Impact of Flipping the Switch: Evaluating the Effectiveness of Low-Income Residential Energy Education Programs

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ABSTRACT

Evaluations of different low-income energy education initiatives have revealed wide variability in energy savings. This paper utilizes data from a number of energy education programs to illustrate the evaluated energy savings. The paper includes a discussion of methods for and challenges of assessing impacts of energy education programs. Topics covered include the advantages and disadvantages of participant self-reporting, participant surveys, use of engineering algorithms to calculate savings, and billing analysis.

In addition, we describe best practices observed for low-income energy education programs, which are applicable to both programs offered in conjunction with other programs and those offered on a stand-alone basis. Finally, to assess effectiveness of different approaches, we map educational strategies to program outcomes.

Introduction

Low-cost measures and energy education are important mechanisms to provide materials and information to help low-income households reduce their energy expenses over the long term. The need for low-income energy assistance is large. For example, every year in Oregon (with conditions similar to most states), approximately 400,000 eligible families receive no assistance in reducing their energy usage or energy costs (Khawaja 2007). Energy assistance and weatherization play a crucial part in reducing low-income families' energy burdens. Energy assistance, however, is limited annually by state and federal budgets, and is helped in small part by the generosity of customer contributions. State- and utility-sponsored weatherization programs offer great energy savings to a small number of households. However, they are often unable to assist people living in rental properties when an owner must fund a portion of the improvements.

In contrast, energy education programs, which include the use of low-cost energy-efficiency measures, help overcome these obstacles because they can be offered to a very large number of families, generally do not require approval from the property owner or manager, and do not require an investment by the resident. The programs provide families with the knowledge and tools to install low-cost, energy-efficiency measures, change some behaviors, gain more control over their energy use, and pocket the benefits from saving on their energy bills. These habits and measures are transportable and stay with the client. Energy-efficiency classes and tools allow access to and awareness of energy savings that may not otherwise be available.

Energy education can be a source of significant energy savings at both the household and program level. Households have reported savings of $8 to $45 per month from simply installing energy-efficiency measures and instituting some simple energy-saving behaviors in their homes (Berney et al. 2007).

A host of energy education programs in the late 1980s and early 1990s demonstrated the benefit of energy education for low-income households (PACE 1994). Those efforts continue today; many weatherization programs include energy education as a standard offering to their clients, a number of utilities and states sponsor stand-alone energy education programs for low-income households and students (Khawaja, Steiner 2005; Steiner 2006). Savings generated from evaluated energy education programs have ranged from 2% to 16% of pre-treatment consumption (PACE 1994, Quantec studies).

The energy education programs generally offer:

- An overview of energy sources and an explanation of how energy reaches the home;
- Discussion of energy-using equipment in a household and identification of household fuels;
- Review of average energy costs overall and by end-use, and other factors contributing to those costs;
- How to manage large-cost end uses, such as heating, cooling, hot water usage, and refrigeration;
- The cost and energy benefits of installing efficiency tool kit measures; and
- Measure installation demonstrations and practice.

Tested approaches to delivering energy education include offering it as: an additional component of low-income weatherization programs, workshops, or in-home delivery with energy-efficiency tool kits; as a one-time or multiple session; and in videos or other media. Energy education, when combined with weatherization, can help protect investment in a home while encouraging the adoption of behaviors to save a household additional dollars. These delivery mechanisms often not only include energy education, but also an energy-efficiency component—most often low-cost, energy-saving materials that participants install themselves.

Energy-efficiency tool kits typically include compact fluorescent lamps (CFLs), a high-efficiency showerhead, high-efficiency faucet aerators (for the bathroom and kitchen), a furnace filter alarm, and tools for measuring room temperatures and temperatures of water heaters, refrigerators, and freezers. Some kits also include: high-efficiency, hand-held showerheads; infiltration reduction tools such as caulk, plastic window covering, light switch plate and outlet gaskets, and rope putty (backer rod); an LED night light; a shower timer; and a digital space heat thermometer.

This paper reviews methodologies used to evaluate the impacts of energy education, summarizes results from Quantec energy education evaluations, compares those with other evaluated programs, and offers a short list of energy education best practices gleaned from program evaluations and through developing, delivering, and assessing energy education training.

It should be noted that we do not wish to imply energy education and low-cost measures are a substitute for the valuable services provided by weatherization programs. We simply suggest that, due to budgetary and capacity constraints, states are not able to provide weatherization services to large numbers of households in need. Energy education provides temporary relief when offered as a stand-alone program. When offered in conjunction with weatherization, it further increases savings. We also believe energy education programs can be used as a screening tool for improving weatherization targeting.

Methodologies for Assessing the Impact of Energy Education

Measurement and Verification

Measurement and verification costs are often constrained, and low-income programs are not exempt. Measurement protocols described in The International Performance Measurement and Verification Protocol suggest using Option A where combined uncertainty from all estimates will not significantly affect overall reported savings and estimates are realistic, achievable, and based on equipment that can produce savings (Efficiency Valuation Organization 2007). Option A is used where multiple energy conservation measures are installed, and savings are expected to be less than 10% of the utility metered consumption. Option A is less costly than metering and can be used to control evaluation costs when key parameters used to compute savings are well known. These parameters are met in the low-income energy education programs evaluated, and the surveys plus engineering algorithms employed in the evaluations are a reasonable and cost-effective means of estimating savings. The survey methods, findings, and engineering algorithms used to estimate savings for several of Quantec's low-income energy education evaluations are discussed in the sections that follow.

Written Surveys

Most of the programs evaluated by Quantec (Table 1) utilize written surveys, completed by participants after installing their energy-efficiency measures. The surveys integrate data collection directly into program delivery. The surveys collect key characteristics that define baseline consumption (type of equipment, occupancy, and pre-installation usage factors), measure installation rates, and record changes in behavior affecting energy use. These surveys are then analyzed to assess program impacts. The data collection tools are also designed to capture key household characteristics that impact energy consumption, increase awareness of energy-using equipment in the home, remind participants of measures they can install and actions they can take to impact their energy usage, and provide a measure of accountability with program participants.

Participants are often asked to measure showerhead and kitchen sink faucet aerator flow rates. Measuring flow rates is demonstrated within the workshop or classroom; however, it can be difficult to perform the measurements with great precision. In some programs (South Carolina, Oregon REACH, Energy Smart), agency staff actually have done most measuring and installations with participants and have helped them fill out their surveys. Often between 20% and 50% of participants replacing their showerheads or faucet aerators do not measure the flow rate of their replaced or new equipment (no measurements are included with returned surveys). Data are screened for outliers; for example, showerhead flow rates of 10 gallons per minute (GPM) were excluded. While post-installation flow rates of 1.5 GPM were reported, the lowest evaluated rate used 1.8 GPM as a conservative estimate.

Response rates can be a drawback when using surveys returned by clients via mail to assess program impacts. One-time, energy education sessions, followed by mail-in surveys, can result in low response rates of around 30% (Drakos et al. 2005). When energy education is part of a school classroom setting or has multiple sessions as part of the program offering, securing completed participant surveys is less difficult.

Early respondents are likely to be families with a greater tendency to take action. One evaluation showed that later respondents (those responding because incentives increased from $10 to $25 for returned surveys) installed measures at reduced rates, from 1% to 9% lower (Khawaja et al. 2003). Prior to this finding, savings were estimated by attributing respondents' pre-usage characteristics and installation rates to nonrespondents without discounting. With this finding, however, participant households have been classified as either respondents (those who returned written surveys) or nonrespondents (those who did not return written surveys). To establish the "high" end of savings estimates, survey respondents' self-reported pre-installation usage characteristics and measure installation rates have been used. The "low" savings estimate participant nonrespondents install measures at half the rate of participant respondents. Program and "average participant" savings are computed as the weighted average of the high and low savings estimates. Reducing the participant nonrespondent installation rates to half that of respondents' corrects for self-selection bias of respondent participants and provides a reasonable range of expected savings.

Phone Surveys

Participant phone surveys in the weeks directly after energy education delivery allow an evaluator to capture information about energy-efficiency retrofits completed. Phone surveys have also been used to analyze participant satisfaction with energy-efficiency products included in tool kits. Participant phone surveys offer an opportunity to assess the quality of energy education offered and whether the energy conservation messages a participant receives are remembered, compelling, and acted upon. The survey can also uncover problems or misinformation delivered through energy education. These surveys provide valuable information for the program implementer. When several respondents stop using a product, the program sponsor and supplier can determine if a product quality issue occured or an energy conservation tool is inappropriate for a population. For example, in a program evaluated by Quantec, the feedback about hot water thermometers, showerheads and aerators resulted in changes to the kit products provided by Resource Action Programs.

The challenges inherent in phone surveys are endemic to assessing any low-income program. The percentage of bad contact information and disconnected numbers can be 30%-50% of the sample (Drakos, Khawaja 2006). Participants easiest to reach are more likely to be stable households where the likelihood of taking action may be higher. Respondents may be inclined to respond positively to the program because of other assistance received by an agency. As mentioned above, nonrespondents' data are discounted to account for this potential self-selection bias.

Engineering Algorithms and Measure Savings

Commonly accepted engineering algorithms and respondent-provided installation data allows cost-efficient analyses of energy education program savings. The calculations defined below use the installation rates, baseline usage, and pre-installation characteristics reported by respondents. Algorithms used to calculate impacts of the common tool kit measures are also shown.

Compact Fluorescent Lamps. In addition to bulb installation rates, participant surveys ask the wattage of replaced bulbs and average daily usage of the fixtures. The following formula is used to calculate annual CFL savings:

$$\frac{(\text{No. of participants} \times \text{installation rate}) \times (\text{Average hours/day} \times 365\ \text{days}) \times (\text{Wattage replaced} - \text{Wattage CFL})}{1{,}000}$$

In all cases presented below, the estimated savings of the installed CFL were within the range of estimate provided by other more costly and detailed studies.

High-Efficiency Showerhead. Installation of high-efficiency showerheads result in water and electric or natural gas savings. In a PacifiCorp evaluation, savings from efficient showerheads were evaluated using extensive on-site data collection and measurement (Khawaja, Reichmuth 1998). Savings estimated in the low-income program evaluations cited in this paper, using participant data and engineering algorithms, conform to savings estimated in the PacifiCorp study.

Program participants were provided with instructions during the energy education and were asked to measure and report the GPM flow rate of their existing showerheads and then with the replacement showerheads. They reported the average number of showers per week and average length of showers across household members. Annual household water savings from efficient showerheads were calculated as: [1]

(Average reported pre GPM - Estimated post GPM) x *(Minutes of use per day* x *365 days)*

$$\text{Annual electric water heater kWh saved} = (No.\ participants \times installation\ rate \times percent\ with\ electric\ water\ heat) \times Annual\ water\ savings\ per\ participant \times \left(\frac{8.33\, lbs./gallon \times 40°F\Delta T}{3{,}413 \times water\ heater\ efficiency(0.90)} \right)$$

$$\text{Annual gas water heater therms saved} = (No.\ participants \times installation\ rate \times percent\ with\ gas\ water\ heat) \times Annual\ water\ savings\ per\ participant \times \left(\frac{8.33\, lbs./gallon \times 40°F\Delta T}{100{,}000 \times water\ heater\ efficiency(0.60)} \right)$$

Faucet Aerators. Savings from faucet aerators are calculated in the same manner as the showerhead savings.[2] The key information used to determine the kitchen and bathroom aerator savings includes participant measured pre- and post-installation flow rate, average water usage per day, fuel saturations, and the average installation rate. Kitchen faucet savings estimate average kitchen sink water usage as 15 minutes per day plus 1 minute per occupant for households without dishwashers. For households with dishwashers, usage was estimated at 3 minutes per day plus an additional 30 seconds of usage per occupant. Bathroom faucet use is assumed to be approximately 1.5 minutes per day per household member. Studies reviewed to develop these estimates relied primarily on self-report data.

Furnace Filter Alarm. Over time, significant solids, such as dirt and dust, build-up on furnace filters. This build-up creates pressure that activates a furnace filter alarm and alerts a resident to change the filter. Savings resulting from more regular filter changes are estimated to be 2% of the base energy consumption for heating (Reichmuth 1999). The Energy Information Administration's Residential Energy Consumption Survey (EIA RECS) Reports have been consulted for average heating consumption per household based on the climate of the program delivery area, with average consumption generalized to the participant population. The problems inherent with the EIA RECS are that data are from 2001 and are not adjusted for the low-income population, house size, specific demographics, or the quality of their housing stock.

Space Heating and Cooling Temperature Adjustment. For most households, the best method for saving energy and money is lowering the thermostat in the winter and raising it in the summer. For every degree change in temperature, an average 2% decrease in consumption for heating or cooling occurs (Morrill et al. 2003). The EIA RECS data has been used to determine baseline energy consumption for space heating and space cooling in different climate zones.

Water Heater Temperature Adjustment. Households reducing their water heater temperature can save energy and protect family members from scalding. A household reducing their water heater temperature 10 degrees will reduce water heating energy usage by 4% (Morrill et al. 2003). Again, the EIA RECS data have been used to determine baseline energy consumption for hot water heaters for different climate zones. However, surveys and discussions indicate that sometimes water heaters are

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1 A Btu is the amount of energy it takes to raise the temperature of 1 pound of water 1 degree F. 8.33 is a conversion factor for gallons to pounds; 45 degrees is the assumed temperature difference between ground water and delivered water in the shower; in the kWh calculation for electric water heaters, division by 3,413 converts Btu to watts; in the therms calculation for gas water heaters, division by 100,000 converts Btu to therms. The assumed efficiency of the electric water heater is 90%; the assumed efficiency of the gas water heater is 60%.

2 Assumed 35°F temperature increase at kitchen sink.

turned too low, and residents raise the temperature. The number of increasing and decreasing temperatures often result in very little savings from water heater temperature adjustments.

Refrigerator and Freezer Temperature Adjustment. Evaluations use a conservative estimate of 1% savings for every degree a refrigerator, freezer, or stand-alone freezer is turned up. Most recently, participant self-report data showed more participants turn down their refrigerator and freezer temperatures (to protect their food quality) than turn up the temperature (which can also be a food quality issue). Quantec recently estimated zero savings for refrigerator and freezer adjustments.

Billing Analysis

Billing analysis employing weather-normalized customer consumption data provided by a utility is commonly used to estimate impacts of demand-side management programs. To estimate net program savings, the change in pre- to post-program participant energy consumption is compared with a group of similar customers who did not participate in the program. Billing analysis typically requires consistent residency for two or more years, including one year before and one year after measure installation.

Quantec used billing analyses to calculate savings for the Indiana REACH program which focused on low cost measures and behavior modification (Khawaja 2001). Results from the billing analysis showed a slightly higher level of savings (gross annual about 1,000 kWh) than those calculated with engineering algorithms (gross) for programs with similar measures and energy education. We feel the engineering algorithms are not overstated and conform to the billing analysis. Quantec typically opts to use surveys and engineering estimates in low-income evaluations for several reasons:

- Low-income households have higher rates of mobility than the rest of the population (Colton 1994), consistently reducing the size of available study population using pre- and post-billing analyses.
- Changes in household demographics affect energy usage both positively and negatively on a greater scale than energy education and energy-efficiency measures. Billing data are inherently too "noisy" to see savings estimates less than 10% of pre-consumption levels.
- Billing analysis can be costly, and the added cost to the program can negate the cost-effectiveness of an entire program.
- We strongly believe that when the measure savings are established in more rigorous studies, the use of self-reported data provide sufficiently reliable estimates of total savings.

Overview of Energy Education Initiatives

Quantec has evaluated over ten energy education programs in seven states. Table 1 below shows selected evaluation findings. Table 2 is a comparison of individual measure installation rates and savings from various Quantec evaluations. Table 3 details the maximum and minimum installation rates and electric and natural gas savings across the programs cited in Table 2. The key for program acronyms used in Table 3 are provided in Table 2 headings.

Quantec evaluations, using billing analysis and engineering algorithms, show savings for stand-alone energy education programs ranging from 2.5% to 12.5% of annual consumption. These savings align with those found in a number of energy education programs evaluated with billing analysis. These low-income programs, included in PACE (1994), combined energy education with weatherization and/or distribution of energy-efficiency measures to participant families. Savings ranged between 3% and 16%, depending on the program. The most significant savings were found when households participated in several energy education sessions.

Many factors beyond installation rates determine savings generated by these energy education programs:

Table 1. Summary of Quantec Evaluated Low Income Programs

Program	No. of Partici-pants	Surveys Returned	Avg. Electric Savings (KWh)	Avg. Gas Savings (therms)	Percent Electric Savings	Percent Gas Savings	Societal Cost Test	Program Delivery	Evaluation Method
Indiana REACH Energy Education 1999 - 2001	74	29	462 *** 1,548****		3.6%*** 12.5%****		Not available	Limited number of participants in REACH program also received energy education.	Participants were surveyed by phone and mail. Surveys asked participants to recount recommendations made in the workshops and any action taken. Billing analysis compared energy education participants and REACH participants not receiving energy education.
Indiana Energy Education Program 2002-2003	12,714	8,106	695	44	6.7%	6.0%	Not available	One client workshop delivered during LIHEAP intake. On-site at senior and disabled housing. Year 2 returning participants received different kit measures.	Participant mailed-in surveys.* Non-respondents assumed to install at ½ respondent rate. Follow-up phone surveys in year 1 and 2. Adjusted engineering savings.
Iowa Energy Wise Program 2004-2005	990	425	462	91.3	5.7%	10.8%	4.7	One client workshop delivered at agency, on-site with other low income programs.	Participant mailed-in surveys.* Responses extended to all participants. Adjusted engineering savings.
South Carolina Energy Wise Program 2004-2005	1,200	756	831	15.1	6.0%	3.0%	Not available	One workshop or education delivered one-on-one in client's home or at agency.	Participant mailed-in surveys.* Responses extended to all participants. Adjusted engineering savings.
Washington Low-Income Bill Assistance Energy Education Component 2005-2006	1,436	956	890	N/A**	5.7%		1.53	Two client workshops delivered at agency, on-site with other low income programs. English and Spanish.	Participants completed two surveys* over the course of the two workshops. Non-respondents assumed to install at ½ the respondent rate. Follow-up phone surveys in year 1 and year 2. Adjusted engineering savings.
Iowa LivingWise Energy Ed in Schools 2005-2006	1,045	478	386	22.1	2.5%	2.5%	Not available	Classroom curriculum delivered by the school's 6th grade science teachers.	Students filled out two surveys* as their homework. Non-respondents assumed to install at ½ the respondent rate. Adjusted engineering savings.
Washington Energy Education in Schools 2006-2007	3,160	2,701	782		5.0%		2.02	Three classroom sessions taught to 6th graders by science teacher employed by community action agency. Showerheads only distributed to those students with electric water heating.	Students filled out three surveys* as homework. Responses extended to all participants. Adjusted engineering savings.
Utah LivingWise Energy Ed in Schools, 2001	4,571	2,927	654	57	6.6%	9.2%	1.51	Classroom curriculum delivered by the school's 6th grade science teachers.	Students filled out two surveys* as homework. High savings – responses extended to all participants. Low savings – nonrespondents installed at ½ respondent rate. Weighted average reported.

*All surveys included questions on baseline household characteristics: number of occupants, type of space- and water-heating equipment, type of cooling equipment. Surveys also asked for current household energy usage information, whether provided energy-efficiency tools were installed, and what type of equipment they replaced. ** Program provided to electric utility customers using electric space and water heating. *** Energy education participants change in annual consumption. **** Energy education participants compared to nonparticipants' change in annual consumption.

Table 2. Quantec Evaluated Energy Education Programs 2001 - 2006

Measure	Indiana Low Income Energy Education 2003-2004 (IN)			Iowa Energy Wise 2004-2005** (IA EW)			South Carolina Energy Wise 2004-2005** (SC)			Oregon REACH Energy Education Only Participants 2005-2006 (OR)			Washington LI Energy Education 2005-2006* (WA LI)		Utah LivingWise Energy Education in Schools Program 2001 (UT)			Kentucky- National Energy Education Development (NEED) Program in Schools 2003 – 2005 (KY)			Washington Energy Ed in Schools 2005-2006* (WEE)		Iowa LivingWise Energy Education in Schools 2005-2006 (IA LW)		
Measure Installation Rates, Electric and Natural Gas Savings per Average Household																									
	Rate	kWh	Therms	Rate	kWh	Therms	Rate	kWh	Therms	Rate	kWh	Therms	Rate	kWh	Rate	kWh	Therms	Rate	kWh	Therms	Rate	kWh	Rate	kWh	Therms
CFL – 1	95%	95		94%	74		94%	73		91%	64		90%	88	99%	99		73%	49		94%	95	70%	32	
CFL – 2	89%	66		90%	71		91%	69		90%	50		88%	79											
Showerhead	57%	224	7.4	67%	118	27.0	71%	394	4.0	58%	374	0.6	26%	349	63%	209	36.0	40%	181	8.0	75%	199	41%	187	8.7
Kitchen Aerator	64%	59	1.9	52%	41	7.8	78%	56	0.6	58%	127	0.2			70%	23	17.0	31%	27	1.0	79%	74	55%	41	1.9
Bathroom Aerator	59%	29	1.0	54%	22	4.1	68%	37	0.4	67%	60	0.1						34%	22	1.0					
LED Nightlight													53%	32	93%	17					95%	8	78%	12	
Outlet Gaskets										51%	17	0.1	56%	5											
Filter Tone Alarm				71%	23	2.7	68%	40	3.4						52%	35	3.2						29%	7	1.5
Behavioral Change Rates, Electric and Natural Gas Savings per Average Household																									
Adjust Hot Water Heater	48%	31	1.9	30%	13	2.7	30%	42	0.5	20%	32	0.1			62%	32	4.0	13%	9	0.5			22%	9	0.6
Adjust Heating	50%	108	27.2	30%	40	20.1	30%	80	6.0	64%	211	0.8	8%	29	70%	44	11.1	61%	14	2.0	75%	135	54%	62	9.4
Adjust Air Conditioning	41%	55		30%	19		30%	12		4%	1		1%	0.3	65%	38					67%	17	66%	37	
Adjust Refrigerator and/or Freezer															51%	13		12%	3						
Reduce Hot Water Use				30%	8	1.4	30%	29	0.2	41%	67	0.1	5%	8											
Purchase & Install Additional CFLs													2%	4							59%	75			
Change Furnace Filter	57%	28	4.5										3%	2											
Reduce ShowerTime										25%	97		64%	281							80%	178			
Total		**695**	**43.9**		**429**	**65.8**		**832**	**15.1**		**1,100**	**2.0**		**877**		**507**	**84.6**		**305**	**12.5**		**781**		**387**	**22.1**

* These programs were sponsored by an electric utility, therefore only kWh savings are reported by measure. ** These two program surveys did not ask participants to specify energy saving behaviors instituted in their home after energy education. Using past program analyses, we estimated an average 30% of participants would institute these behavioral changes.

Table 3. Quantec Evaluated Energy Education Programs Maximums and Minimums

Measure Installation Rates, Electric and Gas Savings per Average Household												
	Installation Rates				Electric Savings (kWh)				Natural Gas Savings (Therms)			
	Max	Program	Min	Program	Max	Program	Min	Program	Max	Program	Min	Program
CFL – 1	99%	UT	70%	IA LW	99	UT	32	IA LW				
CFL – 2	91%	SC	88%	WA LI	79	WA LI	50	OR				
Showerhead	75%	WEE	26%	WA LI	394	SC	118	IA	36.0	UT	0.6	OR
Kitchen Aerator	79%	WEE	31%	KY	127	OR	23	UT	17.0	UT	0.2	OR
Bathroom Aerator	68%	SC	34%	KY	60	OR	22	IA EW	4.1	IA EW	0.1	OR
LED Nightlight	95%	WEE	53%	WA LI	32	WA LI	8	WEE				
Outlet Gaskets	56%	WA LI	51%	OR	17	OR	5	WA LI	0.1	WA/OR	0.1	WA/OR
Filter Tone Alarm	71%	IA EW	29%	IA LW	40	SC	7	IA LW	3.4	SC	1.5	IA LW
Behavior Change Rates, Electric and Gas Savings per Average Household												
Adjust Hot Water Heater	62%	UT	13%	KY	42	SC	9	KY	4.0	UT	0.1	OR
Adjust Heating	75%	WEE	8%	WA LI	211	OR	14	KY	27.2	IN	0.8	OR
Adjust Air Conditioning	67%	WEE	1%	WA LI	55	IN	0.3	WA LI				
Adjust Refrigerator or Freezer	51%	UT	12%	KY	13	UT	2.5	KY				
Reduce Hot Water Use	41%	OR	5%	WALI	67	OR	8	WA LI	1.4	IA EW	0.1	OR
Purchase & Install Additional CFLs	59%	WEE	2%	WA LI	75	WEE	4	WA LI				
Change Filter	57%	IN	3%	WA LI	28	IN	2	WALI	4.5	IN	4.5	IN
Reduce Showering Time	80%	WEE	25%	OR	281	WA LI	97	OR	0.2	OR	0.2	OR
Minimum and Maximum	99%		1%		394		0.3		36.0		0.1	

- **Pre-installation usage characteristics.** Especially in the case of showerheads, the average household savings can be affected dramatically by the difference in average pre-installation flow rate of 0.1 GPM. Replacing incandescent lighting can also show varied savings depending on the wattage of the bulb replaced and the reported hours of operation.
- **Fuel saturations for different programs.** In Oregon's REACH program, the low-income population lives largely in homes with electric water and space heating. Utah, on the other hand, is dominated by homes with natural gas. Hence, Utah's program is cited several times in Table 3 under the "Max" average household natural gas savings.
- **Specific energy efficiency measures supplied by a program.** The participants from the Washington low-income energy education program installed outlet gaskets at a much higher rate than the Oregon REACH participants. However, the Washington program offered only one outlet gasket per household, while the Oregon program offered four. The inclusion of shower timers in a kit helps households remember to reduce their showering time and report that behavior change.
- **Survey tools created for the program.** While many of the surveys listed specific energy saving behaviors and action items and asked if participants would use them, the Washington low-income energy education survey asked participants to name (unprompted) the energy saving behaviors they would institute. The Washington low-income program often had the "Min" rate for behavioral changes.

The programs showing the highest installation rates are: the Washington Energy Education in Schools; the Utah LivingWise Energy Education in Schools; and the South Carolina Energy Wise Program. The delivery strategies for these programs provide some clues to the effectiveness of different education approaches. The Washington program is delivered through three classroom sessions, provided by teachers working for local community action agencies. The teachers have delivered this program over the course of three school years. They provide hands-on activities in the classroom as well as give away door prizes at assemblies at the end of the school year. The benefit of the Washington program is that the classes: are provided by the community action agency teachers, giving the classroom teacher some downtime; provide an interesting new "face" in the classroom; and energy teachers are relatively visible at the schools.

The Utah LivingWise program, offered for just one year, was enthusiastically implemented by teachers and shows good installation rates. The South Carolina Energy Wise Program was delivered to some participants as a workshop and to others in the home, providing some assistance installing energy-efficiency measures. This methodology was especially helpful for seniors, who were often less able to install measures (Drakos et al. 2006). The other benefit of the in-home education is that as many as 20% of households indicate they do not install energy-efficiency measures because they require assistance, and another 10% state they plan to install measures at a later date (Khawaja et al. 2003). The in-home energy education helps reduce both barriers.

Energy Education Best Practices

Energy is an abstract concept, and, in most people's daily lives, it is hardly considered. Electric or natural gas meters are relatively unnoticed by household members. The expense of energy may be considered when a household receives a bill or when rising fuel prices make the local news.

Energy education should help participants understand how energy is used in the home and empower families to generate their own energy savings. Quantec has found the most effective energy education includes client-specific messages, an action focus, a highly interactive atmosphere with hands-on learning opportunities, the translation of energy impacts to dollars saved, written commitments from clients, and follow-up with participants. A short list of findings and best practices based on evaluations and direct involvement in the development and delivery of energy education training include the following.

Educate participants on the energy using equipment in their homes. Participant surveys and discussions with agency staff show that prior to energy education, many people do not always make a connection between energy-using equipment in their homes, their overall energy use, and their energy bills (Drakos, Khawaja 2007). We have found even some community action agency staff are unaware of the energy usage of a CFL versus an incandescent light bulb. Participants have also indicated they did not know their furnace had a filter, let alone it should be changed regularly (Drakos et al. 2006, 2007).

Appeal to different learning styles. The majority of people do not incorporate new knowledge through a lecture or by reading a flyer. Some people learn visually, thinking and learning best in pictures and visual displays, including graphs and charts. Others learn best using their auditory senses, talking things through and listening to others. For these people, written information will have little meaning. Some people learn best kinesthetically, through the use of their tactile senses. People who learn this way should be engaged with physical activities and exploration of energy conservation measures and their use (Furjanic, Trotman 2000). Recognizing this, energy education programs integrate all learning styles.

Connect energy to money. Sharing with families all the different ways in which they "spend" energy and encouraging them to calculate their annual energy expenses helps define the need for saving energy. Some programs have encouraged families to make a game of calculating energy use from day to day or week to week by checking power meters (Drakos et al. 2006).

Gift low-cost, energy-efficiency measures. The most simple method to save energy is installing low-cost, energy-efficiency measures, such as high-efficiency showerheads and aerators. These measures require only a small time investment and can deliver significant savings (Drakos et al., 2006). Participants do not have to change their lifestyles to experience those savings.

Engage children in energy efficiency. The natural enthusiasm of children can be harnessed by educators and parents to help families achieve greater energy efficiency. Some of the most highly successful and widely supported programs we have evaluated are energy education programs in schools. If the kids are engaged and interested, they educate their families and understand the value of their work.

Schedule energy education in coordination with the LIHEAP application process. Agencies reported scheduling several energy education and LIHEAP application appointments at the same time. Applicants arrive and are checked-in by agency staff to assure all necessary paperwork has been completed. While applicants attend the energy education session, applications are processed. Depending on the number of attendees and staff, the applicants may be notified of their award levels at the conclusion of the education session (Khawaja et al. 2003).

Hold sessions in coordination with other agency activities or in conjunction with community events. Agencies recruited participants through other activities held at their agencies, such as Head Start and *Share the Warmth,* allowing them to conduct sessions outside their energy assistance cycle, which for many agencies is the busiest time of year. Further, it addressed other barriers that may preclude attendance at energy education by a LIHEAP participant, such as the availability of childcare.

References

Berney, J., Drakos, J. Khawaja, M.S., 2004-2006 Oregon REACH Program Interim Report April, 2007.

Drakos, J., *Iowa T3 Training*, Memo to Jack Clark, Iowa Utilities Association, Jan. 2007, Feb. 2007.

Drakos, J., Hedman, B., *School-Based Energy Education – 2005 – 2006,* Memo to Matt Daunis, Aquila Networks, Fred Neu, Atmos Energy, Lisa Pucelik, Alliant Energy, February 2007.

Drakos, J., Khawaja, M.S., Low Income Bill Assistance Program: Adult Energy Education Pilot Component, Year 2, January 2007.

Drakos, J., Khawaja M.S., Steiner, J., Low Income Bill Assistance Program: Adult Energy Education Pilot Component, Year 1, June 2006.

Drakos, J, Munk, D, Steiner, J., Iowa Energy Wise Program Analysis, December 2005.

Drakos, J, Munk, D, Steiner, J., *Preliminary Energy Wise Analysis,* Memo to Jack Clark, Iowa Utilities Association, July 2005.

Drakos, J, Munk, D, Steiner, J., South Carolina Energy Wise First Year Program Summary and Recommendations, Jan 2006.

Efficiency Valuation Organization, International Performance Measurement Verification Protocol, 2007.

Energy Information Administration, Residential Energy Consumption Surveys, 2001.

Furjanic, S. W., Trotman, L. A., Turning Training into Learning: How to Design and Deliver Programs that Get Results, New York, New York 2000.

Khawaja, M.S., *Community Energy Project, Inc. and Cost Effectiveness of Energy Education,* Letter to Robert Roth Senior, Assistant Attorney General, Oregon Department of Justice, May 2007.

Khawaja, M.S., Indiana REACH Evaluation, October, 2001.

Khawaja, M.S., Gage, L.M. Kentucky NEED: Impact Evaluation, October 2005.

Khawaja, M.S., Luedtke, J., Miller, L., Indiana Energy Assistance Program Energy Education Pilot: 2003-2004 Program Year Process and Impact Evaluation, Sept. 2003.

Khawaja, M.S., Luedtke, J., Miller, L., Utah Schools Program: Impact Evaluation, Nov. 2001.

Khawaja, M.S., Reichmuth, H., Impact Evaluation of PacifiCorp/EBCONS Multifamily Program, 1998.

Khawaja, M.S., Steiner, J., "Energy Efficiency Through Education and Low-Cost Measures," Home Energy, Sept./Oct. 2005.

Knight, P.A., Your Energy Savings, A Resident's Handbook, March 1998.

Morrill, J., Thorne, J., and Wilson, A., Consumer Guide to Home Energy Savings, 8th edition, 2003.

Professional Association for Consumer Energy Education (PACE), An Annotated Bibliography of Research Verified Energy Education Programs, Version 2, July 1994.

Reichmuth, H., Engineering Estimates of Savings from Use of Filter Tone Alarm, November 1999.

Steiner, J., *Assessment of Washington Energy Education in Schools–2005-2006,* Memo to Becky Eberle, PacifiCorp, Jan 2007.