MYCAP and PWC produced the most kWh savings per dollar spent at 1.90 and 1.82 kWh/\$. OHCAC seemed to produce the lowest savings per dollar at 0.77 kWh/\$. The overall analysis sample produced 1.60 kWh in annual savings per dollar spent --savings of 1,559 kWh at a cost of \$975.

Figure 5 shows the net savings by agency plotted against the audit-projected savings recorded in SMOC~ERS. The diagonal line shows perfect agreement between the two values. The vertical spikes through each point show the uncertainty in the net savings estimate (90% confidence interval). A reference line is shown at the average net savings for the analysis group of 1,559 kWh.



**Figure 5. Measured vs. Projected Savings by Provider: High Use Program**

The graph illustrates the fact that PWC and MYCAP were the only providers with net savings that are statistically significantly higher than the overall statewide average (their spikes are fully above the line showing the average) while there are a few providers with lower savings than the average.

The graph also shows that, although there is some relationship between projected and measured savings for most agencies, the realization rates vary widely. OHCAC projected the highest savings of all agencies yet achieved the lowest savings – yielding a realization rate of 28% (782 kWh saved out of 2,785 kWh projected). PWC, MYCAP and CHN all had realization rates between 74% and 78%.

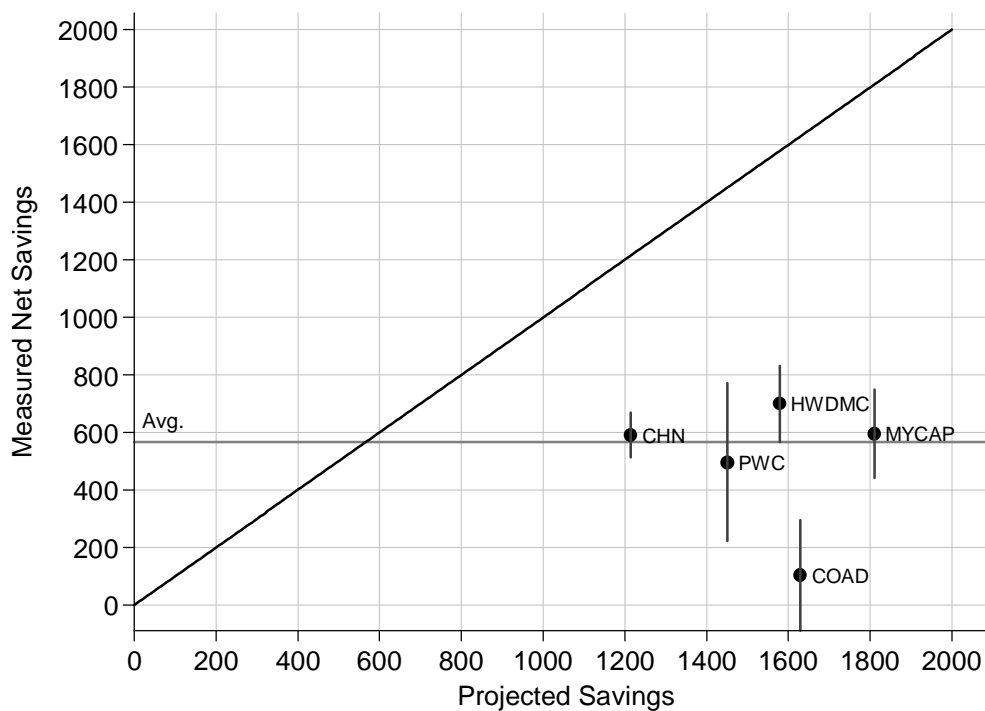
Table 22 shows the net savings results for the Moderate Use program. Providers with fewer than 50 homes in the analysis are not shown.

**Table 22. Moderate Use Program: Savings by Provider**

Provider	# Homes	Gross		Net Savings	Net % Savings	Cost \$/home	Annual kWh per \$ spent
		Pre-use	Savings				
CHN	1,426	6,103	602	590 (±78)	9.7% (±1.3%)	\$748	0.79
COAD	137	6,891	296	104 (±192)	1.5% (±2.8%)	\$553	0.19
HWDMC	260	6,524	740	699 (±133)	10.7% (±2.0%)	\$796	0.88
MYCAP	199	5,958	657	595 (±154)	10.0% (±2.6%)	\$809	0.74
PWC	167	6,838	718	496 (±274)	7.3% (±4.0%)	\$707	0.70

Moderate Use provider savings ranged from 104 kWh to 699 kWh. HWDMC produced the highest savings and COAD produced the lowest. The Moderate Use program produced less than half the savings per dollar spent as the High Use program.

Figure 6 graphs the net savings by provider against the projected savings for the Moderate Use program. The realization rates are clearly much lower than were found in the High Use program as the data points for each agency are much further below the line of agreement. CHN had the largest realization rate at 49% closely followed by HWDMC at 44%. The realization rate was just 6% for COAD and their savings are not statistically different from zero.

**Figure 6. Measured vs. Projected Savings by Provider: Moderate Use Program**

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## V. Bill Payment Impacts

One of the major justifications for funding EPP through the Universal Service Fund rider is that it will provide cost effective savings for ratepayers by reducing the cost of PIPP. Prior evaluations analyzed the full retail bills and the customer and fuel assistance payments of participants and a comparison group of future participants in order to assess what proportion of program electric savings accrue to ratepayers versus to the customers. The analysis was needed because PIPP customers were responsible for paying their full bills in the summer. The findings were generally consistent with this split.

In November 2010, PIPP rules are changing so that customers pay their PIPP amount all year. Therefore, although one could assess payment impacts for the first year or so of savings from EPP PY 2006, all savings after the PIPP rule change will accrue to ratepayers. Since most of the lifetime bill savings from EPP PY06 treatments are still to occur, it makes little sense to try to allocate the small portion that will have accrued prior to the change in PIPP. The vast majority (more than 90%) of PY06 bill savings will accrue to ratepayers and essentially all future EPP savings will accrue entirely to ratepayers.

## VI. Environmental Impacts

In addition to the direct value of the electricity savings and associated changes in PIPP operating costs and customers' pocketbooks, the savings from EPP reduce emissions and other environmental impacts caused by power generation and distribution.

We used utility emission coefficients developed from EPA data for 2000 through 2002 (primarily relying on their eGRID2002 database) and aggregated on a statewide basis (see "Emission Factors and Energy Prices for the Cleaner and Greener Environmental Program", Leonardo Academy, Madison, WI 2004).

We applied the emissions coefficients to the best estimates of measured savings for each program and summarize the results in Table 23.

**Table 23. Environmental Impacts of EPP**

	<b>CO2</b>	<b>NOx</b>	<b>SOx</b>	<b>PM-10</b>
<b>Emission Factor: pounds per kWh</b>	2.1	0.005834	0.01881	0.000236
<b>Annual Impacts: per participant</b>	lbs.	lbs.	lbs.	lbs.
High Use Program	3,268	9.1	29.3	0.37
Moderate Use Program	1,216	3.4	10.9	0.14
TEE Program	8,390	23.3	75.1	0.94
<b>Annual Impacts: program</b>	tons	lbs.	lbs.	lbs.
High Use Program (n=12,956)	21,168	117,611	379,201	4,758
Moderate Use Program (n=4,279)	2,601	14,454	46,603	585
TEE Program (n=607)	2,546	14,147	45,614	572
<b>Program Lifetime Impacts</b>	tons	lbs.	lbs.	lbs.
High Use Program (n=12,956)	221,715	1,231,889	3,971,861	49,833
Moderate Use Program (n=4,279)	31,006	172,274	555,448	6,969
TEE Program (n=607)	41,925	232,946	751,065	9,423
<b>Total</b>	<b>294,646</b>	<b>1,637,110</b>	<b>5,278,373</b>	<b>66,225</b>

The table shows that EPP is estimated to reduce CO2 emissions by nearly 300,000 tons over the life of the measures and provide reductions of more than 1.6 million pounds of NOx, 5.3 million pounds of SOx and about 66,000 pounds of PM-10 particulates. The reductions in NOx and CO2 are equivalent to removing about 4,000 cars from the road for the life of the measures.

## VII. Cost Effectiveness

We assessed the cost effectiveness of the EPP programs using a life cycle cost analysis approach. The steps in the analysis included:

- calculate the annual total value of the energy savings using the usage reductions from the impact analysis multiplied by a savings-weighted average of the utility retail rates (using values from the Public Utility Commission of Ohio web site) ;
- estimate the life of the savings by taking a savings-weighted average for the refrigerator (assumed at 15 years), lighting (7 years), TEE weatherization (20 years) and 10 years for “other” savings – primarily dryers;
- calculate the lifetime energy benefits as the present value of the electric bill savings using a discount rate of 5% to reflect the time value of money and assuming constant electric rates for the life of the measures (likely understating the value of future savings);
- for program costs, include all costs paid to the local providers to perform the work including the per job audit and administrative fees but do not include any administrative costs incurred by OCS or any weatherization costs incurred by other programs (which are unknown);
- calculate the net value as the lifetime energy savings benefits minus the program costs
- calculate the savings to investment ratio as the ratio of the lifetime energy savings benefits to the program costs.

We also calculated the cost-effectiveness of refrigeration and lighting measures for the High Use program based on our analysis of measure savings and the measure installation costs. The results of the analysis are summarized in Table 24.

**Table 24. Cost Effectiveness Analysis**

	Program Cost	Savings kWh	Annual Bill Savings	Lifetime Energy Benefits	Net Benefit	Savings– Investment Ratio
<b>High Use Program (per home)</b>	<b>\$975</b>	<b>1,556</b>	<b>\$155</b>	<b>\$1,243</b>	<b>\$268</b>	<b>1.27</b>
Refrigeration Measures	\$471	597	\$60	\$618	\$147	1.31
Lighting	\$191	749	\$75	\$433	\$242	2.26
<b>Moderate Use Program</b>	<b>\$758</b>	<b>579</b>	<b>\$62</b>	<b>\$546</b>	<b>-\$212</b>	<b>0.72</b>
<b>TEE Program (excl other funders)</b>	<b>\$1,817</b>	<b>3,995</b>	<b>\$340</b>	<b>\$3,755</b>	<b>\$1,938</b>	<b>2.07</b>

The High Use program continues to produce cost-effective energy savings as it has in all prior evaluations. The present value of the lifetime energy savings is greater than the cost of the program treatments. The SIR has declined from 1.5 in the prior evaluation due to a small reduction in savings accompanied by a small increase in costs.

The Moderate Use program does not appear to be cost-effective based on energy savings alone. In the prior evaluation the SIR was 0.87 but program managers believed that some combination of larger savings or lower costs could make it a cost effective program component. Although there is some added uncertainty in the evaluation results, it appears that the Moderate Use program has not met those goals and either needs significant changes to costs and/or savings or should be discontinued.

The TEE program appears to be very cost-effective but that result should not be considered very reliable since costs were expended by other programs that are not accounted for in this analysis.

In terms of specific measures within the High Use program, refrigeration and lighting measures are both still cost-effective. Refrigeration measure cost-effectiveness has drop from 1.98 in the last evaluation to 1.31 as costs have increased and savings declined. Lighting savings are much more cost-effective than the last evaluation which had an SIR of 1.45. This change is the result of lower costs per bulb and better targeting of bulbs to high savings opportunities.

In terms of simple payback time (cost divided by annual bill savings), the High Use program has a 6.3 year payback, the TEE program has a 5.3 year payback (excluding other funders), and the Moderate Use program has a 12.2 year payback.

All three programs may be more cost-effective than shown if electric rates increase in the future.

One factor not included in the cost effectiveness analysis was the impact of fuel switching of dryers to gas on gas costs. Gas bills should increase by about \$35-\$50 per year per dryer. These costs will mostly likely be born by the gas utility ratepayers (assuming gas PIPP participation). If these costs are included in the analysis, then the SIR for the High Use program might decline from 1.27 to about 1.25. Based on reported measure costs, it does not appear that dryer fuel switching is a cost-effective measure unless local electric rates are very high compared to gas rates. The calculation for screening dryer fuel switching should be reviewed.

It is worth noting that this cost-effectiveness analysis does not include the value of any benefits beyond electric bill reductions. Non-energy benefits such as environmental emission reductions, economic development and job creation impacts, ancillary water savings (from low flow devices), etc. are all valued at zero in this analysis.

## VIII. Aggregate Impacts

This evaluation has primarily focused on assessing program impacts on a per participant basis. In this section, we compile the key findings and calculate aggregate impacts for the program year 2006 full participant population – the 12,956 High Use participants, 4,279 Moderate Use participants, and 607 TEE participants. The results of these calculations are summarized in Table 25.

**Table 25. EPP Aggregate Impact Summary PY 2006**

	High Use		Moderate Use		TEE		Total Program
	Per Home	Program	Per Home	Program	Per Home	Program	
<b># Participants</b>		12,956		4,279		607	17,842
<b>Program Cost</b>	\$975	\$12,632,100	\$758	\$3,243,482	\$1,817	\$1,102,919	\$16,978,501
<b>Electric Savings: kWh/yr</b>	1556	20,159,536	579	2,477,541	3995	2,424,965	25,062,042
<b>Annual Retail Bill Reduction</b>	\$155	\$2,011,922	\$62	\$264,849	\$340	\$206,365	\$2,483,135
<b>Lifetime Bill Reductions PV</b>	\$1,243	\$16,100,608	\$546	\$2,335,720	\$3,755	\$2,279,017	\$20,715,346
<b>Net Savings \$</b>	\$268	\$3,468,508	-\$212	-\$907,762	\$1,938	\$1,176,098	\$3,736,845
<b>Savings to investment Ratio</b>	1.27	1.27	0.72	0.72	2.07	2.07	1.22
<b>Annual Emission Impacts:</b>							
<b>CO2 (tons/yr.)</b>	1.63	21,168	0.61	2,601	4.19	2,546	26,315
<b>NOx (lbs./yr.)</b>	9.1	117,611	3.4	14,454	23.3	14,147	146,212
<b>SOx (lbs./yr.)</b>	29.3	379,201	10.9	46,603	75.1	45,614	471,417
<b>PM-10 (lbs./yr.)</b>	0.37	4,758	0.14	585	0.94	572	5,915

The 17,842 homes served by EPP in PY 06 are saving about 25 million kWh per year leading to annual retail electric bill reductions totaling about \$2.5 million. The present value of these bill savings over the life of the measures is about \$20.7 million. The costs to treat these homes totaled \$17 million, yielding \$3.7 million in net benefits to ratepayers and providing a savings to investment ratio of 1.22.

In addition to providing these financial benefits, the program is estimated to provide annual reductions in pollutant emissions totaling more than 26,000 tons of CO<sub>2</sub>, more than 146,000 pounds of NO<sub>x</sub>, more than 471,000 pounds of SO<sub>x</sub> and more than 5,900 pounds of PM-10 particulates. These impacts are equivalent to about 4,600 average cars of CO<sub>2</sub> emissions and 3,800 cars of NO<sub>x</sub> emissions annually.