Ohio Electric Partnership Program Impact Evaluation

Results for April 2004 – March 2005 Participants

Final Report

Prepared for the Ohio Office of Energy Efficiency

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prepared by: Michael Blasnik
Michael Blasnik & Associates · 150 Poplar St. #2 · Boston, MA 02131 · michael.blasnik@verizon.net

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Executive Summary

This report presents the findings from the third energy savings impact evaluation of the Ohio Electric Partnership Program (EPP). EPP was created under Senate Bill 3 the Ohio Electric Restructuring Act, 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 serves electric PIPP 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 (non heating/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 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 customers in November 2001 and has evolved over time. The Moderate Use baseload program began in February 2003 and the usage thresholds for the High Use and TEE programs were both changed from 8,000 kWh to the current 6,000 kWh in July 2003 to further expand the pool of eligible households. The program has served more than 40,000 PIPP customers to date.

The first energy impact evaluation of the program, completed in September 2004[1], found net savings of 1,775 kWh per High Use participant and 1,122 kWh per Moderate Use participant (based on part year data). The study concluded that the program was cost-effective – the net present value of the bill reductions was 34% greater than the cost of the program. A bill payment analysis found that ratepayers received about 60% of the savings through reduced PIPP shortfalls while participants receive the other 40% through reduced summer bills.

The second impact evaluation was completed in June 2005 and focused on homes treated from January 2003 through March 2004. That evaluation found net savings of 1,750 kWh for the High Use program, 772 kWh for the moderate use program, and 2,913 kWh for the TEE program. Cost/Benefit analysis found that EPP was cost-effective with an overall savings-to-

[1] *Ohio Electric Partnership Program Impact Evaluation: Final Report*, M. Blasnik & Associates, September 8, 2004.

investment ratio of 1.20. The High Use program had an SIR of 1.32 while the Moderate Use program had an SIR of 0.85, indicating that it was not cost-effective.

OEE has continued to work on improving the cost effectiveness of EPP through increasing savings and reducing program costs. These efforts have been guided by program monitoring and evaluation.

Methodology and Data Collection

In this evaluation, the impacts of the three program components were assessed for participants served from April 2004 through March 2005. Comparison groups for statistical analysis were formed from customers who participated in EPP after March 2005.

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

Program Production and Participation

From April 2004 through March 2005, EPP served 10,184 PIPP customers – 7,614 High Use, 2,187 Moderate Use, and 383 TEE. First Energy provided electricity to 51% of EPP customers, American Electric Power served 38%, Cinergy served 4% and Dayton Power & Light served 7%. About two thirds of participants lived in single family site built homes, 11% lived in mobile homes, and 18% lived in apartments. TEE treated more mobile homes (47%) while the Moderate Use program served the greatest proportion of apartments (30%). 55% of EPP customers were homeowners

Among High Use participants, 43% had separate freezers, 12% had secondary refrigerators, 25% had electric hot water, 26% had central air conditioning, 32% used electric space heaters, 14% 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 16 light bulbs, 0.58 refrigerators and 0.20 freezers per home. The Moderate Use program replaced an average of 12 light bulbs, 0.58 refrigerators, 0.11 freezers per participant. These installation rates are somewhat lower than in the previous impact study and may reflect better targeting of measures. The program has started to show more success in convincing participants with secondary refrigerators to give up these appliances with removal rates increasing to 12% compared to 7% in the prior year. Removal of separate freezers has not improved and remains at about 2%.

Direct program costs averaged $879 per High Use participant and $726 per Moderate Use participant which are 17% lower and 12% lower than in the prior impact study, respectively. TEE spending averaged $2,203 per home, more than 20% larger than in the prior study due to increased weatherization treatments.

Data collected in the program tracking system indicated that lighting and refrigerator loads represent about 27% 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 73% of the load.

Electric Impacts

Electric Usage impact results are summarized in Table 1.

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

Program	# homes	Pre-use	Net Savings (sample)	Net % Savings	Program Net Savings
High Use Program	4,789	13,525	**1,650**	12.2%	**1,615**
Moderate Use Program	1,355	6,468	**697**	10.8%	**697**
TEE	238	29,364	**3,151**	10.7%	**3,151**

The High Use program produced average annual net savings of 1,650 kWh in the 4,789 homes in the analysis, equal to 12% of pre-treatment usage. The overall program savings are estimated at 1,615 due to small differences in the frequency of measure installations between the sample and the population. These savings are a little lower than the 1,750 kWh found in the last evaluation and are consistent with the reduced number of measures installed.

The Moderate Use program produced average annual net savings of 697 kWh, equal to 11% of pre-treatment usage. These savings are a little lower than the 772 kWh found in the last study.

The TEE program produced average net savings of 3,151 kWh, equal to about 11% of pre-treatment usage and slightly higher than the 2,913 kWh found in the last study.

The overall savings in the High Use program were equal to about 77% 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 89% of the savings expected based on the audit's short-term metering. This result is a little higher than prior studies.
- Lighting savings were about 55% of the savings projected based on reported wattages and hours of use and averaged 41 kWh per bulb installed and 677 kWh per home (based on 18 bulbs). This result is higher than the earlier study which found just 45% of projected savings. The largest factor responsible for the remaining savings discrepancy is likely an over-estimation of hours of bulb use.

The Moderate Use program analysis found overall savings equal to 46% of audit projections -- 61% of projected for refrigerators and perhaps 36% of projected for light bulbs. These savings shortfalls should be further explored, perhaps through some field inspections.

Bill Payment Impacts

The analysis of bill payment impacts found that approximately 89% of bill savings in the High Use program accrued to ratepayers as a reduction in the costs of PIPP and 11% accrued to the participants (as reduced bills in the non-heating months when customers are responsible for their regular bills if they exceed the PIPP amount). These findings are very different from the 60%/40% split found in two prior evaluation. It is not clear why.

Cost Effectiveness, Environmental, and Aggregate Impacts

We 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: April 2004 through March 2005

	High Use		Moderate Use		TEE		
	Per Home	Program	Per Home	Program	Per Home	Program	Total Program
# Participants		7,614		2,187		383	10,184
Program Cost	$896	$6,822,144	$726	$1,587,762	$2,203	$843,749	$9,253,655
Electric Savings: kWh/yr	1615	12,296,610	697	1,524,339	3151	1,206,833	15,027,782
Annual Retail Bill Reduction	$161	$1,227,202	$75	$162,952	$268	$102,701	$1,492,855
Lifetime Bill Reductions PV	$1,345	$10,240,348	$635	$1,387,912	$2,808	$1,075,505	$12,703,765
-Ratepayer benefits	$1,197	$9,113,910	$539	$1,179,725	$2,583	$989,464	$11,283,099
-PIPP Customer benefits	$148	$1,126,438	$95	$208,187	$225	$86,040	$1,420,665
Net Savings $	$449	**$3,418,204**	-$91	**-$199,850**	$605	**$231,756**	**$3,450,110**
Savings to investment Ratio - overall	1.50	**1.50**	0.87	**0.87**	1.27	**1.27**	**1.37**
Annual Emission Impacts:							
CO2 (tons/yr.)	1.70	12,911	0.73	1,601	3.31	1,267	15,779
NOx (lbs./yr.)	9.4	71,738	4.1	8,893	18.4	7,041	87,672
SOx (lbs./yr.)	30.4	231,299	13.1	28,673	59.3	22,701	282,673
PM-10 (lbs./yr.)	0.38	2,902	0.16	360	0.74	285	3,547

The table shows that the High Use and TEE programs are cost-effective -- the present value of the lifetime energy savings exceeds the program costs. For the High Use program, the net benefits are $3.4 million and the savings to investment ratio (SIR) is 1.50. For TEE, the SIR is 1.37, but this figure may be overstated due to some costs being absorbed by other programs (e.g., HWAP). The Moderate Use program appears to be not cost-effective with an SIR of 0.87, a small improvement over the 0.85 found in the previous study. For the 10,184 participants in EPP in the analysis timeframe, the present value of the energy savings are worth $12.7 million, more than the $9.3 million in program treatment costs, yielding an overall SIR of 1.37.

The $12.7 million in lifetime bill savings are estimated to reduce the cost of PIPP by $11.3 million and provide $1.4 million in out of pocket savings to the participants.

The estimated pollutant emission reductions from the program are a substantial added benefit. Annual reductions are estimated at 16,000 tons of CO2, more than 80,000 pounds of NOx and more than 280,000 pounds of SOx. These reductions are equivalent to 2,800 average cars of CO2 emissions and 2,300 cars of NOx 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 households each year. OEE has achieved on-going improvements in program cost-effectiveness through a combination of treatment cost reductions and better targeting of measures for the High Use Program. The Moderate Use program may need further refinements to improve cost-effectiveness and most likely will require further reductions in program costs and more selective installation of measures.

I. Introduction

This report presents the findings from the 3rd Impact Evaluation of the Electric Partnership Program. The prior impact evaluations assessed electric savings for participants treated through March 2004. In this evaluation, we have focused on exploring any differences from the prior studies and trends on the participant population and program treatments. We have also examined the persistence of savings for participants treated earlier.

The primary analysis involved assessing electric savings and payment impacts for EPP customers treated from April 2004 through March 2005. We developed comparison groups for each program using later-treated customers by analyzing changes in their energy usage in the period prior to actual treatment.

A. Background

EPP was created under Senate Bill 3 the Ohio Electric Restructuring Act, 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 utility electric customers. The program began in late 2001.

Ohio PIPP

PIPP is a special utility payment arrangement that allows low income (<150% of poverty) customers to maintain their service if they pay a fixed proportion of their income. For electric PIPP without electric heat, most household pay 5% of their income. Households with income below 50% of the poverty level pay 3% of their income. Households with electric heat pay 15% of their income. The electric PIPP amounts only apply to winter months (November 1 through April 15). In the remainder of the year, electric PIPP customers must pay their full bill if it is greater than the regular PIPP payment. PIPP is not a payment forgiveness program, but instead adds any difference between the PIPP payment and the full bill to the customer's arrearage. These arrears are deferred, but are supposed to be paid by the customer if they leave PIPP either voluntarily or become income ineligible. Some mechanisms exist for customer arrearage forgiveness and crediting. The utility companies are made whole for the PIPP arrearages each month using funds from the USF rider, which flow through the Ohio Office of Community Services (OCS). In 2000, there were approximately 150,000 electric PIPP customers and the program required ratepayer subsidies of about $70 million. By 2004, the program grew to about 200,000 customers.

B. Electric Partnership Program Design

EPP funding began in July 2001. The program 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, originally defined as greater than 8,000 kWh/yr., changed to 6,000 kWh/yr in July 2003. Measures include extensive lighting retrofits, replacement of inefficient refrigerators and freezers, electric hot water reduction measures, some other miscellaneous measures, and energy education;
- Moderate Use Baseload: started in 2003, 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.
- TEE: targeted toward PIPP customers with moderate or high electric heating and/or cooling loads (originally defined as greater than 8,000 kWh/yr., changed to 6,000 kWh in July 2003) that provides the same measures as the baseload program and also provides weatherization of the building shell including measures such as insulation and air sealing.

Customers are selected and recruited based on an OEE analysis of PIPP customer electric usage data provided by the utilities to OCS. Program treatments began in November 2001.

EPP Providers

EPP was designed to be implemented through a network of local providers throughout the State. The 9 current providers have been selected through an RFP process for multiple contracting periods. Several of the providers subcontract with local community action agencies and other low income energy service providers. One lead provider is a for profit company, Honeywell.

Treatment Approach and SMOC~ERS Software

EPP employs a computerized field audit called 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 and invoicing functions.

The overall treatment approach involves the following steps:

- Local providers recruit PIPP customers from target lists sent by OEE 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 all 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). The results from this metering are entered into SMOC~ERS to estimate annual usage.
- The appliance inventory is used by the software to calculate the total projected electric use by season and overall for High Use and TEE homes. These values are compared 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. The calculation is based on the projected energy savings

from the measure, the local utility rates, and the life of the savings using a net present value approach.

- In addition to the refrigerator and freezer replacements (and occasional removals) and lighting and hot water retrofits, the program provided mattress pads for waterbeds (whose heaters can cause high use), and the capabilities to perform custom measures (e.g., well pump repairs or replacements) and fuel switching of electric water heaters and dryers.
- Once cost-effective measures have been identified, the auditor can then proceed to install measures such as compact fluorescent light bulbs and electric hot water measures (e.g., showerheads, aerators, tank wraps, tank temperature turn downs, etc.). Refrigerator or freezer replacements need to be ordered and the replacement is performed on a separate visit, typically by a sub-contracted refrigerator provider.
- The data on end use wattage and hours is also used to identify the potential savings from actions that the customer could take to reduce their usage. For example, they could dry laundry on a clothes line in the summer or turn off televisions that are left on when no one is watching. The energy auditor is supposed to identify a few actions in each home that the customer agrees to do and that can produce significant savings. A key component of the program design is to work with the customer to identify energy savings actions that they commit to undertake.
- 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.

In theory, the computerized approach makes sense. In practice, there have been many challenges. In addition to early hardware and software problems, the detailed end use analysis can be tedious and may sometimes shift the focus away from the energy education and major treatments. OEE has worked to streamline the process and maximize the utility of the software as a field tool.

C. Evaluation

OEE commissioned a comprehensive multi-year evaluation of EPP at the time of program inception including impact, process, and technical evaluations. Those evaluation activities concluded in June 2005. This impact evaluation is part of an on-going feedback loop that OEE is using to help continuously assess and improve EPP.

II. Methodology and Data

This section briefly describes the data sources and evaluation methods employed in this evaluation. 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 first step in the usage data analysis is to produce "clean" usage data histories based on actual meter readings. The data are then classified into pre-treatment and post-treatment periods based on the dates that program treatments began and ended according to the program tracking data. The next step in the analysis is to adjust the actual usage to a typical-year basis.

We employed a heating and cooling degree day adjustment procedure for analyzing the usage data. We performed a separate analysis for each home for the year before treatment and the year after treatment. We also performed an analysis for all calendar years for all participants to be used in the assessment of savings persistence.

We excluded cases 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 March 2005. The comparison group is used to reflect trends in usage unrelated to the program (e.g., people adding computers or other appliances). 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.

C. Payment Analysis

We focused our analysis of payment impacts on determining the proportion of the bills savings accruing to ratepayers vs. the customer. We analyzed customer payment data by defining specific 12 month pre and post treatment periods with calendar year 2003 defined as the pre-treatment period and 2005 as the post-treatment period. These definitions provide consistency for all cases and allow the analysis to evaluate participants treated in 2004 and use a comparison group from 2006 participants. We calculated the average monthly customer payment for the pre and post treatment periods for each customer. We estimated the full retail bills using average retail rates and the raw electric usage data for each period. We then subtracted the changes found in the comparison group from the changes in the treatment group to estimate the net changes in customer bills and payments.

III. Program Description and Characteristics

This section summarizes information about the program and it's 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 month from January 2003 through March 2006, broken out by program.

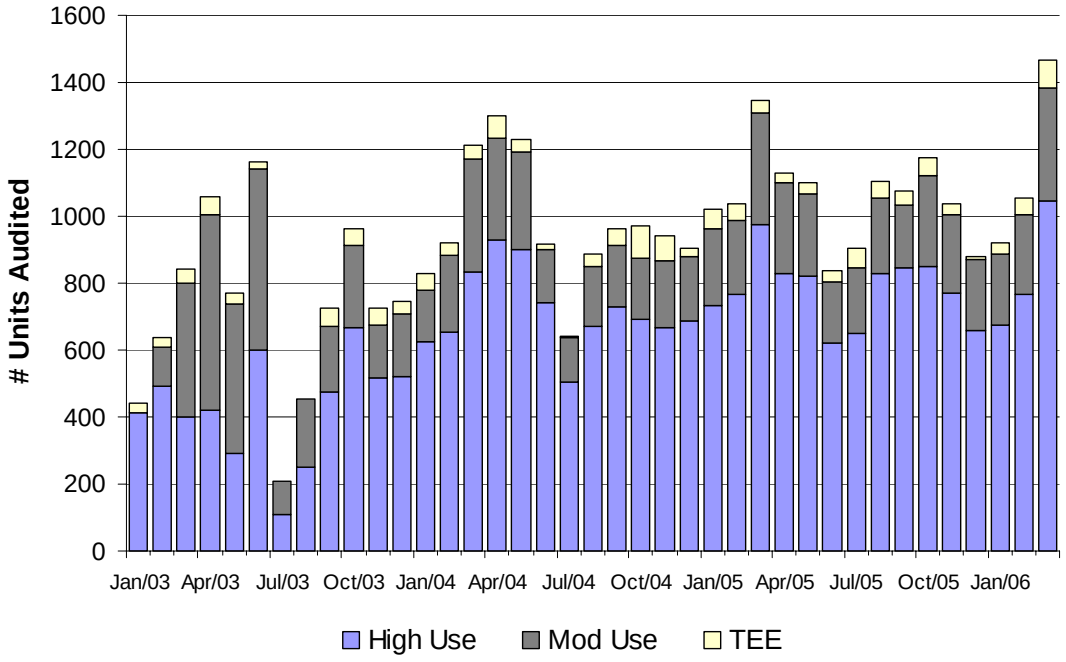

Figure 1. EPP Program Production by month and program

EPP production jumped in early 2003 when the Moderate Use program started, dropped off during the program year transitions in July 03 and July 04, and has stabilized at about 1,000 jobs per month, primarily in the High Use program.

Through mid 2006, EPP has treated more than 40,000 PIPP customers, including 30,000 High Use customers, about 10,000 Moderate Use customers, and about 2,000 TEE customers. The proportion of all eligible households served by EPP is difficult to assess because of the changing (and growing) enrollment in PIPP and widespread changes in account numbers, but it is likely that the program has served more than one third of the High Use population, more than one quarter of the Moderate Use population, and perhaps one sixth of the TEE population.

Table 3 shows EPP production by program component and utility service territory for the 10,184 homes treated in the evaluation target period of April 2004 through March 2005.

Table 3. EPP Production by Program and Utility (April 2004 – March 2005)

	AEP	CG&E	CEI	DP&L	OE	TE	Total
High Use Baseload	3,100	322	1,596	582	1,580	422	7,614
TEE – Weatherization	315	15	2	23	24	2	383
Moderate Use	447	89	794	125	600	130	2,187
Total	3,862	426	2,392	730	2,204	554	10,184

AEP served the largest proportion of High Use participants and nearly all TEE participants. Moderate Use customers were primarily in the CEI and OE territories. Note that 14 Allegheny Power territory units are not shown in the table.

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 April 2004 through March 2005 along with some overall PIPP population data from a previous analysis in 2003.

Table 4. Housing Characteristics of EPP Customers and PIPP Population

	High Use	TEE	Mod. Use	EPP Total	PIPP Population
# Units	7,614	383	2,187	10,184	~200k
Housing Type:					
Single Family	69%	47%	58%	66%	55%
Mobile Home	10%	47%	6%	11%	9%
Multi Family	16%	1%	27%	18%	36%
# Occupants	3.3	3.2	2.5	3.1	2.7
Homeowner	57%	74%	42%	55%	25%

The table shows some clear differences between the EPP programs and between EPP and the PIPP population. EPP customers are much more likely to be homeowners than the PIPP population (55% vs. 25%) and are more likely to live in single family homes and less likely to live in an apartments. Variations between EPP programs are also quite noticeable. The TEE program serves about half mobile homes while the High Use program serves a large proportion of single family site-built homes. The Moderate Use program participants, as one might expect, tend to have smaller households and are more likely to live in multifamily buildings than High Use participants.

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

	AEP	CG&E	CEI	DP&L	OE	TE
# Units	3,100	322	1,596	582	1,580	422
Housing Type:						
Single Family	69%	70%	57%	84%	72%	82%
Mobile Home	16%	10%	4%	3%	11%	7%
Multi Family	10%	16%	33%	12%	12%	11%
# Occupants	3.2	3.3	3.5	2.9	3.4	3.4
Homeowner	62%	64%	44%	69%	56%	56%

CEI participants were most likely to be renters and living in apartments. 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 (because the appliance inventory is optional in that program). The penetration of key electric end-uses for participants in each EPP program for the April 2004 through March 2005 period are summarized in Table 6.

Table 6. Electric End Uses by Program and Utility

Program	Hot Water	Central A/C	Central Heat	Space Heater	Freezer	Extra Fridges	Dryer	Stove
High Use								
AEP	37%	32%	19%	30%	38%	9%	89%	66%
CG&E	25%	61%	17%	44%	41%	13%	88%	67%
CEI	9%	10%	7%	33%	49%	17%	86%	24%
DP&L	16%	40%	13%	37%	38%	10%	89%	78%
OE	24%	18%	13%	30%	47%	12%	74%	43%
TE	15%	15%	7%	33%	48%	8%	68%	32%
High Use - All	**25%**	**26%**	**14%**	**32%**	**43%**	**12%**	**84%**	**51%**
Moderate Use	**5%**	*not always recorded*			**24%**	**5%**	**57%**	**24%**
TEE	**96%**	**29%**	**96%**	**20%**	**37%**	**10%**	**96%**	**94%**

The table shows that a quarter of the High Use program homes have electric hot water, a quarter have central air conditioning, nearly half have freezers, and many have electric space heaters or even installed electric heat. 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 have "all electric" homes (as expected), 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 have a much lower penetration of water heating and central air conditioning particularly compared to the southern utilities. CEI also had the highest penetration of 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 does 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, providing fewer savings opportunities for 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 (April 2004 through March 2005).

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

	AEP	CG&E	CEI	DP&L	OE	TE	All	% total
# Participants	3,100	322	1,596	582	1,580	422	7,614	
Refrigerators	1,319	1,344	1,395	1,389	1,373	1,583	1,367	10%
Freezers	360	454	441	327	441	482	402	3%
Lighting	1,722	2,220	2,064	1,443	1,809	1,821	1,817	14%
Heating/Cooling	5,140	5,436	2,677	4,308	3,522	3,327	4,132	31%
-Air Conditioning	1,637	2,295	462	1,752	817	938	1,218	9%
-Space Heaters	792	902	598	923	540	714	708	5%
-Installed Heat	1,729	1,360	505	777	859	541	1,134	9%
-Other HVAC	982	879	1,113	855	1,307	1,135	1,072	8%
Laundry	1,056	762	1,495	845	898	782	1,071	8%
Stove/Oven	751	802	287	953	510	399	601	5%
Other Kitchen	350	232	324	338	293	182	317	2%
Televisions	984	842	658	1,128	863	1,155	905	7%
Computers	360	263	208	303	369	264	316	2%
Other Electronics	405	313	248	399	413	289	363	3%
Hot Water	1,690	1,161	311	820	1,255	1,202	1,192	9%
Other	735	792	443	825	529	746	642	5%
Total	14,872	14,623	10,551	13,077	12,276	12,233	13,125	100%

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.

The largest single end use was Heating/Cooling, comprising 31% of the total. Refrigeration and lighting are the two main loads expected to be reduced by program measures, excluding education. These loads are estimated to average 3,586 kWh/yr, equal to 27% of usage. Without substantial education savings, it would be difficult to achieve program savings of more than about half of these loads, which would equal about 1,800 kWh/yr or 14% of the total load.

A closer examination of the individual load estimates found that:

- Lighting: the average estimated lighting load dropped from 2,273 kWh (17%) in the last study to the current 1,817 kWh (14%) – a more reasonable value. The average hours of use were estimated at 3.9 hours per day (vs. 4.5 in the last study). The number of bulbs per home averaged 19.5 (vs. 22 in the last study). This lower lighting load estimate is still well above the estimated national average, but these are high use homes. Regression analysis estimated that the true lighting loads are perhaps 12%-25% smaller than the projections. We also found that the reported hours of use appeared to vary systematically between auditors indicating that recorded hours of use are not very accurate.
- Laundry: laundry loads are over-estimated for CEI because the primary provider in their service territory (CHN) has been entering peak, not average, wattage for dryers.
- Hot water: Electric hot water load estimates often appear too low or too high. For homes with hot water, 47% of the usage estimates were outside the range of 2,000 to 7,000 kWh where most loads would be expected. Average loads varied between provider from a reasonable 3,776 kWh for COAD to a quite high 6,359 kWh for HDMC. The estimates also vary too widely within the same provider with the spread between the 25th percentile and 75th percentile often greater than 3,000 kWh.

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. OEE designed EPP 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 they 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. EPP has not had much success with convincing 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 incentive but require skill in "selling" this to the customer. Appliance removals have increased over time for secondary refrigerators, but not freezers.

- **Compact Fluorescent Lights:** Light bulbs are replaced with energy efficient compact fluorescent bulbs in all fixtures deemed feasible and cost effective. Prior to mid-2005, nearly all bulbs used regularly qualified for replacement because of generous assumptions in the software. Changes in 2005 led to a significant decline in the number of bulbs per home. See the figure in the following section
- **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.
- **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 April 2004 through March 2005.

Table 8. Measure Installations and Costs by Program and Utility (April 2004 – March 2005)

	High Use Baseload Program								
	AEP	CG&E	CEI	DP&L	OE	TE	All	Mod Use	TEE
# Homes	3,100	322	1,596	582	1,580	422	7,614	2,187	383
Measures (per site)									
-Refrigerators Replaced	0.49	0.43	0.64	0.65	0.66	0.75	0.58	0.58	0.39
-Freezers Replaced	0.15	0.23	0.22	0.19	0.24	0.28	0.20	0.11	0.12
-Fridge/Freezer Removals	0.01	0.05	0.02	0.02	0.03	0.04	0.02	0.01	0.04
-Light Bulbs	16.6	22.7	15.4	12.8	16.7	17.8	16.4	12.3	15.9
-Electric Hot Water: any	26%	15%	4%	13%	16%	12%	17%	3%	78%
Measure Costs (per site):									
-Refrigeration	$297	$294	$396	$432	$427	$515	$367	$317	$231
-Lighting	$222	$346	$347	$186	$310	$244	$270	$224	$219
-Other Measures	$8	$5	$2	$4	$6	$8	$6	$1	$87
Total Measure Cost /site	$527	$645	$745	$622	$743	$767	$643	$542	$537
Audit/Education/Admin	$223	$214	$226	$222	$219	$225	$223	$173	$320
Weatherization Cost*									$1,335
Total Treatment Cost	$765	$877	$992	$849	$973	$999	$879	$726	$2,203

* 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 0.58 refrigerators and 0.20 freezers per home (vs. 0.52 and 0.25 in the previous study) – 67% of homes had one or more appliance replaced;
- installed 16.4 light bulbs per home (vs. 18 in the previous study);
- provided electric hot water measures in about one sixth of the homes;
- convinced relatively few participants to have secondary refrigerators or freezers removed;
- spent an average of $879 per home on program treatments (vs. $1,056 in previous study) with 42% of the spending paying for refrigerators and freezers, 31% for lighting, and 25% for audit, administrative, and education costs.

High Use program spending averaged $177 less per home than in the previous study. The savings came from a $54 reduction in audit/education/admin costs, a $56 reduction in lighting costs, and a $63 reduction in refrigerator costs.

Refrigerator and freezer installation rates were highest for TE participants, leading to the highest average measure spending. CG&E participants received the most lighting retrofits by far,

averaging nearly 23 bulbs per home. The average cost per bulb installed was about $16 for the High Use program and ranged from about $13 for homes in the AEP territory to $23 for CEI homes. Per bulb costs averaged $21 for homes treated in 2002 and should continue to drop as CFL prices have dropped significantly over time.

The relatively low rate of secondary refrigerator and freezer removals has been identified in prior evaluations as a potential lost opportunity. There is some evidence of improvement. Secondary refrigerators were found in 12% of High Use participant homes and 22% of these units were replaced along with the primary unit (two-for-two swaps) while 10% were removed. In the previous study, just 6% had been removed. For freezers, 43% of participants had separate freezers and 37% of those units were replaced while just 2% were removed (vs. 1% in previous study). The rates of removals varied widely between providers and between auditors. Some providers were able to remove more than 40% of secondary refrigerators while others removed none. For freezers, removal rates ranged from 0% to 6%. The improvement in removal of secondary refrigerators is encouraging, but freezer removals are still quite rare and more training and/or better incentives (to customers and providers) may be needed to increase the removal rates for both appliances.

The Moderate Use program also showed a reduction in treatment costs from the previous evaluation – from $822 to $726. This reduction is due about equally to reductions in refrigerator and lighting costs. As in previous evaluations, the Moderate Use program had about the same rate of refrigerator replacement as the High Use program. This finding is still somewhat unexpected given the much lower overall usage levels. The TEE program had a much lower rates of refrigerator replacements than the other programs. Data on weatherization measure costs appears incomplete since zero costs were recorded in 37% of the cases.

Spending on measures other than refrigeration and lighting averaged $6 per home in the High Use program and primarily included water heater measures and a small number of water bed mattress pads and custom measures. The $87 average spending on “Other” measures for TEE reflects the fact that virtually all TEE participants have electric hot water.

Measure Installation Trends

Changes in program rules, software algorithms, and measure costs as well as follow-up training for providers have all led to changes in some measure installation rates over time.

As noted previously, software assumptions about CFL lighting retrofits (specifically measure lifetime, savings, and discount rate) have led to reductions in the number of bulbs installed per home. Figure 2 shows the average number of bulbs installed per home for the High Use and Moderate Use programs from January 2003 through mid 2006. The evaluation target period of April 2004 through March 2005 is bracketed by vertical lines. The changes in the audit software went into effect immediately after this target period and have led to a substantial decline in the number of qualifying bulbs per home. This change is expected to improve program cost-effectiveness by reducing costs more substantially than savings.

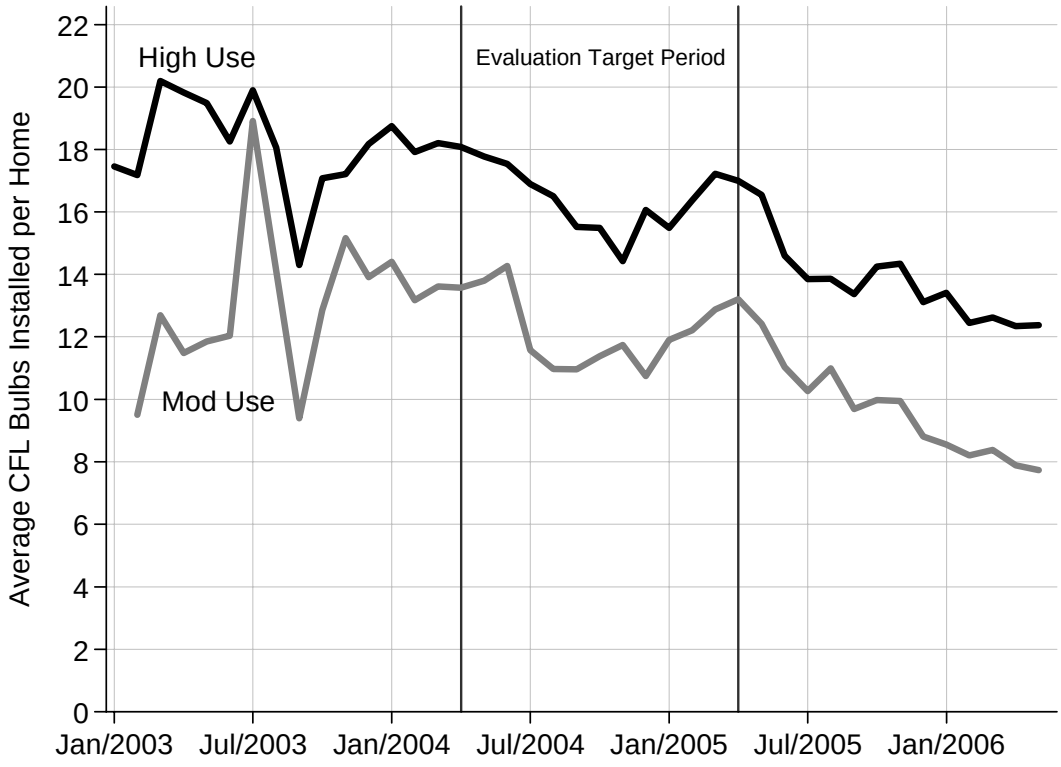

Figure 2. Light Bulb Installation Rates over Time

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

Sample / Attrition Cause	High Use	Mod Use	TEE
Treated Population Units	**7,614**	**2,187**	**383**
-No Usage match	-244	-65	-17
-Insufficient Usage Data (total or seasonal)	-2,424	-715	-121
-Estimated Usage <1,200 or >70,000	-56	-19	-2
-Change in Usage >65%or 2.2 IQRs	-101	-33	-5
=Analysis Sample Units	**4,789**	**1,355**	**238**
Attrition %	37%	38%	38%

All three programs had attrition rates of 37%-38%. Nearly all attrition was from a lack of pre and/or post-treatment data. Attrition was highest for CG&E due to problems with their data submissions to OCS. For the comparison group, attrition was about 50% 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

	Average Usage & Gross Savings (kWh/yr)				Net of Weighted Comparison Group	
Group	# units	Pre-use	Post-use	Savings	Net Savings	Net % Savings
All Participants	**4,789**	**13,525**	11,841	**1,684**	**1,650 (±82)**	**12.2% (±0.6%)**
Comparison Group	5,082	12,821	12,770	51		
Weighted Comparison	**4,903**	**13,380**	13,346	**34**		

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 4 factors: location (weather station), housing type (site built, mobile home or multifamily), pre-treatment total usage (in 9 bins), and pre-treatment winter seasonal usage (in 5 bins).

The participants' weather-adjusted annual electric usage declined by an average of 1,684 kWh. The comparison group's weather-adjusted usage declined by an average of 51 kWh. We noticed differences between the participant and comparison group on pre-treatment usage as well as geographic location, housing type, and winter seasonal usage. We addressed these differences by stratifying the comparison group on these four factors and weighting each grouping to match the proportion of participants in that grouping. 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 17 kWh adjustment in the overall comparison group, we used the approach for all group break-outs of savings where larger adjustments sometimes occurred.

Based on the weighted comparison group, the annual net electric savings averaged 1,650 kWh, equal to 12.2% of pre-treatment usage. These savings are a little smaller than the prior evaluation which found savings of 1,766 kWh and 13.4%. As in the prior evaluations, the EPP High Use savings compare 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

	Average Usage & Gross Savings (kWh/yr)			Net of Weighted Comparison Group	
Load Components	Pre-use	Post-use	Savings	Net Savings	Net % Savings
Baseload	9,327	8,169	1,157	**1,496**	16.0%
Winter/Heating	2,591	2,516	75	**36**	1.4%
Summer/Cooling	1,607	1,156	451	**117**	7.3%

The seasonal break out of savings is similar to the last evaluation. Nearly all of the savings occur in the baseload usage. The net savings in baseload usage include a 339 kWh usage increase for the comparison group which may be seen as consistent with the general increase in residential end uses due to greater penetration of computers, cell phone chargers, and other miscellaneous plug loads. There was a modest 117 kWh net savings in the summer load, which may be expected given the summer-peaking nature of refrigerator usage. The winter load had little if any net savings, implying that the use of electric space heat did not change much.

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 3 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 one fifth had an apparent increase in

usage. In the comparison group, half of all homes had increased usage, 45% had savings between 0% and 25%, and 5% had savings of more than 25%.

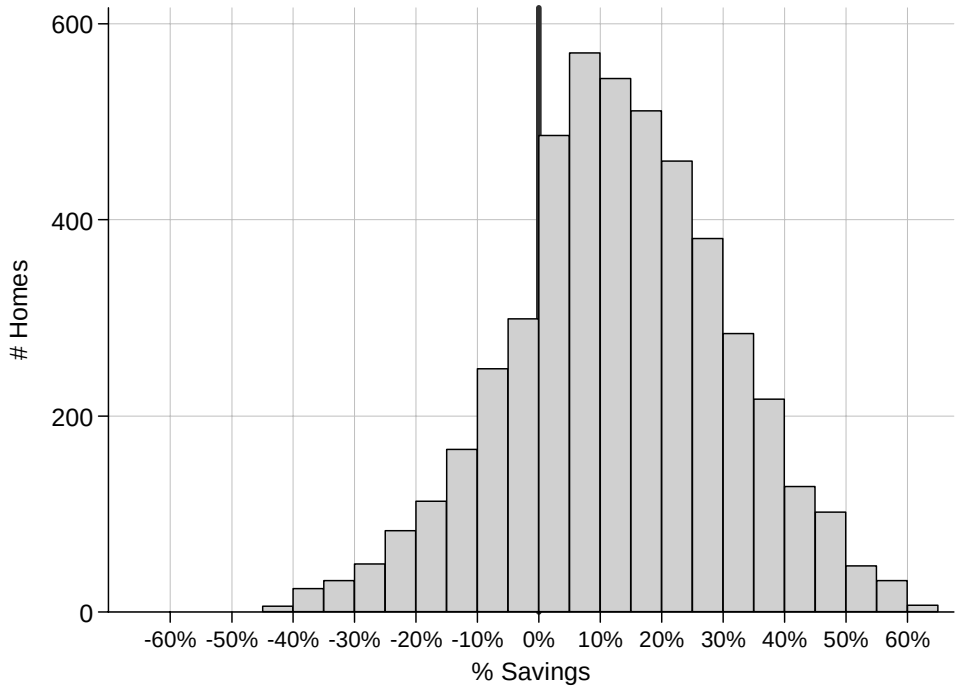

Figure 3. Distribution of % Savings (gross): High Use Participants

Pre-treatment usage is often related to energy savings. Figure 4 shows the distribution of pre-treatment annual electric usage for the High Use participants.

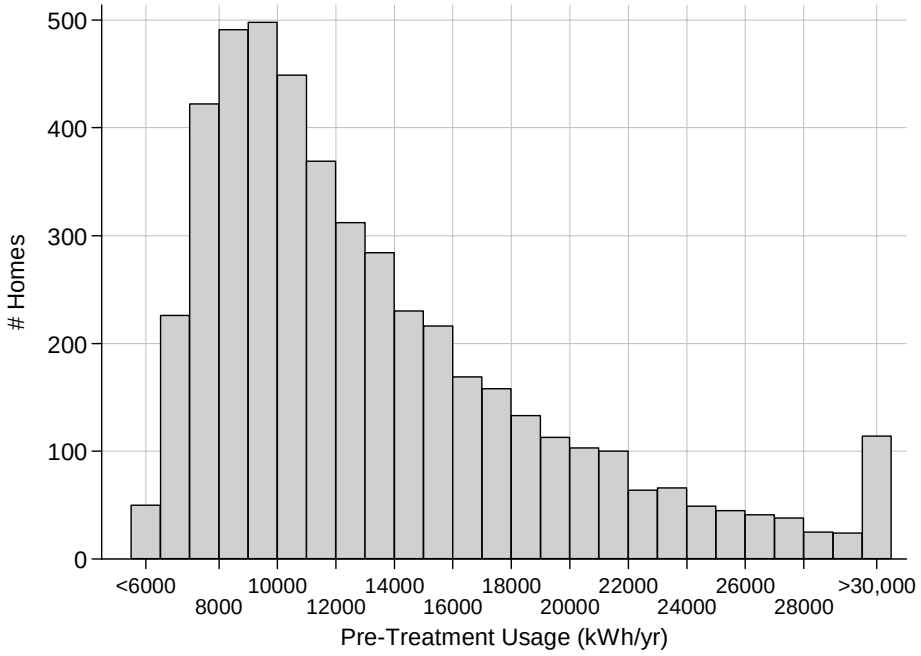

Figure 4. Distribution of Pre-Treatment Usage: High Use Participants

Pre-treatment usage averaged 13,525 kWh but the median usage was 11,660 kWh, reflecting a skewed distribution. Half the participants used between 8,000 and 14,000 kWh, while 10% used more than 22,000 kWh. The penetration of electric hot water grows as usage increases.

Figure 5 shows the distribution of net savings for participants by level of pre-treatment usage. For each category of usage, the average net savings is shown by the gray-filled circle and the capped line reflects the statistical uncertainty (±90% confidence interval).

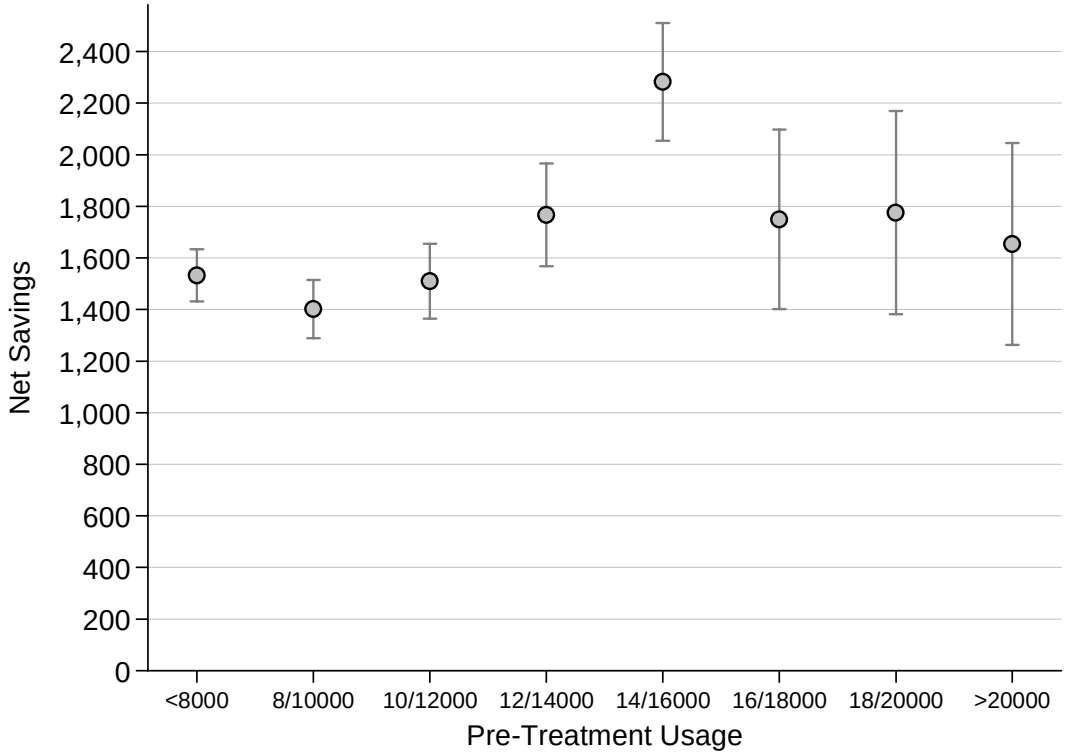

Figure 5. Net Savings by Pre-Treatment Usage : High Use program
note: Circle shows average (mean) savings, gray capped lines show ±90% confidence interval. All figures in kWh/year

The graph shows a changing relationship between usage and savings. Houses using more than 12,000 kWh generally have greater savings than those using less, but savings appear to peak at 14,000-16,000 kWh of usage and decline at higher usage levels. Savings also appear fairly flat from 6,000 through 12,000 kWh. This lack of a relationship is consistent with prior evaluations. The EPP High Use program primarily addresses refrigeration and lighting loads and those loads do not grow in direct proportion to total usage, especially as usage increases past 12,000 kWh. Therefore, although low usage homes (those not qualified for the High Use program) tend to have smaller refrigerator and lighting savings opportunities, the savings opportunities do not steadily grow with further usage increases. 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.

Since homes are screened into the High Use program based on their baseload usage (not total usage), it may be of interest to examine how savings vary with baseload usage. Figure 6 is the same as Figure 5 except it shows the savings by level of pre-treatment baseload usage.

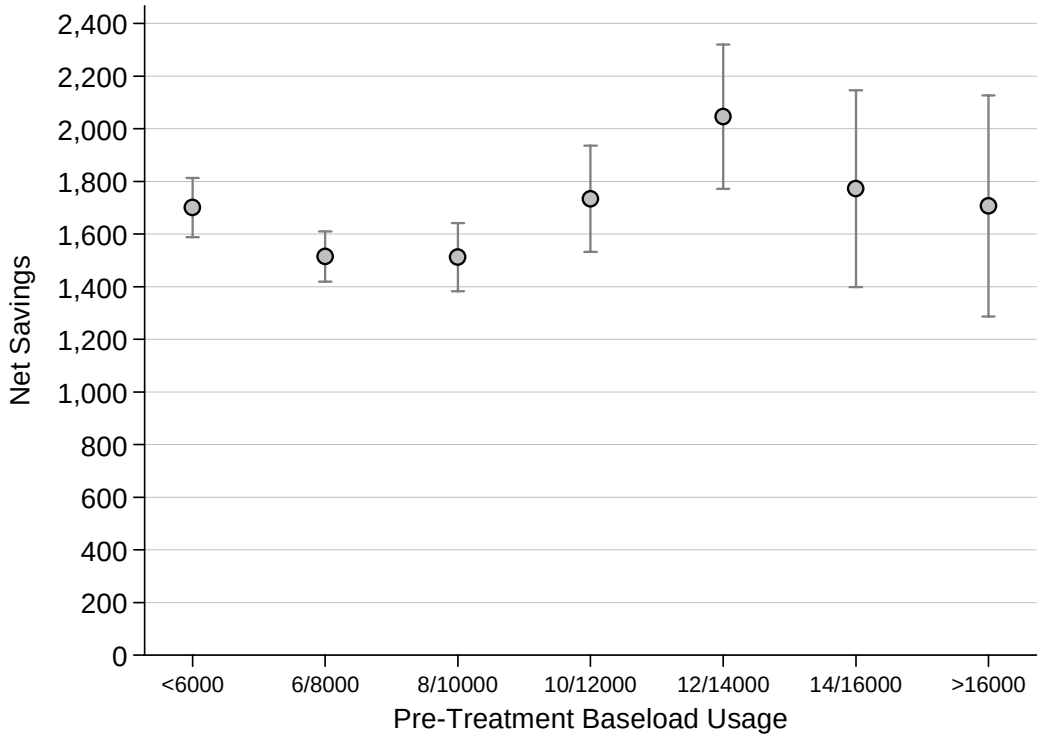

Figure 6. Net Savings by Pre-Treatment Baseload Usage : High Use program
note: Circle shows average (mean) savings, gray capped lines show ±90% confidence interval

The relationship appears similar to that for total usage – savings is generally higher for houses with pre-treatment baseload usage greater than 10,000 or 12,000 kWh, but the patterns above and below are not consistent or clear.

We explored variations in usage and net savings based on a variety of treatment and housing characteristics including refrigerator and freezer measures, 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 ±90% confidence intervals)

Group	# Homes	Pre-use	Gross Savings	Net Savings	Net % Savings
By Utility Service Territory					
AEP	1,873	15,676	1,604	1,488 (±132)	9.5% (±0.8%)
CG&E	140	14,996	2,204	1,862 (±418)	12.4% (±2.8%)
CEI	1,055	10,761	1,497	1,632 (±132)	15.2% (±1.2%)
DP&L	354	14,571	2,065	1,887 (±267)	12.9% (±1.8%)
OE	1,069	12,458	1,792	1,834 (±127)	14.7% (±1.0%)
TE	298	11,684	1,762	1,689 (±258)	14.5% (±2.2%)
By Refrigerator Measures					
Any Refrigeration Measure	**3,112**	**13,347**	**2,049**	**2,030 (±92)**	**15.2% (±0.7%)**
- single refrigerator replaced	1,938	12,987	1,860	1,882 (±103)	14.5% (±0.8%)
- single freezer replaced	317	13,973	1,839	1,912 (±232)	13.7% (±1.7%)
- 2+ appliances replaced	855	13,916	2,556	2,407 (±151)	17.3% (±1.1%)
No Refrigeration Measure	**1,479**	**13,910**	**947**	**884 (±119)**	**6.4% (±0.9%)**
By Electric Water Heating					
Hot Water: no measures	389	17,526	1,117	1,264 (±296)	7.2% (±1.7%)
Hot Water: with measures	769	19,094	1,287	1,326 (±255)	6.9% (±1.3%)
Not Electric Hot Water	3,631	11,917	1,829	1,779 (±85)	14.9% (±0.7%)
By Housing Type					
Single Family Home	3,354	13,473	1,806	1,736 (±99)	12.9% (±0.7%)
Mobile Home	454	17,020	1,123	1,178 (±318)	6.9% (±1.9%)
Apartment	746	11,721	1,474	1,486 (±176)	12.7% (±1.5%)

Net savings were fairly similar across utility companies and ranged from a low of 1,488 kWh for customers served by AEP to a high of 1,887 kWh for DP&L.

Refrigerator and freezer replacements clearly were a major driver of savings. Houses that did not receive any refrigeration measures had less than half the average savings of those that did – 884 kWh vs. 2,030 kWh. Homes that received just a freezer replacement appeared to save a little more than those that received just a refrigerator replacement, but there were other differences between these groups.

Participants with electric hot water used about 50% more electricity on average than other participants but saved less in absolute, and especially percentage, terms. The lower savings in homes with electric hot water was explored in the prior impact studies which found that electric water heating can qualify an otherwise moderate use home as high usage, providing fewer opportunities for lighting and refrigeration savings.

The two thirds of the electric hot water homes that had hot water measures installed only showed an average of 62 kWh greater savings than those that did not receive hot water measures (the difference was 321 kWh in the last study). There is considerable statistical uncertainty in the size of this difference and we uncovered a curious pattern in the results. For site built homes, net savings were 373 kWh higher if hot water measures were installed than if they weren't – comparable to the prior study. But mobile homes that received hot water measures actually had lower measured savings than those which did not. We explored this anomaly further and found that the difference is due to mobile homes treated by one agency – COAD. There were 167 COAD mobile homes with electric hot water in the analysis. The net savings were 1,934 kWh for the 48 homes that did not receive hot water measures, but just 628 kWh for the 119 mobile homes that did receive the measures. This unusual finding may be related to the fact that some EPP high use homes have electric heat and could be treated by COAD through HWAP. Therefore homes without EPP-listed hot water measures may have received the measures under HWAP and also received weatherization, boosting their savings due to non-EPP treatments.

In terms of overall housing type differences, single family site-built homes had highest average savings and mobile homes had the lowest average savings. Mobile homes had the highest usage of all housing types due to their higher prevalence of electric hot water (75% in the mobile home sample vs. 18% for single family) and electric heat (30% for mobile homes and 8% for single family).

High Use: Comparison to Projected Savings

The overall net annual savings of 1,650 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 are a little lower than in the last impact study.

One way to assess the success of the program is to compare the measured savings to those expected from engineering-based calculations. This type of comparison can help put the measured savings in context, provide feedback on the accuracy of the field data collected (and the 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, but making some minor changes to deal with some data entry problems. 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
By Utility:							
AEP	758	1,196	88	11	2,054	**1,488**	**72%**
CG&E	920	1,552	40	1	2,513	**1,862**	**74%**
CEI	834	1,332	23	5	2,194	**1,632**	**74%**
DP&L	769	1,029	18	28	1,843	**1,887**	**102%**
OE	885	1,243	68	11	2,207	**1,834**	**83%**
TE	1,086	1,299	28	27	2,440	**1,689**	**69%**
Overall	**829**	**1,241**	**59**	**12**	**2,141**	**1,650**	**77%**

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 2,141 kWh per home and the measured net savings were 1,650 kWh, equal to 77% of projected (referred to as the realization rate). Although net savings were higher in the last evaluation, the realization rate was lower (69%) due to much higher projected savings of 2,565 kWh. Most of the reduction in projected savings came from the lighting which was estimated at 1,511 kWh in the last study. The projected lighting savings per bulb averaged 96 kWh in the first impact study, 84 kWh/bulb in the second study, and 76 kWh/bulb in this study. It appears that field personnel are providing more realistic savings estimates than in the past.

The utility-specific estimated realization rates ranged from 69% for TE to 102% for DP&L. The realization rates compare favorably to other similar programs. It is worth noting that the savings projections and realization rates in the table do not include any savings estimated from energy education and customer actions. To the extent that education savings are projected to add to the total, the realization rate would decline commensurately.

Measure Savings Analysis

In the first impact evaluation, we found that most of the savings shortfall was due to a 45% realization rate for lighting measures (43 kWh per bulb vs. 96 kWh/bulb projected) and, to a lesser extent, a 79% realization rate for refrigeration measures. A detailed analysis based on statistical evidence and field observations indicated 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). In the second impact evaluation, no relationship could be found between lighting measures and measured savings but there were issues with weather anomalies and a large comparison group adjustment that may have skewed that analysis.

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 modeling was much more successful this time. The analysis found :

- Refrigeration measures saved about 89% of projected and were well correlated with measured savings (the 90% confidence interval ranged from 80%-98% realization rate). This result is noticeably higher than the 77% found in the previous evaluation or the 79% found in the first evaluation. There was no significant difference in the estimated realization between refrigerators and freezers and so a pooled realization rate was estimated to maximize statistical strength. Applying this realization rate to projected savings, the average savings are 926 kWh per refrigerator replaced and 760 kWh per freezer replaced.
- Lighting retrofits are estimated to save 55% of the projected savings, equal to 41 kWh per bulb -- quite similar to the 43 kWh/bulb from the first impact study. Unlike in prior evaluations, the projected lighting savings was actually a better predictor of measured savings than the number of bulbs installed, implying that savings projections have improved. The realization rate was fairly well determined with a 90% confidence interval ranging from 44% to 65%.
- The small proportion of projected savings from other measures categories (primarily hot water) were not statistically discernible

We used these realization rates to calculate the measure impacts per installation and estimate the overall program savings by using population treatment installation data. We found that the overall program population of 7,614 High Use participants had fewer refrigeration measures installed and slightly more lighting measures installed than the analysis sample. We used data on the measure installations rates for the full population to estimate overall program savings. Table 14 summarizes the results of this analysis.

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

		Savings: kWh/Install			
Measure	**Realization Rate**	**Projected**	**Realized**	**#/home**	**Savings per home**
- Refrigerator Replacement	89%	1043	926	0.58	536
- Freezer Replacement	89%	856	760	0.20	151
Refrigeration Measures	89%	987	877	0.80	**700**
Lighting	55%	76/bulb	41	18.0	**677**
Other Measures + Education				1	**237**
Total	77%				**1,615**

Refrigeration measures are estimated to save 700 kWh per home and lighting retrofits are estimated to save 677 kWh per home. Refrigerator and lighting retrofits accounted for all but 237 kWh of the average savings. These remaining savings could be from other program measures and education, or they could be some unallocated portion of the savings from

refrigeration and lighting. Based on the program population installation rates, we estimate that **the High Use program provided average annual savings of 1,615 kWh per participant.** This figure is 35 kWh smaller than the net savings from the billing analysis because of the smaller projected savings from refrigerators in the population compared to the billing analysis sample. The average costs for the population were also smaller than the analysis group's costs ($879 vs. $901) The 1,615 kWh is the best estimate of average savings for the program.

C. Moderate Use Baseload Program Electric Impacts

Table 15 shows the results of the usage analysis for the Moderate use baseload program.

Table 15. Moderate Use Baseload Program: Electric Savings Results

	Average Usage & Gross Savings (kWh/yr)				Net of Weighted Comparison Group	
Group	# units	Pre-use	Post-use	Savings	Net Savings	Net % Savings
All Participants	**1,355**	**6,468**	5,657	**811**	**697 (±80)**	**10.8% (±1.2%)**
Comparison Group	1,678	6,065	6,006	59		
Weighted Comparison	**1,663**	**6,234**	6,120	**114**		

Note: ± figures are 90% statistical confidence intervals on the net savings. Weighted comparison group is matched on geography (weather station), building type, and pre-treatment usage categorized into 3 levels.

Moderate Use program participants had net annual savings of 697 kWh on average, equal to about 11% of pre-treatment usage. These savings are 88 kWh less than was found in the previous study. The weighted matching of the comparison group (based on weather station, building type, and pre-treatment usage), led to a 55 kWh decrease in net savings compared to an unweighted comparison group.

The pre-treatment usage of participants is a little less than half the usage of the High Use group. Table 16 shows a break–out of savings between baseload, winter, and summer components.

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

	Average Usage & Gross Savings (kWh/yr)			Net of Weighted Comparison Group	
Load Components	Pre-use	Post-use	Savings	Net Savings	Net % Savings
Baseload	4,728	4,169	559	**689**	14.6%
Winter/Heating	984	906	78	**-32**	-3.3%
Summer/Cooling	756	583	173	**40**	5.3%

Virtually all savings occurred in baseload with statistically insignificant changes in the estimated winter and summer loads.

Moderate Use Program: Usage and Savings Variations

Similarly to the analysis of High Use participants, we explored the usage and savings for the Moderate Use program. The graphs below show the distribution of pre-treatment usage and % gross savings for the Moderate Use participants.

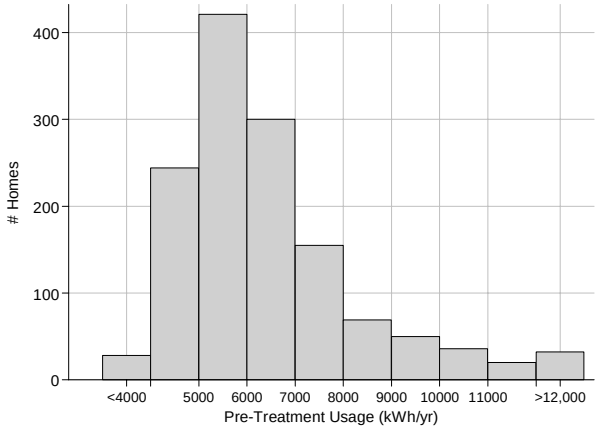

Figure 7. Distribution of Pre-Treatment Usage: Moderate Use Participants

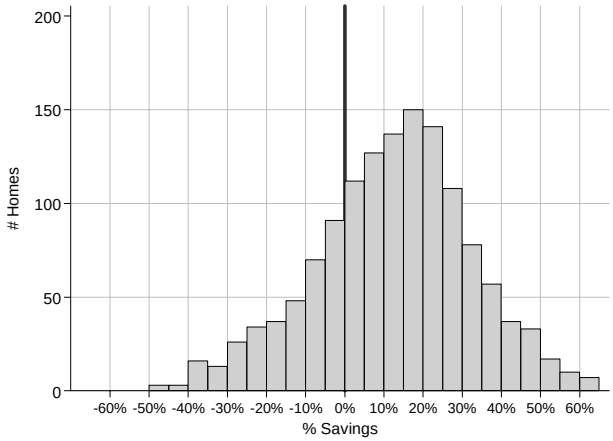

Figure 8. Distribution of % Savings (gross): Moderate Use Participants

The pre-treatment usage levels are, as expected, concentrated in the range of 4,000 to 8,000 kWh. Moderate Use participants are selected based on a baseload usage of 4,000 to 6,000 kWh, but seasonal loads add to that, yielding an average pre-treatment total usage of 6,468 kWh. The distribution of % savings shows a peak at a higher percent savings range – 15%-20%.

We explored variations in usage and net 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 ±90% conf. intervals)

Group	# Homes	Pre-use	Gross Savings	Net Savings	Net % Savings
By Utility Territory:					
AEP	228	7,297	849	450 (±177)	6.2% (±2.4%)
CG&E	44	7,556	269	185 (±439)	2.4% (±5.8%)
CEI	513	6,013	630	720 (±129)	12.0% (±2.1%)
DP&L	85	6,408	923	764 (±268)	11.9% (±4.2%)
OE	392	6,446	1,018	846 (±115)	13.1% (±1.8%)
TE	93	6,580	989	718 (±243)	10.9% (±3.7%)
By Refrigerator Measures:					
Any Refrigeration Measure	847	6,479	1,005	871 (±92)	13.4% (±1.4%)
- single refrigerator replaced	664	6,455	1,012	888 (±100)	13.8% (±1.5%)
- single freezer replaced	64	6,723	532	281 (±304)	13.8% (±1.5%)
- 2+ appliances replaced	119	6,480	1,221	1093 (±194)	16.9% (±3.0%)
No Refrigeration Measure	420	6,342	387	342 (±115)	5.4% (±1.8%)
By Housing Type:					
Single Family Home	806	6,571	850	674 (±98)	10.3% (±1.5%)
Mobile Home	65	6,771	763	472 (±468)	7.0% (±6.9%)
Apartment	346	6,309	744	728 (±154)	11.5% (±2.4%)

Most of the Moderate Use participants are in the CEI, OE, and AEP service territories. It appears that those in the OE territory had the largest savings. The low savings results for CG&E territory is based on a small sample with large uncertainty.

Homes that received refrigeration measures saved more than twice as much as those that did not. The low savings result for homes receiving just a freezer replacement is based on a small sample and had wide uncertainty. The 342 kWh net savings for the 420 homes that did not receive refrigeration measures is low considering that these homes received an average of 12 light bulbs each, which should be able to provide savings of at least 400 kWh based on the High Use program measure savings analysis. In the previous evaluation, the no-refrigerator group had similarly small net savings of just 295 kWh.

In terms of housing type, apartments actually had the highest net savings at 728 kWh, but these results do not statistically differ from the 674 kWh for single family homes and the entire difference is due to different comparison group adjustments.

Moderate Use: Projected Savings & Measure Savings Analysis

The projected savings for the Moderate Use participant sample, based on data in SMOC~ERS, averaged 1,508 kWh. The net electric savings of 697 kWh equal just 46% of these savings, considerably lower than the 79% rate found for the High Use program, but similar to the rate found in the last evaluation. Refrigeration savings were projected at 630 kWh and lighting

savings at 868 kWh with all other savings totaling 9 kWh. If the savings realization rate were the same as the High Use program (89% for refrigerators and 55% for lighting), then net savings from lighting and refrigeration should have totaled 1038 kWh. It appears that the realization rates for one or both measures are lower in the Moderate Use program.

We used a regression modeling approach to explore the savings in the Moderate Use program. We found a lower estimated realization rate for refrigerator savings of 61% (vs. 89% for High Use) and we found no statistically significant relationship between measured savings and projected lighting savings. Refrigerator replacement decisions in the Moderate Use program are made based on either a rated usage look-up or 1 hour metering, while the High Use program uses 2 hour metering. Research has shown that these alternate refrigerator audit approaches should perform almost as well as the 2 hour metering, but it appears that there may be some problems in implementation.

If the refrigerator savings realization rate is 61%, then 385 kWh of the total 697 kWh net savings in the analysis sample is attributable to refrigeration measures, leaving 312 kWh for lighting and all other measures (including education), or a 36% realization rate for the remaining savings.

In order to estimate savings for the full population of 2,187 participants served by the Moderate Use program between April 2004 and March 2005, we used the 61% realization rate for refrigeration measures and a 36% rate for lighting measures. The results of this analysis are shown in Table 18. By using the 36% realization rate for the lighting, we have essentially defined the savings from other measures as zero.

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

		Savings: kWh/Install			
Measure	**Realization Rate**	**Projected**	**Realized**	**#/home**	**Avg. kWh per home**
Refrigeration Measures	61%	891	544	0.70	**381**
Lighting	36%	72/bulb	26	12.3	**316**
Other Measures + Education					**0**
Total	46%				**697**

Based on installation data for the Moderate Use population served from April 2004 through March 2005, **the average program savings are estimated at 697 kWh**. These savings are equal to the analysis sample due to the fact that the small differences between the sample and population are offsetting. This result is considered the best estimate of program savings.

D. TEE Program Electric Impacts

The TEE program completed 383 units between April 2004 and March 2005. We had sufficient pre-treatment and post-treatment usage data for 238 of these units. A large proportion of these units (37%) 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

	Average Usage & Gross Savings (kWh/yr)				Net of Weighted Comparison Group	
Group	# units	Pre-use	Post-use	Savings	Net Savings	Net % Savings
Participants	**238**	**29,364**	25,904	**3,461**	**3,151 (±691)**	**10.7% (±2.4%)**
Comparison Group	244	28,746	28,502	245		
Weighted Comparison	**230**	**28,972**	28,662	**310**		

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 3,151 kWh/yr, equal to about 11% of pre-treatment usage. These savings are similar to the 2,913 kWh and 11.6% found in the previous evaluation. The comparison group had savings of about 1%. We stratified and weighted the comparison group to match on weather station, building type, and pre-treatment usage.

The estimated kWh and percentage savings are fairly good in comparison with 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

	Average Usage & Gross Savings (kWh/yr)			Net of Weighted Comparison Group	
Load Components	Pre-use	Post-use	Savings	Net Savings	Net % Savings
Baseload	12,663	12,044	618	**1,093**	8.6%
Winter/Heating	14,903	12,750	2,152	**1,782**	12.0%
Summer/Cooling	1,799	1,109	690	**276**	15.3%

The estimated winter/heating savings are estimated at 1,782 kWh, equal to about 12% of the pre-treatment winter/heating usage. 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 89 homes with no listed weatherization measures is about the same as for those with weatherization measures, implying that the homes did in fact receive weatherization but either it was not entered into the tracking system or it was provided by another program (e.g., HWAP or a utility program).
- Two providers served all but 3 of the homes: COAD treated 189 units and HWDMC treated 46 units in the analysis sample. The **savings were about the same for both providers** and did not differ statistically or substantively.

- Housing Type: **Net savings were higher in single family homes than mobile homes**. The 120 single family homes in the analysis had average net savings of 3,638 kWh, equal to 12% of the 30,303 kWh in pre-treatment usage. In the 99 mobile homes in the analysis, savings averaged 2,505 kWh, equal to 9% of the 27,878 kWh pre-treatment usage.

Given the problem with tracking system information on weatherization measures and the relatively small sample size, 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 will tend to provide greatest savings opportunities while houses that only qualify as high usage due to the presence of electric water heating will 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

Provider	# Homes	Pre-use	Gross Savings	Net Savings	Net % Savings	Cost $/home	Annual kWh per $ spent
ACCAA	135	12,767	784	806 (±297)	6.3% (±2.3%)	$728	1.11
CAWM	151	15,445	2,126	1,873 (±381)	12.1% (±2.5%)	$1,028	1.82
CHN	1020	10,696	1,598	1,752 (±119)	16.4% (±1.1%)	$1,027	1.71
COAD	945	17,005	1,479	1,262 (±189)	7.4% (±1.1%)	$741	1.70
EANDC	110	11,644	2,187	2,285 (±354)	19.6% (±3.0%)	$1,458	1.57
HWDMC	1778	13,687	1,728	1,664 (±115)	12.2% (±0.8%)	$844	1.97
NCSB	219	11,609	2,413	2,560 (±280)	22.0% (±2.4%)	$1,148	2.23
OHCAC	107	12,858	954	1,102 (±364)	8.6% (±2.8%)	$888	1.24
PORT	62	13,180	1,208	970 (±484)	7.4% (±3.7%)	$924	1.05
PWC	85	14,826	2,474	2,264 (±504)	15.3% (±3.4%)	$945	2.40
SCOPE	36	17,560	1,922	1,576 (±754)	9.0% (±4.3%)	$801	1.97
YACAC	141	10,585	2,205	2,334 (±266)	22.1% (±2.5%)	$993	2.35

Among High Use program providers, NCSB had the highest average savings at 2,560 kWh/yr. and YACAC had the second highest at 2,334 kWh/yr. The lowest savings were 806 kWh/yr for ACCAA (who also had the lowest savings in the previous evaluation). The table also shows that

spending varied widely by provider with EANDC spending the most at $1,458 per home and ACCAA spending the least at $728 per home. The last column in the table shows that YACAC produced the most kWh savings per dollar spent at 2.35 kWh/$ while PORT produced the least savings per dollar spent at 1.05 kWh/$. The analysis sample averaged 1.83 kWh per dollar spent.

Figure 9 shows these net savings by provider for the High Use program along with uncertainty bounds (±90% confidence intervals) shown by the capped lines. The width of each confidence intervals reflects both the sample size and amount of variability in savings for each provider. A reference line is shown at the average net savings for the analysis group of 1,650 kWh.

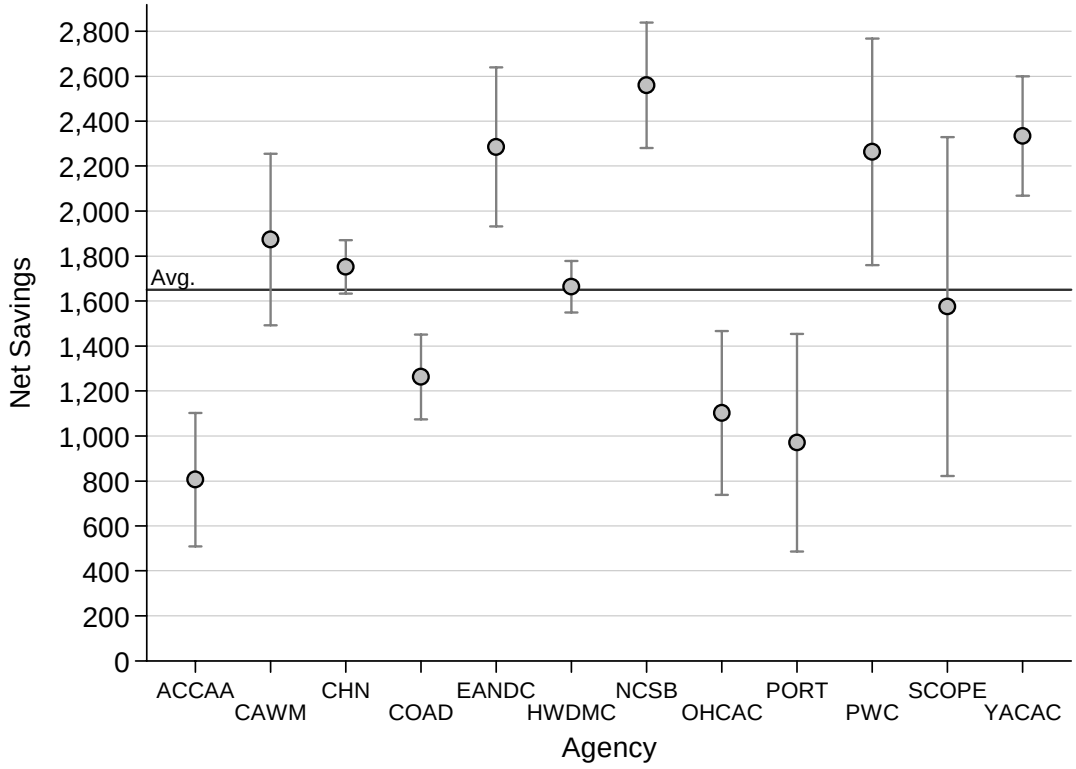

Figure 9. Net Savings by Provider: High Use Program
note: circle shows average net savings, capped lines show ±90% confidence interval

The figures illustrates the fact that four providers had average net savings that are statistically significantly higher than the overall statewide average (their capped lines are fully above the line showing the average) and four providers had savings that were significantly lower than the overall average.

Figure 10 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 graph shows that there is some relationship between projected and measured savings but realization rates vary widely by agency ranging from 43% for ACCAA (806 measured vs. 1868 projected) to 108% for NCSB (the only point above the line). Of the four highest saving agencies, one (EANDC) stands out as having a low realization rate (i.e. the data point is far below the line).

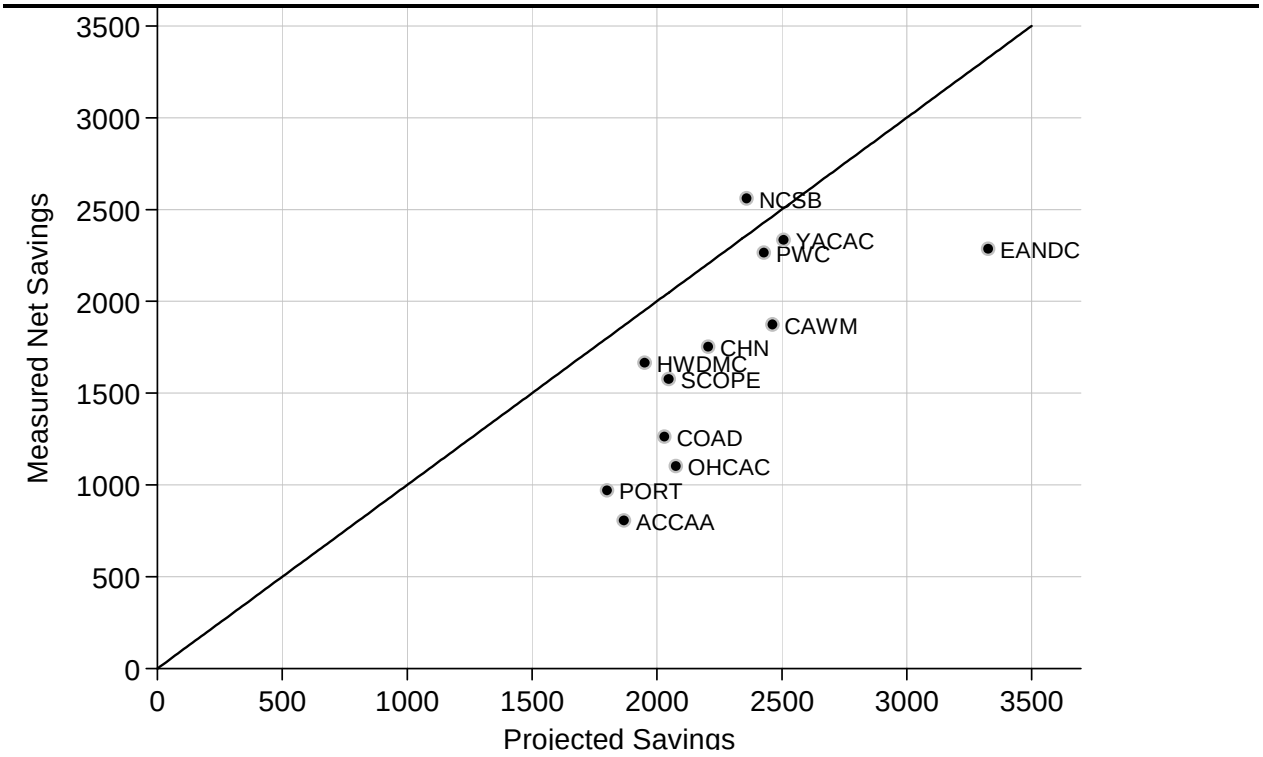

Figure 10. Measured vs. Projected Savings by Provider: High Use Program

Table 22 shows the net savings results for the Moderate Use program. Providers with fewer than 30 homes in the analysis are not shown.

Table 22. Moderate Use Program: Savings by Provider

Provider	# Homes	Pre-use	Gross Savings	Net Savings	Net % Savings	Cost $/home	Annual kWh per $ spent
ACCAA	39	6,366	786	809 (±420)	12.7% (±6.6%)	$542	1.49
CHN	506	6,004	645	725 (±115)	12.1% (±1.9%)	$757	0.96
COAD	34	6,967	585	497 (±411)	7.1% (±5.9%)	$601	0.83
EANDC	31	6,591	961	752 (±382)	11.4% (±5.8%)	$1,072	0.70
HWDMC	472	6,950	878	576 (±118)	8.3% (±1.7%)	$667	0.86
NCSB	75	6,734	1,408	1,095 (±269)	16.3% (±4.0%)	$883	1.24
PWC	30	7,224	156	203 (±480)	2.8% (±6.6%)	$685	0.30
YACAC	97	5,943	1,162	1,167 (±199)	19.6% (±3.3%)	$789	1.48

Moderate Use provider savings ranged from 203 kWh to 1,167 kWh. PWC had higher than average HU savings but the lowest MU savings (although the sample is small). ACCAA was the lowest cost provider and produced the most savings per dollar spent, followed closely by YACAC. On average, the moderate use program produced only slightly better than half savings of the High Use program per dollar spent.

Figure 11 graphs the net savings by provider and Figure 12 shows the savings vs. projections.

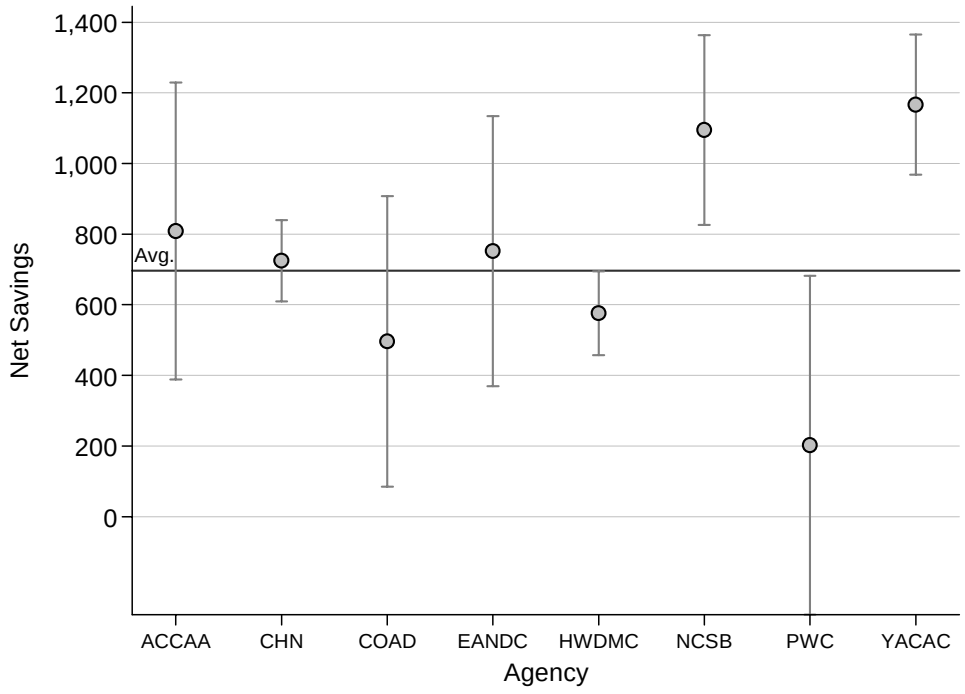

Figure 11. Net Savings by Provider: Moderate Use Program

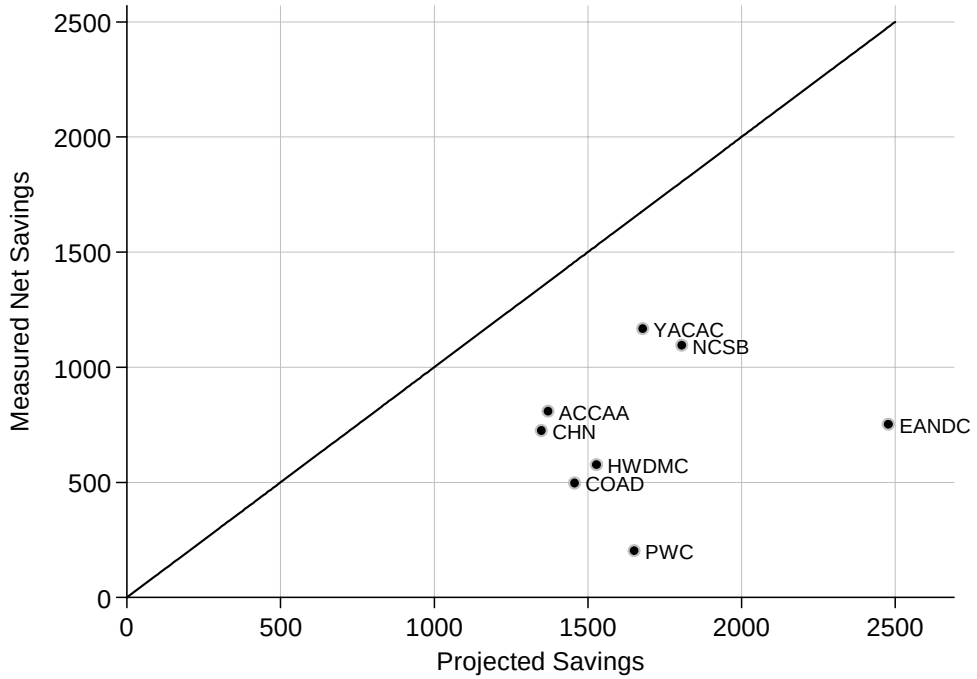

Figure 12. Measured vs. Projected Savings by Provider: Moderate Use Program

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. In Appendix A we describe some of the issues and challenges with analyzing bill payment data, but also suggest that the analysis for EPP could focus on confirming what seem like common sense assumptions:

- electricity savings should not affect PIPP customer payments in months where their bills are unaffected by usage (November through April).
- customer payments should decline in months where they are responsible for their full bill since their bills will be smaller and program savings should accrue to the customer.

The exact split of the bill savings between ratepayers and PIPP customers should depend on the seasonality of the electric savings and what proportion of the customers summer bills are smaller than their PIPP amounts (indicating that ratepayers should receive the benefits).

There are some complications however, since one could argue that customer savings in the summer months should enable them to better keep up with their summer bills and those bills sometimes go unpaid and end up being charged to ratepayers as pre-PIPP arrearages for customers who fail to make summer payments and make a new arrangement as the winter starts. Customer bill savings in the summer may help them make their regular PIPP payments in the winter. In addition, EPP provides some counseling to customers about paying their PIPP bills and can refer customers to other resources. If this work is having an effect it may lead to some additional improvement in bill paying behavior. In prior evaluations, we found slight support for these extra impacts as about 60% of the bill savings went to ratepayers and 40% went to the participants, approximately what would be expected based on the approximately 50/50 split in PIPP summer rule months.

In this evaluation, we compared payments in calendar year 2003 to payments in calendar year 2005 for 2004 program participants and for a comparison group composed of 2006 participants. We restricted the analysis to customers with between 11 and 13 billing transactions in both the pre and post treatment periods and calculated average monthly values and multiplied by 12.

We focused the analysis on customer payments compared to full bills because prior research has found that LIHEAP payments are often received immediately before usage reduction program participation (they are available at the same office as program enrollment), potentially biasing pre/post comparisons. In addition, data from the utilities on these payments appears somewhat inconsistent. Therefore, we focus on changes in the payment shortfall calculated without considering fuel assistance (so our "shortfall" overstates the true shortfall). We also made calculations including the fuel assistance payments.

We had sufficient data to analyze for 3,337 High Use participants, 197 TEE participants, and 975 Moderate Use participants. The results of the payment analysis are summarized in Table 23.

Table 23. Bill Payment Impacts : High Use Program (all values in $/year unless otherwise noted)

	Participants			Comparison Group	
	Pre	Post	Change	Change	Net Impact
High Use Program n=3,337					
Customer Payments	$646	$622	-$24	-$6	-$18
Full Bill (estimated)	$1,205	$1,143	-$62	+$98	-$160
Shortfall (Bill – Customer Pay)	**$559**	**$521**	**-$38**	**+$104**	**-$142**
Full Shortfall (Bill – All Pay)	$510	$468	-$42	+$94	-$136
Electric Usage kWh/yr	12,578	12,009	-569	+916	-1,485
# Payments Made: #/yr	7.4	7.4	0.0	0.0	0.0
Moderate Use Program n=975					
Customer Payments	$414	$403	-$11	-$3	-$8
Full Bill (estimated)	$633	$618	-$15	+$39	-$54
Shortfall (Bill – Customer Pay)	**$219**	**$215**	**-$4**	**+$42**	**-$46**
Full Shortfall (Bill – All Pay)	$193	$178	-$15	+$24	-$40
Electric Usage kWh/yr	5,845	5,719	-126	+341	-468
# Payments Made: #/yr	7.0	7.1	+.1	-.1	+.2
TEE Program n=197					
Customer Payments	$893	$1,022	+$129	+$152	-$23
Full Bill (estimated)	$2,240	$2.046	-$195	+$111	-$306
Shortfall (Bill – Customer Pay)	**$1,347**	**$1,024**	**-$323**	**-$41**	**-$282**
Full Shortfall (Bill – All Pay)	$1,251	$955	-$296	-$11	-$285
Electric Usage kWh/yr	27,232	24,856	-2,376	+1,388	-3,764
# Payments Made: #/yr	7.9	8.6	+.8	+1.1	-0.4

The table shows that, for High Use participants:

- full retail bills declined by $62 on average after treatment while the comparison group's bills increased by $98, yielding a net $160 reduction in retail bills. This result is generally consistent with the net savings analysis.
- customer payments declined by $24 while the comparison group payments declined by $6, yielding a net decline of $18 in customer payments – representing the participant's average out of pocket savings (due to reduced bills in the summer).
- The payment shortfall (defined as the difference between the full retail bills and the customer payments) declined by $38 for participants while increasing by $104 for the comparison group, yielding a net $142 reduction in the payment shortfall – this is the ratepayers' savings.

- **Overall it appears that the ratepayers received 89% of the High Use program bill savings** ($142/$160) while the participant received just 11%. This marks a major change from the 62%/38% split found in the prior evaluation and supports the idea that some extra payment behavior improvements have been achieved.
- The net raw usage reduction averaged 1,485 kWh, which is fairly similar to the weather-adjusted net savings of 1,534 found for this group of participants (apparently the payment analysis group is biased somewhat toward lower savers).
- The number of customer payments made per year did not change.

The table shows generally similar findings for the Moderate Use and TEE programs. In the Moderate Use program, ratepayers received 85% of the net benefits ($46 of $54). In TEE, ratepayers received 92% of the benefits but the small sample size gives this result considerable uncertainty. The table also shows that the overall conclusions are relatively unaffected by the inclusion of fuel assistance payments in the analysis.

It is not clear why the payment analysis results differ so markedly from the prior evaluations and from general expectations about how lower summer bills will affect PIPP customers. This issue deserves to be re-examined in the next evaluation of EPP.

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 24.

Table 24. Environmental Impacts of EPP

	CO2	NOx	SOx	PM-10
Emission Factor: pounds per kWh	2.1	0.005834	0.01881	0.000236
Annual Impacts: per participant	lbs.	lbs.	lbs.	lbs.
High Use Program	3,392	9.4	30.4	0.38
Moderate Use Program	1,464	4.1	13.1	0.16
TEE Program	6,617	18.4	59.3	0.74
Annual Impacts: program	tons	lbs.	lbs.	lbs.
High Use Program (n=7,614)	12,911	71,738	231,299	2,902
Moderate Use Program (n=2,187)	1,601	8,893	28,673	360
TEE Program (n=383)	1,267	7,041	22,701	285
Program Lifetime Impacts	tons	lbs.	lbs.	lbs.
High Use Program (n=7,614)	142,888	793,916	2,559,745	32,116
Moderate Use Program (n=2,187)	18,203	101,140	326,097	4,091
TEE Program (n=383)	19,259	107,004	345,002	4,329
Total	180,350	1,002,060	3,230,844	40,536

The table shows that EPP is estimated to reduce CO2 emissions by more than 180,000 tons over the life of the measures and provide reductions of more than a million pounds of NOx, 3.2 million pounds of SOx and about 40,000 pounds of PM-10 particulates. The reductions in NOx and CO2 are equivalent to removing about 2,500 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 of the refrigerator lifetime (assumed at 15 years in SMOC~ERS) and the lighting lifetime (based on an assumed 10,000 hours of burn time, adjusting the estimated hours of use downward by 25% to reflect our analysis results, and capping the life at seven years), and assuming a 20 year measure life for TEE weatherization treatments;
- 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 futuresavings);
- for program costs, include all costs paid to the local providers to perform the work including the per job audit and administrative fees. We did not include any administrative costs incurred by OEE.
- 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 25.

Table 25. Cost Effectiveness Analysis

	Program Cost	Savings kWh	Annual Bill Savings	Lifetime Energy Benefits	Net Benefit	Savings–Investment Ratio
High Use Program (per home)	**$896**	**1,615**	**$161**	**$1,345**	**$449**	**1.50**
Refrigerator (per unit)	$459	875	$87	$906	$448	1.98
Lighting (per home)	$270	677	$68	$391	$121	1.45
Moderate Use Program	**$726**	**697**	**$75**	**$635**	**$-91**	**0.87**
TEE Program	**$2,203**	**3,151**	**$268**	**$2,808**	**$605**	**1.27**

The High Use and TEE programs are producing cost-effective energy savings – the present value of the lifetime energy savings is greater than the cost of the program treatments, but the Moderate Use program appears to not be quite cost-effective based on energy savings alone. These results are generally similar to the previous evaluation that found SIRs of 1.32 for the

High Use program, 0.85 for the Moderate Use program, and 1.43 for TEE. The cost reductions in the High Use and Moderate Use programs improved their cost-effectiveness, especially for the High Use program.

The refrigeration measures are highly cost effective and produce the vast majority of the net benefits. Lighting measures were considerably more cost-effective than in the prior evaluation (which found SIR=1.15). In terms of simple payback time (cost divided by annual bill savings), the High Use program has a 5.6 year payback, the TEE program has a 8.2 year payback, and the Moderate Use program has a 9.7 year payback.

The TEE program's cost-effectiveness may be over-stated to the extent that other programs may have provided weatherization treatments to these homes. All three programs may be more cost-effective than shown if electric rates increase in the future.

The analysis shown in the table includes the entire benefit of the energy savings, but that benefit will be split between ratepayers and the participants. The payment analysis indicated that 85%-92% of the lifetime benefits will accrue to ratepayers through PIPP subsidy reductions and the remainder will accrue to the participants. This finding was unexpected as the proportion was at about 60% in each of the first two evaluations. If one uses these proportions and assesses the cost effectiveness of the programs from a ratepayer-only perspective, then the High Use and TEE programs both still appear cost-effective.

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 populations analyzed – the 7,614 High Use participants, 2,187 Moderate Use participants, and 383 TEE participants treated from April 2004 through March 2005. The results of these calculations are summarized in Table 26.

Table 26. EPP Aggregate Impact Summary (April 2004 through March 2005)

	High Use		Moderate Use		TEE		
	Per Home	Program	Per Home	Program	Per Home	Program	Total Program
# Participants		7,614		2,187		383	10,184
Program Cost	$896	$6,822,144	$726	$1,587,762	$2,203	$843,749	$9,253,655
Electric Savings: kWh/yr	1615	12,296,610	697	1,524,339	3151	1,206,833	15,027,782
Annual Retail Bill Reduction	$161	$1,227,202	$75	$162,952	$268	$102,701	$1,492,855
Lifetime Bill Reductions PV	$1,345	$10,240,348	$635	$1,387,912	$2,808	$1,075,505	$12,703,765
-Ratepayer benefits	$1,197	$9,113,910	$539	$1,179,725	$2,583	$989,464	$11,283,099
-PIPP Customer benefits	$148	$1,126,438	$95	$208,187	$225	$86,040	$1,420,665
Net Savings $	$449	**$3,418,204**	-$91	**-$199,850**	$605	**$231,756**	**$3,450,110**
Savings to investment Ratio - overall	1.50	**1.50**	0.87	**0.87**	1.27	**1.27**	**1.37**
Annual Emission Impacts:							
CO2 (tons/yr.)	1.70	12,911	0.73	1,601	3.31	1,267	15,779
NOx (lbs./yr.)	9.4	71,738	4.1	8,893	18.4	7,041	87,672
SOx (lbs./yr.)	30.4	231,299	13.1	28,673	59.3	22,701	282,673
PM-10 (lbs./yr.)	0.38	2,902	0.16	360	0.74	285	3,547

The 10,184 homes served by EPP in the analysis period are saving about 15 million kWh per year leading to retail electric bill reductions totaling about $1.5 million. The present value of these bill savings over the life of the measures is about $12.7 million. The costs to treat these homes totaled $9.3 million, yielding $3.5 million in net benefits and providing a savings to investment ratio of 1.37. The $12.7 million in lifetime bill savings are estimated to reduce the cost of PIPP by $11.3 million and provide $1.4 million in direct savings to the participants.

In addition to providing these financial benefits, the program is estimated to provide annual reductions in pollutant emissions totaling more than 15,000 tons of CO2, more than 87,000 pounds of NOx, more than 280,000 pounds of SOx and more than 3,500 pounds of PM-10 particulates. These impacts are equivalent to 2,800 average cars of CO2 emissions and 2,300 cars of NOx emissions annually.