The Market Value of Energy Efficiency: What Have We Learned? What Do We Still Need to Learn?

David Lee, U.S. Environmental Protection Agency, Washington, D.C.
Rick Nevin, ICF, Incorporated, Fairfax, VA
Barbara C. Farhar, National Renewable Energy Laboratory, Golden CO

ABSTRACT

The Environmental Protection Agency (EPA) and the Department of Energy (DOE) at the National Energy Renewable Laboratory (NREL) are investigating the market value of energy efficiency in residential homes. The demonstrated market value for energy efficiency is crucial to the success of EPA's ENERGY STAR Homes Program, providing market information to builders who are deciding whether to construct ENERGY STAR Homes, to lenders who may want to understand the performance of mortgages for energy-efficient homes, and to home owners seeking returns on additional investments in energy-efficient homes. The paper discusses the current dilemma facing the ENERGY STAR Homes Program and the need to demonstrate the value of energy efficiency. The paper presents a brief literature review of past studies on the market value of energy efficiency, as well as a recent analysis on the American Housing Survey. This study suggests that property values increase by $20 to $24 for every $1 reduction in annual fuel bill. Finally, the paper concludes with an summary of a joint research project between EPA and NREL on the market value of ENERGY STAR Homes, and the potential implications of this research.

Background

Since the mid-1970s, the building, financing and energy policy communities have debated the value of energy efficiency in home construction. The Energy Crisis of the 1970s awakened the American public to the fact that home utilities were a significant and costly portion of a household's monthly budget, and that disposable income declined with increasing energy costs. Yet, this rational consumer perspective has not, to date, altered the building and financial communities' belief that energy-efficiency home improvements do not hold value in the real estate market, and that energy efficiency does not sell homes. If this perspective were true, why should builders construct energy-efficient homes? Why should lenders loan money for energy-efficiency enhancements if such improvements serve as collateral? The market value of energy-efficient housing is a complex analytical problem; many variables drive housing price, such as lot size, home square footage, location and amenities (e.g., air-conditioning, garages, and kitchen countertops). When such analyses are coupled with the major demographic and economic trends over the last 20 years, the importance of energy efficiency is quickly lost to builders and lenders who must show a profitable bottom line.

The Importance of the Value of Energy Efficiency

Determining the value of energy efficiency is a dilemma for the energy policy community, and in particular, the Environmental Protection Agency's (EPA's) ENERGY STAR Homes Program. The ENERGY STAR Homes Program is a voluntary program that encourages home builders to construct homes that are 30% more energy efficient than homes built to the Model Energy Code, and encourages lenders to provide mortgages for ENERGY STAR Home Buyers. Through its technical assistance and marketing efforts, the ENERGY STAR Homes Program works with its building allies and financial lenders to create a demand for energy-efficient new homes. Data demonstrating the market value of energy efficiency would make this task considerably easier. Since its inception in the fall of 1995, 492 builders have joined the ENERGY STAR Program. Close to 2,000 ENERGY STAR Homes have been built.

To succeed as a market-based voluntary program, the ENERGY STAR Homes Program must demonstrate market value of ENERGY STAR Homes. Home buyers must be persuaded that their investments are rewarded. Economic rewards could be lower monthly utility costs and higher home value at resale. Higher market value also has implications for mortgage lenders. If enhanced value translates into higher home equity, and the level of equity affects default rates, then ENERGY STAR Homes could, in theory, present lower default risk than standard homes. This has implications for mortgage insurance rates for home owners who cannot afford a 20% down payment, as well as for mortgage scoring, a developing tool used by lenders to set mortgage interest rates based on the riskiness of the loan applicant. These are long-term implications not yet recognized by the mortgage industry.

Despite ENERGY STAR Homes' success to date, many mainstream builders remain cautious about committing additional time and resources to build an energy-efficient home that may not sell as readily as a standard home. This market value problem is compounded by lenders who may not lend home buyers full funds to cover the additional cost of the energy-efficiency enhancements of a new home because they are unable to appraise the value of these enhancements. If there is no comparable housing available, appraisers, who work for lenders, cannot place a comparable value on energy-improved homes. Indeed, this is a "Catch-22." Many builders will not construct energy-efficient homes because home buyers cannot obtain full financing for those homes. Lenders will not provide full financing for those homes because builders have not constructed energy-efficient homes that demonstrate their market value.

Literature Search on Market Values for Home Energy Efficiency

Although builders and lenders are skeptical of the market value of energy efficiency in homes, the academic literature suggests, within limitations, that the market actually does appropriately value energy efficiency. We conducted a literature search for studies that attempted to estimate the market value of energy efficiency.

We found six studies published between 1981 and 1986 and one study reported in 1990. During these years, fuel prices and mortgage interest rates fluctuated considerably. Some of the studies directly related residential real estate values to fuel expenditures, while others provided indirect evidence of the relationship between market values and discounted fuel savings based on analyses relating home value to fuel type used and to specific energy-efficiency characteristics (e.g., the amount of insulation).

Halvorsen and Pollakowski (1981) examined data on 269 homes sold in a Seattle neighborhood between 1970 and 1975, to measure the market's preference for an oil-heated house relative to a gas-heated house. The authors were primarily interested in measuring the residential housing market reaction to the oil crisis that began in late 1973, which caused fuel oil prices to increase by about 50% more than gas prices during 1974. The relative cost of fuel oil began to decline in late 1974 (primarily due to increasing prices for natural gas), and by late 1975 the price of fuel oil relative to natural gas was only about 10% higher than in the early 1970s. The authors found a delayed housing market reaction to these changes in fuel costs, with the price differential between gas- and oil-heated houses rising to just $761 in 1974, then to $4,597 in the first six months of 1975, and falling back to $233 during the second half of 1975.

Corgel, Geobel, and Wade (1982) examined data on 100 single-family residences sold in Lubbock, Texas, during 1978 and 1979. Using infrared photographic technology, the authors assessed 61 houses as energy-efficient because the structure appeared dark in the photograph indicating a minimal loss of heat, and 39 houses were coded as inefficient due to relatively light infrared structure photographs. A regression analysis of these data indicated that energy efficiency added about $3,248 to the selling price of a home.

During 1978, Johnson and Kaserman examined 1317 houses sold in Knoxville, Tennessee, constructing a regression analysis that combined data from the Multiple Listing Services of the Board of Realtors, property location data from the Metropolitan Planning Commission, U.S. Census data on neighborhood attributes, and actual utility billing records for each sample house from the Knoxville Utilities Board. Based on a well-specified regression analysis of these data, the authors estimated that the expected selling price of a house is increased by about $20.73 for every one dollar decrease in annual fuel bills.

Laquatra (1986) examined data on 81 homes designed and constructed in Minneapolis-St. Paul in 1980, through the Energy Efficient Housing Demonstration Program, which subsidized the building of energy-efficient homes. For each house in the study, the author estimated a thermal integrity factor (TIF) based upon the amount of energy needed to heat the house. Laquatra's sample of 81 homes had an average TIF of 1.8, which compared to an average TIF of about 7 for conventional homes constructed at that time. The key finding from this research was that home prices increased by $2,510 for each one point decrease in TIF.

Longstreth (1986) examined survey data, collected in 1978, describing the structural characteristics of 505 gas-heated, single-family detached homes sold between 1971 and 1978 in the Columbus, Ohio, MSA. Key findings from this analysis included the following: (1) a 1-inch increase in wall insulation was found to increase the value of a house by $1.90 per square foot; (2) a 1-inch increase in ceiling insulation increased the house value by $3.37 per square foot; and (3) the presence of high quality (energy-efficient) windows increased the value of a house by $1.63 per square foot.

Dinan and Miranowski (1989) examined data on 234 single-family detached homes sold in Des Moines, Iowa, during 1982. In this sample, the authors found that the expected selling price of a house increased by $11.63 for every $1 decrease in the level of fuel expenditures needed to maintain the house at 65 degrees in an average heating season. This fuel cost variable was constructed by adjusting data on actual winter fuel expenditures for differences in billing periods, temperature settings, and the amount of heated space. In other words, this variable was specifically designed to measure variations in energy efficiency, rather than variations in house size or occupant preferences for internal temperature.

Horowitz and Haeri (1990) examined data on 67 electric-heat, single-family detached homes sold in the Tacoma, Washington area between 1983 and 1985, in order to estimate the market value associated with Model Conservation Standards (MCS). MCS is a building code that required increased insulation and energy-efficient windows in electric-heated homes built in this area after June 1984. On average, the authors found that MCS added $1,315 to home value relative to non-MCS homes (homes built just before June, 1984). The authors also analyzed electricity bills for another 293 homes, and found the MCS homes yielded an average of $105 in annual electricity bill savings.

The authors concluded that home buyers discounted their electricity savings at about an 8% discount rate, and noted that this discount rate for energy savings was consistent with after-tax mortgage rates at the time of this study.

Regression Analysis of American Housing Survey (AHS) Data

This literature review suggests that rational home buyers are willing to pay more for energy-efficient homes as long as the incremental cost of energy efficiency does not exceed the present value of expected fuel savings, and suggests that the discount rate used to determine the present value of expected fuel savings could be the home owner's after-tax mortgage interest rate. Throughout the 1990s, the interest rate on 30-year fixed-rate mortgages has ranged from just under 7% to just over 9%. A home owner paying a 7% mortgage rate, and using the mortgage interest deduction in the top marginal income tax bracket, will pay an after-tax interest rate of approximately 4%. At the other extreme, home buyers with a 9% mortgage rate could pay a total financing cost of almost 10% if they pay an additional percentage rate for mortgage insurance and cannot benefit from the mortgage interest deduction (because their standard deduction exceeds their itemized deductions). Using the range of 4% to 10% for after-tax interest rates, we conducted a regression analysis of the AHS to test the hypothesis that homeowners should pay $10 to $ 25 more for every dollar reduction in annual fuel bills, assuming stable fuel prices and an after-tax interest rate between 4% and 10%. This formal study has been accepted by the *Appraisal Institute Journal* and will be published this year.

We tested this hypothesis using 1991, 1993, and 1995 AHS data. The AHS is a unique data source for this research in that it includes both house characteristic data (home value, number of rooms, square feet, lot size, and other key housing characteristics) as well as utility expenditure data. The sample sizes ranged from 16,000 to 17,000 homes, depending on the sample year. All of these data are reported by the homeowner in a lengthy interview with the Census Bureau. Although independent measurement or verification of these data (e.g., actual sale prices for homes) would be preferable to self-reported values, the AHS does provide a relatively large sample to mitigate against concerns about random reporting error. Furthermore, the AHS provides Census Bureau weights indicating the universe of owner-occupied housing units represented by each sample unit.

The analysis examined subsets of the weighted AHS data on owner-occupied attached and detached housing in adequate condition reporting electricity, piped gas, or fuel oil as their main heating fuel. The detached housing sample was of sufficient size to permit a further segmentation analysis for homes in each category of main heating fuel (electricity, piped gas, or fuel oil) to determine whether the regression results showed any variation by fuel type.

In addition to the dependent variable (housing unit value) and the intercept, the independent variables in the regression model included:

(1) established indicators of home value (lot size, unit square feet, age of unit, and number of rooms, plus dummy variables to indicate whether the unit has a porch [or deck, balcony, or patio], garage [or carport], and/or central air-conditioning)

(2) second derivative variables (squared values of lot size and unit square feet, with negative coefficients values anticipated due to diminishing marginal values for additional space)

(3) total annual fuel expenditures (with an expected coefficient value between negative 10 and negative 25, based on the hypothesis that home value decreases by $10-$25 for every dollar increase in annual fuel bills)

(4) fuel interaction variables (a "room utility" variable constructed by multiplying the number of rooms in a house by its annual fuel bill, and a "square feet utility" variable constructed by multiplying the housing unit's square feet by its annual fuel bill, both included in the model to isolate the effect of energy efficiency in the coefficient for total annual fuel expenditures)

(5) location variables (identifying geographic region [e.g., Northeast] and urban status [e.g., central city], as defined by the Census Bureau).

Table 1 shows the total utility coefficients from each of 15 separate regressions for each of the years 1995, 1993, and 1991, for detached housing, attached housing, and subsets of detached housing with electricity, piped gas, or fuel oil as the main heating fuel.

Table 1: Total Utility Coefficients in Home Value Regressions

	1995	1993	1991
Detached Homes	-23.41***	-20.00***	-21.16***
Attached Homes	-20.49	-12.34	-18.88
Detached Electric Homes	-16.42**	-31.43***	-28.55***
Detached Piped Gas Homes	-28.94***	-22.48***	-36.25***
Detached Fuel Oil Homes	-21.92***	-5.05	+6.04
***Significance > 99%; ** Significance > 95%			

For detached homes, the coefficient values for the three sample years are between -20 and -24, at the upper end of the range anticipated by the rational market hypothesis. The attached home analysis was limited by the relatively small sample size for attached homes. The probability that the attached home coefficient for the total fuel expenditure variable is significantly different from zero is only 88% in the 1995 regression analysis, 81% in the 1991 analysis, and even lower in the 1993 analysis. Although sample size limits the statistical significance of the attached housing regression, the coefficients for total fuel expenditures in all three attached home samples are remarkably consistent with the coefficient values for this parameter in the detached housing analysis.

The regression analyses for the subset of detached housing units that identify electricity, piped gas, or fuel oil are also generally consistent with the rational market hypothesis. Most of these fuel expenditure coefficients are within one standard error of the upper end of the range anticipated by the hypothesis, and the analyses of homes with fuel oil and gas heat in 1991 are the only two regressions with fuel expenditure coefficients that are more than two standard errors removed from the range anticipated by the rational market hypothesis.

The anomalous results in the 1991 fuel oil and piped gas regressions almost certainly reflect the extreme spike in fuel oil prices following the invasion of Kuwait in the summer of 1990. AHS respondents in the 1991 survey reported annual fuel bills that reflected extraordinarily high fuel oil prices during the 1990-1991 winter. Furthermore, the AHS sample of detached homes reporting fuel oil as their main heating fuel declined by almost 30% between the 1991 and 1995 surveys, while the sample size for all detached homes was virtually unchanged between these two samples, suggesting that a large percentage of homes with fuel oil heat were converted to gas or electric heat in the years following the 1990 spike in fuel oil prices. Homeowners with the most financial incentive for converting from fuel oil, and those most likely to have the financial means to convert, would tend to be upper income households disproportionately concentrated in larger homes with higher property values. The 1991 survey was actually conducted from July through December of 1991, so a substantial number of households may have reported higher home values in 1991 based on fuel conversions that were planned or underway, but they may have reported their main heating fuel and annual fuel expenditures based on the spike in fuel oil prices from the previous winter. These factors could have substantially distorted the regression results in 1991.

The 15 regression coefficients in Table 1 collectively indicate a clear convergence for the value of home energy efficiency. The convergence of the fuel expenditure coefficients around -20 indicates that homeowners in the 1990s have recognized a value in energy efficiency based on annual fuel savings discounted at about 5%, where 5% reflects a typical after-tax mortgage interest rate for home buyers over these years. These findings are consistent with the research by Johnson and Kaserman (1983), based on 1978 Multiple Listing Service data, which found that the selling price of homes increased by $20.73 for every $1 decrease in annual fuel bills. The underlying conclusion that energy efficiency is reflected in market values based on discounted fuel savings is also supported by the Horowitz and Haeri (1990) research indicating that home buyers discounted energy savings at their after-tax mortgage interest rate.

This recent analysis of AHS data as well as the reviewed literature begins to provide information needed by EPA on the market value of energy efficiency in homes. However, these results are published in journals not ordinarily read by the average builder. Also, the studies have limitations—they relied on small databases relative to the datasets ordinarily used by the financial community on which to base business decisions. Because of their sampling designs, these results cannot be generalized to the national level. Also, the datasets for the reviewed literature are dated. Our analysis of the AHS data resolved many of these issues by using a set of large current datasets. However, the value of housing reported in the AHS is the perceived value of the property by homeowners, not the value reflected in an actual sales price. Furthermore, many independent variables reviewed by these studies, including our study, are likely correlated, potentially creating multi-collinearity problems that could weaken the strength of the R-square values, and the importance of energy efficiency. (The R-Square for the national model is .41.) Despite these limitations, these studies provide a starting point for additional study on the value of energy efficiency in homes.

NREL Study on the Market Value of Energy Efficiency

Consumer perception has generally been omitted from the published literature on the market value of energy-efficient housing. To market ENERGY STAR Homes successfully, the Program and its ENERGY STAR Builders need to understand the benefits of efficient housing that customers perceive. Favorable home buyer attitudes toward efficiency and its perceived benefits can translate into dollars spent for housing with the desired attributes. Analysis of the actual sales prices of energy-efficient and standard housing coupled with measurement of customer perception will be valuable in documenting the effect of housing efficiency on market value. If it can be established that markets respond to the value of energy-efficient housing (e.g., in comfort, quality, reduced utility bills, higher resale value, and environmental benefits) by paying more for it, then mortgage lenders would be more likely to provide funds for energy-efficiency improvements that bring this added market value.

Customer perception of the value of energy-efficient housing remains largely unexplored. Fifteen years ago, Wurtzebach and Waller (1983) called for information that still does not exist today. From their analysis of the feasibility, underwriting, and valuation of residential energy components, they concluded that "energy-efficient components are feasible and reduce underwriting risk. Yet home buyers and lenders alike are still uncertain as to their impact. Time is of the essence. Every new inefficient home locks in additional energy waste due to high retrofit costs. . . . For both home buyers and lenders, the question is whether or not to invest in energy-efficient housing. . . ." (p. 80).

NREL will perform a longitudinal study on the market value of ENERGY STAR Homes. The study's purposes are to develop an understanding of market valuation and default rates of a selected population of energy-efficient and standard homes. The energy community has frequently asserted that default rates for energy-efficiency financing would be lower than those for regular mortgages. This is because of the increased household cash flow resulting from lower utility bills brought about by energy improvements. However, empirical evidence for this assertion is lacking.

If customers are willing to pay more for energy-efficient housing, what added value do they perceive? In addition to such economic reasons as lower utility bills and increased resale price, customers may well have non-economic reasons. Concern for the environment has increased among the U.S. public over the past 15 years (Cambridge Energy Research Associates 1992; Dunlap 1991a,b; Dunlap and Scarce 1991). Environmental well being is affected by energy production and consumption. In answers to survey questions over the past 19 years, increasing majorities of the public have chosen renewable energy and energy efficiency over other energy alternatives (Farhar 1993, 1994a,b). Evidence is beginning to accumulate that these two trends—increasing environmental concern and majority preference for renewable energy and energy efficiency—are linked (Farhar 1996). The result is that consumers say they are willing to pay more for renewables and efficiency (Farhar and Houston 1996).

A 1995 study was conducted to determine the attitudes, opinions, and preferences of consumers regarding newly constructed housing. The survey asked: "If a builder could save you $250 a year in future heating and cooling by charging $2,000 for additional energy-efficient products or features at the time of construction, would you spend the additional $2,000?" Two-thirds of the respondents said they would pay the extra $2,000 and 15% said they would pay an additional $3,000 to save the same amount. The study reported that more than 60% of buyers want "healthy house" features in their new purchase, and 25% said that it is important to buy a home constructed with "green methods" (less wood and more recycled materials, for example) (National Family Opinion Research, Inc. 1995).

Customer willingness to pay for energy-improved housing as measured in surveys indicates a favorable predisposition toward efficiency in housing; it does not predict actual behavior. A study that includes perceptions and preferences among its explanatory variables should be able to explain more of the variance in sales price than one that does not.

Default Rates

Attractive financing is an inherent part of the ENERGY STAR Homes program. The mortgage industry's key concern is the performance of energy-efficiency financing products—that is, whether the default rates for these loans are lower than those for other types of financing products. This is important because the industry believes it has higher risk exposure in two situations: (1) when it loans enough to cover the cost of energy improvements even though that cost is not reflected in appraised value, and (b) when it factors in reduced utility bills in qualifying mortgage borrowers.

Information on default rates for ENERGY STAR Homes, as compared with standard homes, will be useful to lenders in assessing portfolio risk. The mortgage community tends to believe that defaults are caused primarily by devastating events in the lives of borrowers, such as death, illness, divorce, and job loss (Farhar 1998). The mortgage community does not believe that small positive increments in cash flow, such as those that might derive from reductions in utility bills, would have much effect in ameliorating default rate and reducing portfolio risk. However, buyers of energy-efficient homes might be more creditworthy than borrowers in general; if this were the case, it would be an alternative explanation to positive cash flow from reduced utility bills for why defaults might be lower for mortgages on energy-efficient housing.

Study Hypotheses

The purpose of the study is to determine whether energy-efficient houses have higher market value than standard houses, all other things being equal. The test hypothesis is that energy-efficient houses are more highly valued in the market than standard housing, as measured by higher initial sales prices and resale prices. The null hypothesis is that there is no difference between the sales price of an energy-efficient and a standard home with the same characteristics and amenities.

A second hypothesis is that owners of ENERGY STAR Homes are less likely to default on their mortgages than are owners of standard homes (Farhar 1998). There are several reasons why this might be the case. Buyers of ENERGY STAR Homes may be more careful in their use of energy than buyers of standard homes. They may have slightly better cash flow than they otherwise would have because of lower utility costs. They may be more environmentally concerned and more responsible individuals about energy and the environment. Information on the potential differences between buyers of ENERGY STAR and standard homes will be obtained in this study.

Methodology

NREL is planning to investigate the market value of energy-improved homes in selected markets using a statistically-based design. Working with builders, the mortgage community, appraisers, and real estate professionals to design and execute the study, NREL will conduct a longitudinal analysis that will gather data on the market value of new homes. During 1998, a matched pairs analysis will be established that will begin with ENERGY STAR Homes constructed in 1998 and will carry on for 5 years of data collection to trace market value and mortgage performance over time. This approach would operationalize energy efficiency by using the ENERGY STAR Homes label and those of ENERGY STAR Builders. The study will be limited to new ENERGY STAR Homes at the time of sale and resale.

A 5-year longitudinal panel study is planned because most mortgage loans that are going to default will do so within the first 5 years (Farhar 1998). Also, 5 years should be a of time to capture data on the resale value of resold homes in the sample.

Sampling Design

Within the selected study areas, NREL will sample an experimental group of new ENERGY STAR Homes; NREL will also sample a control group of standard new homes that match the energy-efficient homes on key variables known to affect sales price (although these new homes would also meet state and local building codes extant at the time they were built). Ideally, the ENERGY STAR Homes and the standard homes would be built by the same builder in nearby locations. The matched pairs approach will be used, which provides a tight control on relevant variables.

A matched pairs design is statistically feasible but does not permit generalization to an overall universe of housing. Yet, even the findings that cannot be strictly generalized from a statistical standpoint should be directional data for any other ENERGY STAR location and for other energy-efficiency locations. EPA is willing to sacrifice a certain amount of generalizability to get an answer to the question of the effect of energy efficiency on housing prices.

Matched pairs are most feasible if builders can be located who build both energy-efficient and standard housing. If sample selection is controlled for time of sale, and property and neighborhood characteristics are matched other than for efficiency, this is a powerful sampling strategy.

Approximately 1686 Energy Star Homes were built in many locations across the nation during 1997. The sample will constitute a panel that will be followed for 5 years (1998 through 2002). Approximately 4100 Energy Star Homes will be built during 1998 at various locations in several states. The sample size will be approximately 1200 efficient homes matched with 1200 standard homes, which will provide plus or minus 3% maximum expected error at the 95% confidence level. This would be a sample of 29% of the Energy Star Homes built in 1998. Once the panel is established, data will be captured in "real time"—that is, 1998 data will be gathered during 1998, 1999 data during 1999, and so on. Again, the sample will be selected to provide geographic diversity, representation of high-growth areas, with some ENERGY STAR Home activity in 1997 and much more activity is planned in 1998.

Data Collection

Data will be collected on property and locational characteristics found in the literature and known to affect sales price of homes. These data will be used in a regression analysis to assess how the ENERGY STAR label affected sales price, resale price, and default rates.

The econometric studies on the value of energy-efficient housing used similar predictor variables; the most consistently important variables in accounting for the variance in sales price were central air conditioning, garage, number of bathrooms, number of stories, house floor area in square feet, access to work and central business district, brick exterior, and fireplace. Once the matched pairs of houses have been located, the following data will be collected for each home and its mortgage in the experimental and control groups:

- Sales price, resale price
- Amount of mortgage
- Subdivision (which provides locational variables)
- If not subdivision, then other indicator(s) to show matching by location
- Amenities (e.g., number of bedrooms and bathrooms, garage, air conditioning)
- House type (ranch, 2-story, multi-level)

On the loan:

- Occurrence of default
- Loan-to-value ratio (known to affect default)
- Debt-to-income ratio.

The collection of data from occupants of ENERGY STAR and standard housing is central to the research design. These data will address motivations for purchasing an ENERGY STAR Home or a standard home, allowing comparisons between the buyers of each type of housing. Research will focus on why buyers selected their homes, including the amenities they valued and reasons why; recognition of the ENERGY STAR Homes brand; whether the energy performance of their home played a role in their purchase decision and why; and the importance they attached to efficiency benefits relative to other attributes in making their home purchase decision. Research will address how the purchase decision was made in the household and the factors that seemed to influence the decision the most, including price differences.

Home owner satisfaction with their home purchase decision will be traced, as will their satisfaction with their utility bills. In addition, data will be collected on values and lifestyle variables, life changes that could affect default, and attitudes on energy and the environment.

Conclusions: Policy Significance of Findings

The results of the ICF study begin to answer the question of whether home energy-efficiency improvements hold value in the marketplace. If the results of these studies are confirmed through the NREL study, then it will become easier for the EPA's ENERGY STAR Homes Program to persuade builders of the value of ENERGY STAR Homes. The AHS regression analysis indicates that for a $1 decline in heating and cooling costs, the value of the home increases by $20-$24. If an ENERGY STAR Home can save a home owner $35 a month, then this study suggests that the market value of the home increases $8,400 to $10,000. If a builder's cost to upgrade a home to ENERGY STAR levels can range from $2,000 to $4,000, then the return to the ENERGY STAR Home builder, upon sale, ranges from 210% to 500 %. These returns are very high; they should be confirmed through additional study and modified to reflect other relevant findings found in the literature. The findings thus far suggest a positive value for energy efficiency and a reasonable return for builders willing to make energy-efficiency enhancements.

The findings also have implications for the mortgage markets. As noted earlier, lenders are reluctant to loan money for the full price of homes enhanced to energy-efficiency levels higher than a standard home. However, if the AHS analysis findings are confirmed through the NREL evaluation, then lenders should become more comfortable with loans to finance energy-efficiency upgrades for both new and existing homes since such property can serve as adequate collateral.

Finally, the results may affect lenders' perception of the probability of default. Lenders have long recognized that default rates are strongly linked to home owner's equity. A homeowner is less likely to default on a mortgage if that homeowner holds significant equity in the property. If the results of the AHS regression analysis are confirmed through the NREL evaluation, then these results suggest that loans for energy-efficiency enhancements are less risky than loans for other upgrades. Energy-efficiency enhancements confer more equity to the home owner. More home owner equity implies less likelihood of default.

References

Corgel, John B., Paul R. Geobel, and Charles E. Wade. 1982. "Measuring Energy Efficiency for Selection and Adjustment of Comparable Sales," *The Appraisal Journal*, pp.71-78.

Dinan, Terry M. and John A. Miranowski. 1989. "Estimating the Implicit Price of Energy Efficiency Improvements in the Residential Housing Market: A Hedonic Approach." *Journal of Urban Economics. 25:* 52-67.

Dunlap, R.E. 1991a. "Public Opinion in the 1980s: Clear Consensus, Ambiguous Commitment," *Environment*. *33*:12.

Dunlap, R. E. 1991b. "Trends in Public Opinion toward Environmental Issues." *Soc. Nat. Res. 4*: 285-312.

Dunlap, R. E. and R. Scarce. 1991. "Trends: Environmental Problems and Protection." *Public Opinion Quarterly, 55:* 651-672.

Farhar, B.C. 1993. *Trends in Public Perceptions and Preferences on Energy and Environmental Policy.* NREL/TP-461-4857. Golden, CO: National Renewable Energy Laboratory, 376 pp.

Farhar, B.C. 1994a. "Trends: Public Opinion about Energy." *Public Opinion Quarterly. 58*: 603-632.

Farhar, B.C. 1994b. "Trends in U.S. Public Perceptions and Preferences on Energy and Environmental Policy." *Annual Review of Energy and the Environment 19:*211-239.

Farhar, B.C. 1996. "Energy and the Environment: The Public View." *REPP Issue Brief.* No. 3. University of Maryland at College Park: Renewable Energy Policy Project: October.

Farhar, B.C. and A. H. Houston. 1996. *Willingness to Pay for Electricity from Renewable Energy.* NREL/TP-469-21216. Golden, CO: National Renewable Energy Laboratory. September. 26 pp.

Farhar, Barbara C. and Jan Buhrmann. 1997. *Public Response to Residential Grid-Tied PV Systems in Colorado: A Qualitative Market Assessment* (Review Draft). Golden, CO: National Renewable Energy Laboratory.

Farhar, B.C. 1998. "A Longitudinal Evaluation of the Energy Star Homes Brand: Builder and Consumer Market Research (Draft). Golden, CO: National Renewable Energy Laboratory.

Halvorsen, Robert and Henry O. Pollakowski. 1981. "The Effects of Fuel Prices on House Prices," *Urban Studies*, 18: 205-211.

Horowitz, Marvin J. and Hossein Haeri. 1990. "Economic Efficiency vs. Energy Efficiency." *Energy Economics*, pp.122-131.

Johnson, Ruth C. and David L. Kaserman. 1983. "Housing Market Capitalization of Energy-Saving Durable Good Investments. *Economic Inquiry, 21:* 374-386.

Laquatra, Joseph. 1986. "Housing Market Capitalization of Thermal Integrity," *Energy Economics*, 8:134-138.

Longstreth, Molly. 1986. "Impact of Consumers' Personal Characteristics on Hedonic Prices of Energy Conserving Durables," *Energy*, 11: 893-905.

National Family Opinion Research, Inc. 1995. *1995 Consumer New Home Survey*, conducted for *Professional Builder Magazine*. Des Plaines, IL: A Calmers Publication.

Wurtzebach, C.H., and N.G. Waller. 1983. "The Feasibility, Underwriting, and Valuation of Residential Energy Components." *The Appraisal Journal, 51:* 66-80.