
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.

Rural America: Perceptions of Residential Energy Retrofits

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Abstract

Residential energy consumption accounts for most of the overall energy use in the United States (Pew Center Global Climate Change, 2008). Although many larger municipalities are successfully implementing residential energy retrofit programs, these benefits are currently not being seen in most rural townships. Seeking an opportunity to understand and reduce energy consumption in these areas, this study examines how the aging housing stock and owners' perceptions of energy retrofits affect the overall performance of the home. Using the small agricultural community of Woodbine, Iowa, the study compares 3 years of actual historical energy data with the homeowners' perceptions of energy retrofits. The statistical analysis of the perceptions survey not only shows that homeowners changing their energy use habits has a positive effect on lowering energy consumption, but also that homeowners perceiving that they have changed their energy use habits also plays a critical role in reducing their use of energy. The results indicate that the homeowners' simple awareness of their improved energy use practices can have a positive effect on lowering their monthly utility bills without having to invest large amounts of money into energy reduction.

Status Quo

Multiple surveys since the 1990s demonstrate national trends of consumers' preference for renewable energy. Further U.S. Department of Energy research at the regional and state levels confirmed that residential customers favor renewable sources and are willing to pay more to power their home with those resources (Stein and Meier, 2000). Using Woodbine, Iowa, as a representative example of Midwestern rural America, this case study investigates if awareness programs and basic energy conservation information do in fact reduce energy bills.

Located in western Iowa, Woodbine is an agriculturally based community approximately 50 miles northeast of the Omaha, Nebraska metropolitan area. The town has 647 households consisting of a representative sample of the U.S. housing stock. With a medium household income of only \$30,083, the residents are a mix of blue collar, lower to middle-income families. Most of the homes were built before 1979 and many have had additions or renovations made throughout the life of the home. With property values stagnant, investing in energy retrofit projects has been financially difficult.

Importance of the Study

Residential energy savings remain the largest untapped opportunity to reduce our dependence on fossil fuels whether domestically or abroad. The public and private communities continue to invest in new energy sources. Today, the average cost for private, large-scale wind production is \$0.08 per kilowatt hour and solar production can reach upwards of \$0.20 per kilowatt hour. By simply retrofitting residential properties, an energy company conserving kilowatt hours enables the power companies to reuse the energy at a cost of \$0.03 per kilowatt hour (McGraw Hill Construction, 2009). The combination of this economic benefit with the pride a homeowner gains when improving the performance of his or her home highlights the importance of residential energy retrofit and the sense of empowerment owners gain. A challenge in the aging housing stock is the necessary structural work that is needed to increase the energy performance of the home. In an effort not to exclude older homes, the necessary question arises: How much, if any, can an energy savings education or awareness program affect the overall energy savings of these homes?

Homeowner Perceptions Survey

To help understand the effects that the homeowners' perception of overall energy efficiency and habitual habits have on consumption, the research team developed a customized homeowner survey. The 20-question survey asked a range of questions regarding the residents' feelings toward their personal utility bills, thoughts on energy conservation nationally, and perceived condition of their home. The surveys were delivered, along with monthly utility bills, to all 647 residences of Woodbine. The following month, 92 residences returned completed surveys to the local utility provider. Although the survey data gave a broad range of very valuable information about each household, two specific questions were designed to be compared against actual utility consumption data of the same household. Focusing on these two questions, to what extent do actual changes to living habits have and whether the basic perception of the owners' living habits affected utility costs in their home.

In collaboration with the local utility provider, the researcher was granted access to 3 years of monthly energy use data for each home. Participants in the study also concurrently were provided a homeowner perception survey in their monthly utility bill. The research team analyzed the actual changes in each participant’s energy use habits and his or her awareness of habit changes to determine the effect of each action; for example, the effect of change of habit versus awareness of their action.

To examine the importance of habit changes versus perceptions of habit changes, we examined the responses to questions 10 and 14. For question 10, “How much do you feel your living habits contribute to your overall utility costs?” participants were given four response choices: (1) a lot, (2) some, (3) a little, and (4) none. Responses *a lot* and *some* were coded as positive, and responses *a little* and *none* were coded as negative. For question 14, “Have you changed your habits in the last 12 months to help lower your utility bills?” respondents were given a response choice of either *yes* or *no*. Again, *yes* was coded as positive and *no* was coded as negative. A multiple regression correlation analysis was run on the two questions using their actual utility consumption data to determine the effects of homeowners’ habits and actual energy usage.

Of the 92 completed surveys, 40 surveys indicated positive responses for both questions 10 (perception of impact of changes in habits) and question 14 (real changes of habits). Of the 40 completed surveys, residents in homes with lower energy usage completed 28. With 70 percent (28 of 40 respondents) of the homes showing actual lower energy consumption in comparison with their neighbors, all indicators would confirm that a homeowner’s perception has an influence on energy consumption during a 3-year period. Exhibit 1 highlights the findings, dividing the observed residences into two types—the lower 50 percent of energy consumers and the upper 50 percent of energy users, when normalized by BTU/SQ/DD¹ calculations.

Exhibit 1

Positive Responses to Questions 10 and 14

Observed	Positive Response to Questions 10 and 14	Negative Response to at Least One Question	Total
Lower 50%	28	29	57
Upper 50%	12	21	33
Total	40	50	90

Lessons Learned

The homeowners’ perception survey provided valuable information for this study and could assist researchers conducting future community perspective studies. This study upholds the argument that both positive homeowner habits and homeowners’ perceptions of being energy efficient in the home are effective when working to reduce household energy consumption.

¹ BTU/SQ/DD—Standardized energy equation used to normalize energy usage. British Thermal Unit divided by the Square Foot of the residence divided by the Degree Days.

The survey data collected by this research were consistent with the findings of the Green Trends and perception studies that McGraw Hill Construction and the National Association of Home Builders conducted (McGraw Hill Construction, 2008; NAHB, 2010). Unique to this study was the ability to use a single community to statistically validate the qualitative data of the survey with the quantitative data of historical energy consumption. The statistical analysis of the homeowners' perceptions survey showed that changing habits has a positive effect on lowering energy consumption, but that recognizing improved ways to reduce energy consumption, regardless of actual changes in day-to-day practice to reduce energy consumption, plays a critical role in reducing energy consumption. The results indicate the key role of an educational or awareness program with a community-based retrofit program.

The research suggests that the first approach in working with a smaller, rural community is a simple awareness and educational program. Such programs can be facilitated by the local volunteer community action boards or by energy providers looking for ways to cut down on peak load stresses. Making homeowners aware of visual inspection items, such as inappropriately installed insulation, turning down or using a programmable thermostat, or easily using the storm windows that are sitting in the corner of the shed, can have positive effects on reducing energy consumption with no out-of-pocket cost to the owner. Exhibit 2 shows a crawl space under a conditioned living space

Exhibit 2

Crawl Space Under a Conditioned Living Area With Missing Floor Insulation



where the floor insulation has fallen away, a condition that can require a home's mechanical system to work overtime, costing the owner more in utility cost each month. Exhibit 3 serves as reminder that by simply turning down the thermostat or installing a programmable thermostat that lowers while the homeowner is away, the homeowner can realize utility savings. Exhibit 4 illustrates that installing storm windows over older windows can improve the thermal performance of a home at a much lower cost than installing new windows.

Being able to analyze and understand consumption patterns in the aging housing stock is best accomplished through a partnership with local utility providers. Access to actual historical home consumption is critical to the accuracy of preauditing retrofit candidates. With the variables of the housing stock, any computer simulation simply cannot predict savings calculations. Homeowners can always provide personal consumption data, but the utility provider's database enables the research team to analyze the homes as a community and then comparatively on an individual basis. Homeowners' habits and lifestyles must also play a role in the data collection. Habitual information enables the preauditor to provide and assess what influence, if any, these habits and lifestyles are having on consumption patterns. Researchers can collect all of the above-mentioned preaudit information before visually inspecting the property. This preaudit collection can enable a community retrofit strategist to prioritize candidates and significantly reduce the audit investment time and to increase the potential of audits being performed on homes that will lead to retrofits with significant energy savings.

Exhibit 3

A Programmable Thermostat Can Help Reduce Utility Costs



Exhibit 4

Storm Windows Can Improve the Thermal Performance of a Home



Research needs to continue to implement pilot projects in multiple communities across the country. Increased partnerships with private industries will enable researchers and professionals to develop retrofit practices that are not only accurate and sustainable but also profitable for privatized energy retrofit business models.

Author

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