## *Industrial Revolution*

*Every home makes compromises among different and often competing goals: comfort, convenience, durability, energy consumption, maintenance, construction costs, appearance, strength, community acceptance, and resale value. Often consumers and developers making the tradeoffs among these goals do so with incomplete information, increasing the risks and slowing the adoption of innovative products and processes. This slow diffusion negatively affects productivity, quality, performance, and value. This department of* Cityscape *presents, in graphic form, a few promising technological improvements to the U.S. housing stock. If you have an idea for a future department feature, please send your diagram or photograph, along with a few well-chosen words, to elizabeth.a.cocke@hud.gov.*

# Key Behaviors of Residents Who Need Energy Education

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## Abstract

*In the past decade, U.S. initiatives to promote sustainability in homebuilding have resulted in myriad choices of high-performance construction products and innovative technologies for contractors and homeowners. The Louisiana State University Agricultural Center has built a showcase home known as the LaHouse Resource Center (hereafter LaHouse), which serves as a permanent, evolving display of sustainable building ideas. Although educational displays like those at LaHouse have resulted in contractors and homeowners becoming more aware of the available technology options, the challenge remains in that residents' behaviors drive energy consumption and, therefore, changing their behavior would have the greatest effect in driving energy sustainability. Effective energy education is one approach for changing behavior, in particular for low-income residents, given that high rates of energy consumption may be disproportionate to their income and they may reside in less efficient homes than the rest of the population. This article identifies the three key behaviors of low-income residents that have been shown to drive energy usage and discusses alternatives for effective energy education.*

## The Status Quo

In recent years, U.S. policymakers have introduced many programs available to serve low-income residents that aim to improve the general condition of the houses and reduce their energy bills. Despite all efforts to date, remarkable amounts of research show that improving house condition with high-performance products and innovative technology is not enough. These improvement measures cannot be fully effective unless residents' behavioral patterns change as a result of effective energy-education methods. Residents' behavior is as important as the potential energy savings from using innovative and more efficient technology, accounting for at least 40 percent of energy variation among previous studies on energy usage of identical houses (Maier, Krzaczek, and Tejchman, 2009). Most recently, in a study on low-income housing in Philadelphia, Pennsylvania, 50 residents were interviewed regarding ideas for energy savings. Only one-half of the residents interviewed offered potential energy-saving suggestions, 32 percent of the ideas were related to compact fluorescent light bulbs, and 23 percent mentioned unplugging electronics and appliances (Langenvin, Gurian, and Wen, 2013). Although these ideas are certainly encouraging and good energy-saving practices, in general reduction on energy usage from switching to rated energy-efficient appliances will be counterbalanced by increases in population and appliance usage (EIA, 2014).

Identifying key behavioral tendencies of low-income residents and tailoring energy education to address those behaviors constitute a key challenge in the national agenda toward a more sustainable built environment. In particular, it is vital for low-income residents who share particular demographics and socioeconomic factors (for example, level of and access to education) to have accessibility to effective energy education. According to the American Housing Survey, of public housing residents nationwide, 67 percent are classified as extremely low income, 31 percent are elderly people, 35 percent are people with disabilities, and 47 percent have less than a high school diploma. In addition, the typical low-income household has less access to information than an affluent household.

## Low-Income Residents' Behaviors

Effectively addressing the energy efficiency of low-income households takes a dual approach: (1) improving the overall efficiency of the house and (2) providing energy education. Policymakers should target those who are most responsible for energy consumption: the residents. Residents' behaviors regarding energy consumption refer to actions and responses to stimuli that influence energy usage either directly or indirectly (Fabi et al., 2012). Some examples of such behaviors include window opening, use of air-conditioning (AC) units, AC temperature settings, and energy-saving practices (such as adjusting the temperature on a water heater, closing draperies, and so on). Further, addressing this challenge through residents' behavioral patterns as the main energy-usage strategy in low-income housing has some significant advantages (Langenvin, Gurian, and Wen, 2013; Maier, Krzaczek, and Tejchman, 2009; Plenur and Cruickshank, 2012).

1. Energy savings usually are achieved with minimal initial cost and without the expense of additional equipment.
2. Energy savings are quickly achieved when utilities are under the control of residents.
3. With time, residents develop energy-saving habits.

A recent research study in Louisiana sought to identify and rank the most significant behaviors of low-income residents in terms of the effect of the behaviors on energy savings (Nahmens et al., 2011). As a result of this study, three key behaviors of residents were identified for a hot and humid climate.

- **Behavior 1: Residents' behaviors regarding cooling set point during summer** are related to the temperature set by residents on their AC units: (1) the average temperature of the house during summer in the daytime while the house is occupied, (2) the average temperature of the house during summer in the daytime while the house is empty, and (3) the average temperature of the house during summer in the nighttime while residents are asleep.
- **Behavior 2: Energy-saving practices** are defined as any behaviors in which residents of a household engage that reduces their overall energy usage. Such behaviors include those related to the residents' day-to-day activities and interaction with the house, such as adjusting the temperature of the water heater; using the bathroom fan during and after showering; closing draperies, curtains, shades, and blinds in the summer; the number of loads of laundry washed in a week; and hanging cloths outside to dry.
- **Behavior 3: Residents' behaviors regarding indoor environmental quality** are related to the quality of the indoor air and other factors regarding the indoor environment that could affect the health and comfort of residents, such as the number of ceiling fans, frequency of use of ceiling fans, frequency of use of the kitchen exhaust fan, and frequency of changing the AC filter.

## Energy Education for Residents

Embracing energy-conservation behaviors in daily activities with the aim of developing new energy-efficient habits requires effective training programs. Educating and training households to consistently follow energy-efficient behaviors could bring about significant changes to energy usage for low-income residents and the residential sector as a whole. Effective energy-education programs need to consider the following two critical points. First, target behaviors that are likely to save the most energy. Second, use proven, effective educational strategies, such as demonstration techniques, that consider low-income residents' unique socioeconomics and demographics.

The most common energy-education strategies that energy companies, state offices, and contractors employ include the use of printed material, digital material, demonstration and hands-on techniques, and technology-based techniques (for example, real-time feedbacks and webinars). When educators

use printed material as part of their strategy, they usually provide residents a number of brochures, booklets, and manuals to review. Likewise, when they use digital material, they provide residents compact discs or digital video discs that typically contain a large amount of information. Research shows, however, that low-income residents are not likely to spend more than 15 minutes of their time reading those materials (Nahmens et al., 2012). Moreover, Wood and Newborough (2003) noted that these types of materials are usually effective in the short term, but they do not keep residents interested for a long time or result in long-term habits. Easy implementation of these types of educational strategies, however, makes them the main candidate for most educational programs on energy efficiency.

Another educational strategy is based on technology techniques, such as real-time feedback using products that continuously monitor energy usage and inform residents about their energy consumption. Previous research shows that this strategy has a greater effect on energy consciousness than on energy-conservation behavior in both high- and low-income households (Allen and Janda, 2006). Furthermore, the review of a number of different energy-education models in the context of energy programs for low-income residents reveals some challenges associated with technology-based techniques, particularly in achieving the specific goal that technology was designed to address. In most cases, technology is designed to provide the client with tailored information on energy consumption and energy-saving opportunities. Yet, results reveal that technology has failed to keep the resident motivated to take the action. In addition, most technology-intensive tools for energy education are costly (Carroll and Berger, 2008).

Demonstration is another energy-education strategy that educators use to change the behavior of low-income households. This strategy involves direct interaction between a credible energy-education professional and residents, along with hands-on experiences by the resident. For instance, they educate residents about how to manage the temperature for the water heater, refrigerator, and furnace and how to use setback procedures on the thermostat (Nahmens et al., 2012). Furthermore, it is critical for educators to demonstrate the connection between the temperature setting on the thermostat and the amount of energy consumption. Thus, this strategy highlights the effect of the newly learned behaviors on their energy bill.

In Louisiana, a home-energy performance study was conducted and energy-efficiency education provided to homeowners after the state improved their houses with energy-efficient measures (Nahmens et al., 2012). Results from this study showed that energy savings ranged widely among homeowners who received and did not receive energy education. Those homeowners whose energy education was based on demonstration had significantly more energy savings (46 percent on average) than those whose education was based on the other types of energy-education strategies used. Energy-education strategies are usually evaluated in terms of overall energy savings and cost effectiveness. Findings from other studies in this area show evidence that the most promising tactic for changing behavior in low-income households is the direct demonstration of various energy-saving methods and behaviors through presentations by a reliable energy-education expert, along with the hands-on experience of residents (Carroll and Berger, 2008; Gregory, 2007; Nahmens et al., 2012).

## Final Remarks

This article highlighted the most significant behaviors that drive energy consumption in low-income households and the strengths and weaknesses of frequently used educational strategies for reduced energy consumption in those households. Educators need to target the behaviors of these residents, and owners of the properties in which these residents live need to the implement high-performance construction products and innovative technologies to move toward a more sustainable built environment. Residents' behaviors related to (1) cooling set-point, (2) energy-saving practices, and (3) indoor environmental quality are the most significant behaviors that drive the energy consumption of low-income households in a hot and humid climate. Hands-on and demonstration components in the energy-education process are recommended as an effective strategy for low-income residents. For example, physically showing and guiding residents in the process of setting their programmable thermostat, while explaining what the optimal temperatures for summer and winter would be for their houses based on the condition of their houses. In addition, "dollar bill" or other visual aids can be used to illustrate the financial prize of those thermostat settings and other energy-saving practices.

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