

An Educational Approach for Reducing Energy Demand in the U.S. Residential Sector

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Abstract

Energy use in the residential sector of the United States comprises 21% of the country's total energy demand. Americans generally lack knowledge about improving a home's level of energy efficiency. Research has shown that trusted messengers can deliver educational programs that significantly reduce energy demand at the household level. This paper reports on an educational program developed and delivered through a partnership between the New York State Energy Research and Development Authority (NYSERDA) and Cornell Cooperative Extension (CCE). The program, the Consumer Education Program for Residential Energy Efficiency (CEPREE) was in operation from 2003 until 2016 and reached 75,000 New York State residents through over 6,000 workshops and other program activities. In addition to homeowners, other groups targeted for educational outreach included homebuilders, real estate professionals, multifamily building superintendents, retailers, and a residential buildings manager at a military base.

Keywords: Energy efficiency; Consumer education; Cooperative extension service

Introduction

The U.S. residential sector is responsible for 21% of the country's total energy demand [1]. Reducing this figure is not possible unless American knowledge of residential energy efficiency is substantially improved [2]. This article reports on an effective collaboration between CCE and NYSERDA in a 13-year effort to transform markets for residential energy efficiency in New York State. The collaboration showed that the Cooperative Extension Service can effectively teach people in local communities about residential energy efficiency. To prevent distortions, any intervention cannot focus solely on supply or demand, but must address both sides of the market. For this reason,

program elements of CEPREE targeted homeowners, renters, builders, landlords, real estate brokers, and retailers. Fuller [3] reported that trusted messengers can deliver educational programs that significantly reduce energy demand at the household level. Trusted messengers typically include family members and neighbors. They also include Extension Educators who deliver unbiased, research-based educational programs in their communities. Also, Extension Educators do not sell products or services, and people know they are not delivering programs for financial gain. Extension programs across the United States focus on residential energy efficiency with specific foci on the building enclosure; Heating, Ventilation, and Air Conditioning (HVAC) systems; and individual behaviors [4]. These are elements of market transformation strategies.

Materials and Methods

In 1914 the U.S. Congress created the Cooperative Extension Service (CES) as a partnership between the U.S. Department of Agriculture (USDA) and the country's Land Grant Universities to apply research-based knowledge to rural, agricultural issues [5]. Extension has a history of effective programming in the U.S. During the First World War, Extension was in its early years but demonstrated its effectiveness for quickly attaining national goals [6]. At the time, those goals were to increase food production and preservation that Extension addressed through educational programs for farm, home, and youth audiences. Cornell University is the Land Grant University of New York State. As such, it provides leadership to offices of CCE that serve each of the state's 57 counties and five boroughs of New York City. Skilled educators who routinely participate in professional development opportunities such as in-service education staff these offices. They partner with university faculty to develop timely programs that address educational needs of their communities. One such program was CEPREE. Through a variety of approaches and with a statewide network of county Extension Educators, residential energy efficiency was promoted throughout New York State. Program elements included workshops, meetings, events at the State Fair and county fairs, Earth Day events, and mass media campaigns. Extension Educators took part in annual in-service education programs on the Cornell campus that focused on technological and economic aspects of energy efficiency. Cornell faculty and NYSERDA staff conducted these events jointly.

CEPREE had two distinct phases. In the first seven years of its operation, the program's faculty director notified Extension Educators about the availability of funds. Interested Educators submitted one-page descriptions of their proposed CEPREE-related activities. Cornell faculty and NYSERDA staff conducted a one-day in-service education program for Educators who submitted proposals. Cornell faculty and NYSERDA staff members reviewed these proposals and suggested revisions when necessary. Educators then carried out their programs and submitted quarterly reports to Cornell, which were aggregated by faculty and submitted to NYSERDA. Faculty also submitted annual reports thirty days after each program year. The second phase of CEPREE began in 2011 and was titled EmPower New York This phase of the program focused on one- and two-hour workshops entitled "Save Energy, Save Dollars." While the workshops were open to the public, limited resource households were a targeted audience. To encourage attendance, each attendee received three Compact Fluorescent Lamps (CFLs). Light Emitting Diode (LED) bulbs were not at that time readily available. Attendees received Action Plans, as shown in [Figure 1](#), at the beginning of each workshop.



To reduce my monthly energy costs, I will take the following actions:

Actions	Results
1	
2	
3	
4	
5	
6	
7	

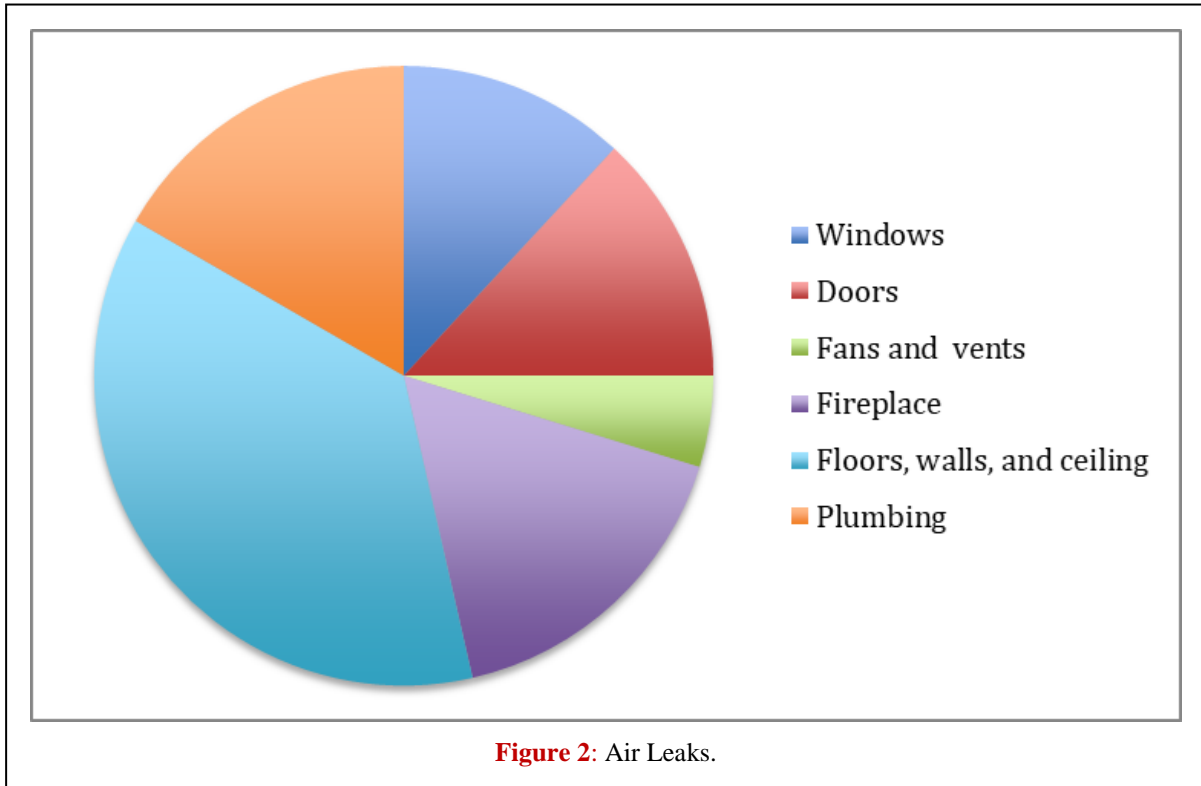
Name: _____

Every small action can lead to BIG energy savings and money in your pocket

Figure 1: Energy Action Plan.

The workshop focused on no-cost and low-cost actions people can take to reduce residential energy expenditures. Energy uses covered were heating and cooling, hot water, appliances, and lighting. Within each topical area, average

savings from each action were added to the Energy Action Plan. While savings from each individual action were not always high, total savings were impressive. Misconceptions about home energy efficiency were also addressed through instruction on building science [7]. For example, the widespread notion that the first step in energy conservation actions should be to increase the amount of attic insulation was shown to be incorrect, and that the first step should be to stop air leaks through the building enclosure. Average losses through air leaks are shown in **Figure 2**.



Educators also learned how losses through air leaks are exacerbated by the stack effect, which occurs when warm air rises to the upper levels of a house and escapes through building enclosure leaks. Those losses are replaced by air drawn into the house through suction pressure that is exerted on the lower levels of the house. The stack effect is illustrated in **Figure 3**.

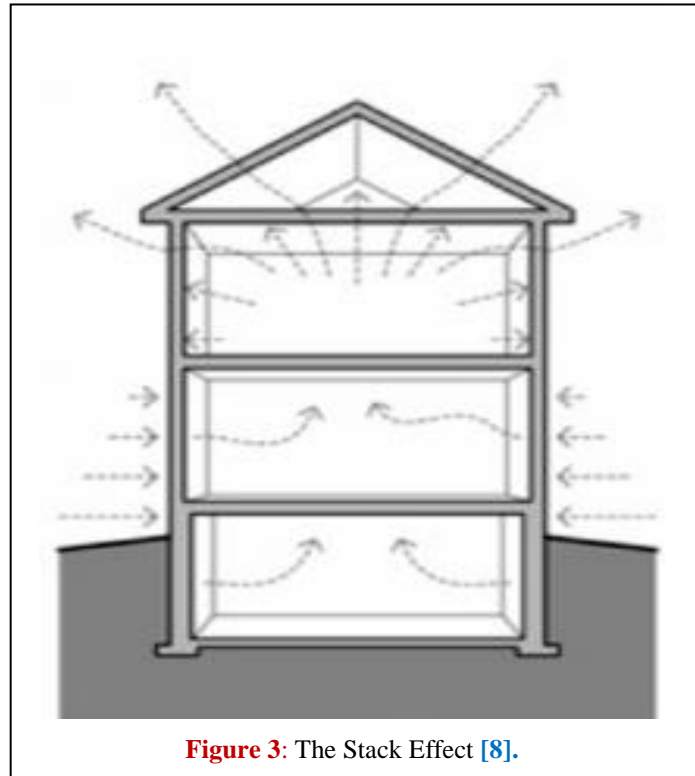


Figure 3: The Stack Effect [8].

Commonalities in Both Phases

In addition to workshops, during both phases of CEPREE Educators conducted special activities related to energy efficiency. These were done at fairs, Earth Day events, and conferences.

The Energy Bike

During the program, Energy Bikes were purchased with Cornell funds. As shown in **Figure 4**, an Energy Bike is a stationary bicycle that has a generator attached to its rear wheel. A plate with different types of light bulbs, a hair dryer, a fan, and a small television is attached to the generator. The bicycle rider powers these devices. The biggest attraction was the light bulbs. Powering one incandescent bulb took some work; powering two even more work; powering three was impossible for many children. Children and adults alike noted that the difference in powering CFLs and LEDs was striking. The Energy Bike was very popular the New York State Fair, county fairs and other events. It was often referred to as a “kid magnet.” And when children would wait in line to take turns on the bike, they often were with parents who were able to learn about energy needs of different devices.



Figure 4: The Energy Bike.

The CompareMeter

The CompareMeter was an interactive display that featured an incandescent bulb and a CFL that were connected to an electric meter. Participants were able to turn on the incandescent bulb and see how frequently the wheel on the meter turned and then compare this to when the CFL was on. The meter was then used with LEDs when those became widely available. The CompareMeter is shown in [Figure 5](#).

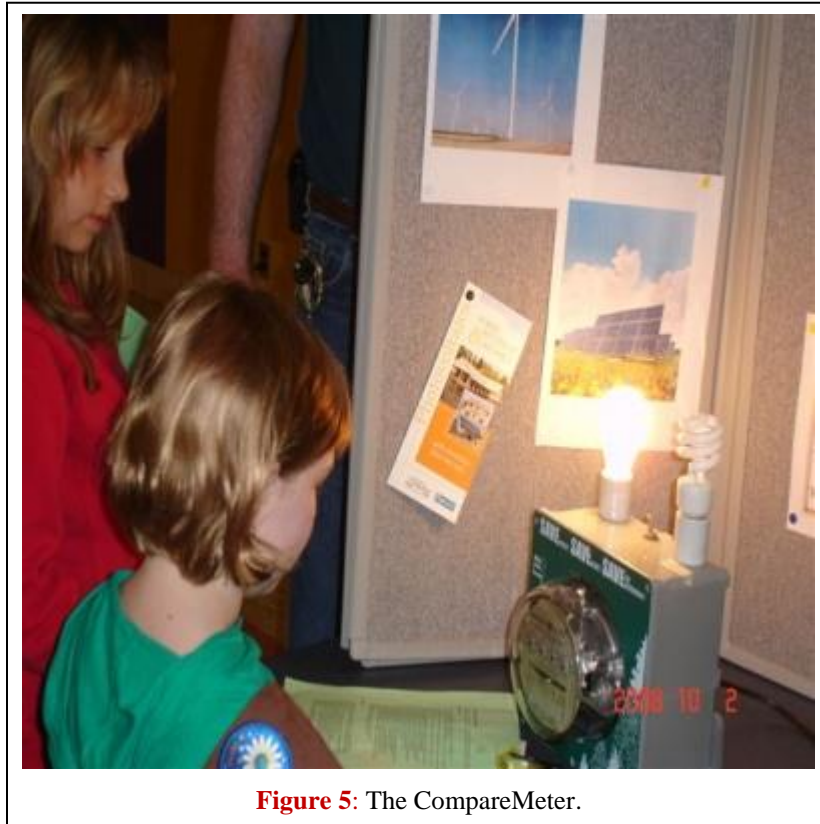


Figure 5: The CompareMeter.

The Energy Buzzer Board

The Energy Buzzer Board was another educational tool used in CEPREE. This battery-operated device had energy-related questions that required yes or no questions and were answered by pushing buttons. A correct answer was met with a green light; a red light and buzzer were activated by an incorrect answer. The Buzzer Board is illustrated in [Figure 6](#).

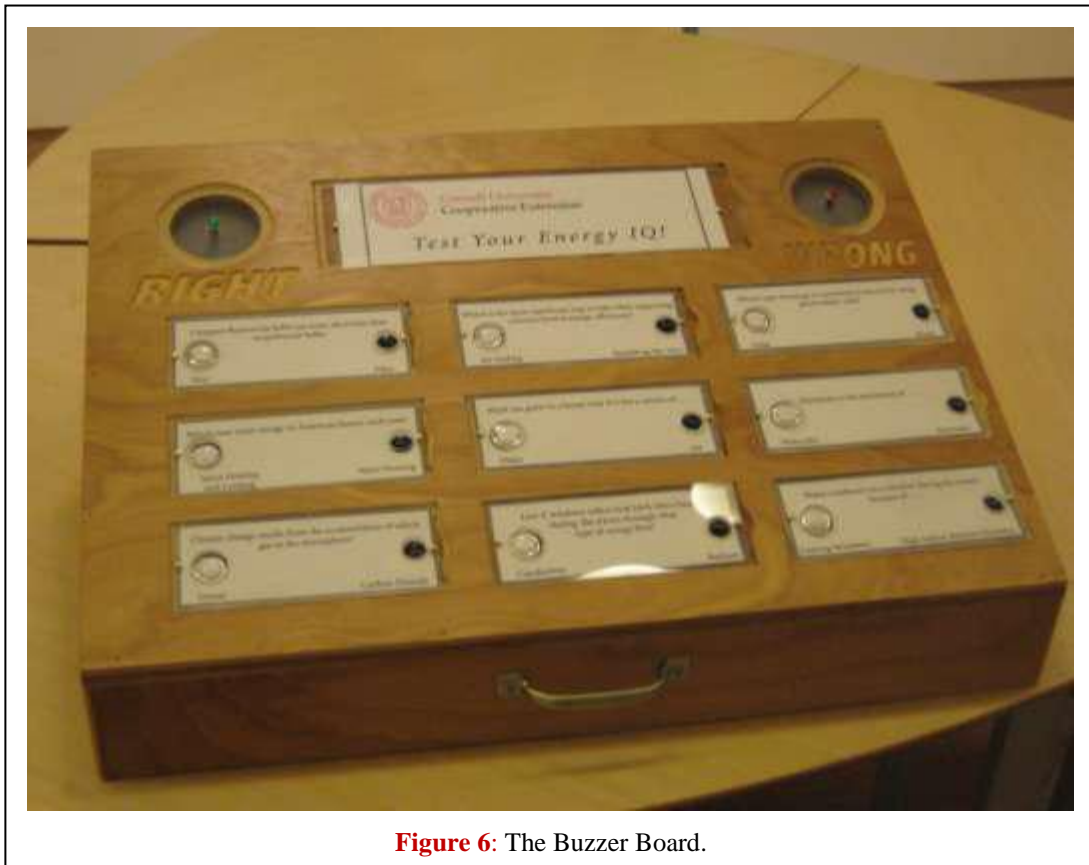


Figure 6: The Buzzer Board.

The Photovoltaic Display

Cornell faculty developed a photovoltaic array modeled after a residential system. The array was capable of generating 600 watts of electricity. The system included an inverter to convert generated direct current to alternating current used by household appliances. The display also included educational posters and handouts as well as information on NYSERDA incentives available to homeowners for installing such a system. This display is shown in [Figure 7](#).





Figure 7: The Photovoltaic Display .

Other CEPREE Activities

In addition to program activities described above, Educators and faculty used a wide variety of approaches to increase the public's understanding of residential energy efficiency. These included energy forums, virtual town meetings, and partnerships with agencies and organizations. Energy forums were county-level public events organized around themes that included renewable energy, weatherization assistance programs, heating system efficiency, and others. Speakers at these events were Cornell faculty, NYSERDA staff, Extension Educators, and renewable energy business owners. One such event was held at a restaurant and attracted over 200 people. Virtual town meetings were held online and structured along similar themes. In 2004, in partnership with the Association of Public and Land-grant Universities, the U.S. Department of Energy, the New York State Builders Association, and county-level homebuilder associations, Cornell faculty conducted educational seminars about energy efficiency for builders across New York State. Builders who participated in these seminars indicated that they were exposed to information they had previously been unaware of.

In one county with a military base the Extension Educator worked with the base's residential facilities manager to conduct a lighting change-out in which 18,000 75-watt incandescent light bulbs were replaced with CFLs. An analysis of this effort indicated annual savings to the base of over \$400,000. An Educator in New York City worked with building superintendents and apartment owners to make them aware of NYSERDA financial

incentives that apply to improving energy efficiency in multiple family dwellings. Educators throughout the state also met with retailers to encourage them to stock Energy Star appliances in their stores. They also educated real estate professionals about residential energy efficiency [9].

Results

Laquatra, Pierce, and Helmholdt [10] reported CEPREE program impacts for the years 2003 through 2008. **Table 1** summarizes those impacts.

Table 1: CEPREE impacts 2003-2008.

Event/Impact	Total
Participating Counties	Between 24 – 34
Presentations	2,160
# Reached via Presentations	73,893
Public Education Events	1,294
Potential Impressions from Public Education Events	2,478,929
County Fair Exhibits	150
Potential Impressions from Fair Exhibits	9.3 million
Press Releases	880
Potential Impressions from Press Releases	66.6 million
Newsletter Articles	632

Table 1 shows that Extension Educators were actively engaged in CEPREE. As noted by Laquatra, Pierce, and Helmholdt [10], while these numbers can demonstrate the reach of a program, behavioral changes are better indicators of a program’s impact. Because funds for tracking behavioral changes were not included in NYSERDA’s contract with Cornell, another approach was taken [11,12]. A 2007 study undertaken by CCE administration [13] found that specifically with energy efficiency education programs, 69% of program participants are likely to implement energy conservation measures they learn from Extension Educators. That figure was applied to the 17,289 people who attended presentations during the 2006 program year. During their presentations Extension Educators stressed the importance of participating in NYSERDA’s Home Performance with Energy Star® program. In that program a technician conducts an energy assessment of a home using, among other devices, a blower door test. Energy efficiency improvements are recommended based on results of the assessment. Plympton and Dagher [14] found that participation in the program results in an average 25% decrease in a home’s energy use, or average electricity savings of 1,298 kWh (12%); average oil or gas savings of 270 therms (22%); and average cash savings of \$400 per year. They applied that to average utility bills in a cold climate to calculate electricity, oil, gas, and cash savings. Laquatra, Pierce, and Helmholdt [10] calculated savings as

$$S = .69 \times 17,289 \times FC$$

where S = Cash savings

FC = saved unit; electricity in kWh, oil or gas in therms, cash in dollars. Calculated savings are shown in [Table 2](#).

Table 2: Projected savings from CEPREE presentations in 2006.

Electricity	15,473,458 kWh
Oil or Gas	3,218,670 therms
Cash	\$4,768,400

Conclusions

When CEPREE results were initially published [10] the authors of the paper shared the results with the U.S. Secretary of Energy through the Office of the Secretary's website. The authors made a specific recommendation to encourage state energy offices to use their State Energy Program (SEP) funds to work with the Cooperative Extension Service on residential energy efficiency education programs. In 2011 DOE, through its office of Energy Efficiency and Renewable Energy (EERE), released a Request for Proposals (RFP) to state energy offices to do just that. Unfortunately, the RFP had a turnaround time of 28 days. Despite this substantial hardship, nine state energy offices submitted proposals to EERE, and proposals from three states, Kentucky, Nebraska, and Wisconsin, were funded to form what was called the State Energy Extension Partnership (SEEP) [11]. In 2017 DOE and USDA announced an expansion of SEEP to focus on assistance to farm families and rural organizations in efforts to increase energy efficiency in homes and businesses [12]. This effort gives recognition to an important issue in several sectors simultaneously and could be a model for more expansive efforts in the future.

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