The Impact of Energy Efficient House Construction on Homeownership Costs: A Comparative Study in Gainesville, Florida

Marc T. Smith
Shimberg Center for Affordable Housing, University of Florida

Pierce Jones
Florida Energy Extension Service, University of Florida

The goal of this study was to determine whether the Energy Star home program, as implemented in Gainesville, Florida, is reducing energy use and therefore costs relative to other homes and the extent of the savings. Analysis of Energy Star qualified houses found the savings were appreciable and statistically significant. The indicated energy savings for the average Energy Star household were $180 per year, which was capitalized to indicate a value increase of the average housing unit of $4,500 and the ability to afford a mortgage of $2,255 more than in the absence of the energy savings. The financial implications of these savings suggest that affordable housing policy needs to factor in continuing ownership costs in addition to the cost of the structure (the "first cost") associated with purchasing a home. If the operating costs can be reduced, then the ability of a household to afford homeownership is improved.

Keywords: *residential energy efficiency; housing cost*

The affordability of homeownership is generally examined based on the costs of qualifying for a home mortgage, which predominately reflects the cost of the structure (the "first cost"). These costs include principal, interest, taxes, and insurance. Less attention has been placed on the operating costs, or life cycle costs, of a home. Yet, the operating costs may be what ultimately determine the ability of a household to continue to own the home. Among the operating costs are maintenance and repair expenses as well as energy costs, the focus

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of this article. Whereas energy costs may not be as significant as mortgage expenses for most households, two decades ago, Struyk (1984) found that some households with incomes below 75% of the poverty line spent about 30% of their income on home energy, with about one half of that used for home heating. A more recent study found that households with incomes below 60% of state median income (the eligibility standard for the U.S. Department of Energy's Weatherization Assistance Program) paid about 14% of income toward household energy bills in 1999 and were projected to reach 20% in 2001 (Power, 2001). For all households, energy bills composed about 4% of income.

To conserve energy and assist households with their energy costs, energy codes and other initiatives have mandated or encouraged more energy efficient homes. One of those initiatives is the Energy Star program of the U.S. Department of Energy and Environmental Protection Agency. There are various Energy Star programs targeting different products. All of the programs are performance based and require third-party certification for products to qualify as energy efficient under the program. Participation in Energy Star programs is voluntary and is generally undertaken with the expectation that the Energy Star label will benefit the marketing of qualified products.

To earn the Energy Star designation, a home must operate 30% more efficiently than a comparable home built to the National Model Energy Code. Generally, an Energy Star home costs more to construct than does a conventional house. This article examines whether homes that are energy efficient can result in operating cost savings that warrant their inclusion as a component of the strategy to promote homeownership. If such is the case, greater efforts may be warranted to educate builders and homebuyers on the benefits of energy efficient construction.

Empirical work was conducted in Gainesville, Florida. On the basis of market penetration, Gainesville is one of the most productive markets for Energy Star homes nationwide. The first Energy Star home built in Florida was completed in Gainesville in the summer of 1997. Since then, the number of Energy Star homes built in Gainesville has steadily risen. Currently, more than 10% of all new homes in the Gainesville area are being built to meet Energy Star standards. Whereas Gainesville is predominately a cooling climate, the results of the empirical work are indicative of the savings that might be achieved in a heating climate.

BACKGROUND

A monograph by McCarthy, Van Zandt, and Rohe (2001) focused on the economic benefits and costs of homeownership. In examining homeownership and housing security, the authors argued that housing costs are relatively fixed for homeowners because of a fixed mortgage payment. Whereas fuel and utilities are included in the monthly housing costs that they compare to rental rates, they do not explicitly address variations in those costs. The authors discussed home maintenance and repair expenditures, but again, the literature that is discussed does not explicitly address energy issues.

Much of the literature on energy costs and homeownership either dates back to the period of the energy crisis in the 1970s or focuses on valuation issues. Nevin and Watson (1998) examined the impact of energy efficient housing on the market value of units. They found that homeowners convert annual fuel savings into house value by multiplying the annual savings by a factor of between 10 and 25, reflecting the after-tax mortgage interest rate. The issue of the capitalization of energy cost savings is important because homebuyers may be hesitant to purchase energy efficient homes if they cannot anticipate living in the home long enough to recover the investment in energy efficiency and do not believe they can recover the costs in higher resale value for the houses.

Nevin and Watson (1998) detailed seven published studies of market valuation of energy efficient homes. Of the studies, six were completed prior to 1986; the other was published in 1990. Most have limited data sets and difficulty specifying a consistent energy savings variable. However, the studies found higher home values as a result of energy efficiency. The Energy Star designation gives a consistent measure of energy improvements for this study. Data sources are also an issue; for example, Nevin and Watson used American Housing Survey data, which introduces issues of self-reporting and uses fuel expenditures as the measure of energy efficiency. This research project used administrative records discussed as follows.

Incorporating energy efficient features in houses may result in higher construction costs. However, over the lifetime of occupancy of the house, the energy savings more than offset the higher initial cost. To provide an incentive for homebuyers to purchase energy efficient homes, energy efficient mortgages allow homebuyers to qualify for larger mortgages than their incomes would otherwise allow. For example, the U.S. Department of Housing and Urban Development's insured energy efficient loans allow homebuyers to finance the cost of energy efficient improvements up to the greater of 5% of a property's value (not to exceed $8,000) or $4,000 (see http://www. hud. gov/buying/insured.cfm). In this way, the potential savings in monthly energy costs are leveraged by homebuyers through extended home purchasing power.

An additional issue in the impact of energy improvements is occupant use. Do occupants with energy saving features in their homes tend to set the thermostat higher in the heating season and lower in the cooling season so that the savings reflected in the bill are not as large as might be expected?[1] Second, do different household types (age, number of children, or employed and therefore away from the house during the day) have different levels of energy use? Neels (1981) found that physical housing characteristics, such as insulation and space to be heated, are more important than are household characteristics in determining energy consumption.

The U.S. Department of Housing and Urban Development, other federal agencies, and the National Association of Home Builders, among others, have sponsored several studies and demonstrations on energy efficiency, with a number of them being completed in the 1970s and 1980s during and immediately following the energy crisis. More recently, energy has moved to the background as a prominent concern, although the winter heating bills in 2000 and 2001 brought the issue to the forefront again. Studies have examined mandatory energy conservation standards (Weicher, 1980). Recent work by Colton (1995) examined several issues related to energy efficiency for low-income housing and first-time homebuyers. The study found that life cycle benefits from energy efficient investments would have the same effect as reducing the initial purchase price of a home from 1.5% to nearly 8% depending on the region. It further concluded that energy efficiency improvements would reduce the operating cost of low- and moderate-income housing, improve overall affordability, enhance creditworthiness of households, and reduce risks associated with mortgages.

The Energy Star Program

An Energy Star–labeled home generally uses 30% less energy for heating, cooling, and water heating than does a comparable home built to the 1993 National Model Energy Code. Energy Star is a performance-based program, which requires a home to earn a Home Energy

Rating System (HERS) score of 86 or better to qualify. A HERS rating is an objective, standardized evaluation of the energy efficiency of a home compared with a simulated reference house (same size and shape as the rated home) that meets minimum 1993 National Model Energy Code requirements. The HERS rating involves at least one onsite inspection of the home that includes a blower door test (to test the leakiness of the house) and a duct test (to test the leakiness of the ducts). In Florida, the results of these tests along with other information about the house are entered into the energy gauge computer simulation program to generate the HERS score and estimate annual energy costs.

In concept, HERS scores range from 0 to 100. The reference house is assigned a score of 80. For every 5% reduction in energy use (compared with the reference house), the score increases by 1 point. So at a minimum, an Energy Star–labeled home must have a HERS score of 86 (i.e., 30% more energy efficient than the 1993 National Model Energy Code reference house).

Florida deviates somewhat because of its energy code (Florida Building Commission, 2001), which is more stringent than the 1993 National Model Energy Code. As a result, a conventional code-compliant house built in north Florida can be expected to have a minimum HERS score of 82. This can be verified by examining the baseline home files that come with Florida's energy gauge software.[2] The net effect is that in north Florida, the heating, cooling, and water heating energy consumption in an Energy Star–labeled home should be only 20% less than in a standard, code-compliant home.

Estimated annual energy end use in the HERS reference home for north Florida is shown in Figure 1. Cooling, heating, and water heating represent 54% of total annual energy end use (21%, 15%, and 18% of total consumption, respectively). Using these estimates, an Energy Star home in north Florida should use 20% less of 54% of total annual energy use or an ~11% reduction in total energy end use.

RESEARCH ISSUES AND METHODOLOGY

The market acceptance of Energy Star homes in Gainesville during the past several years has resulted in a reasonable sample size of homes occupied for full calendar years, experiencing the same climatic conditions. Energy Star provides a specific measure of energy

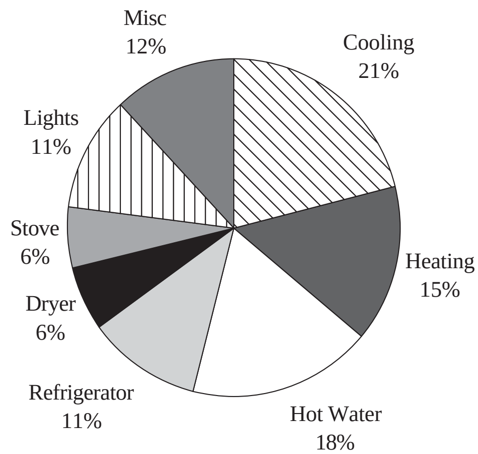

Figure 1: A comparison of end-use energy consumption in a north Florida Home Energy Rating System reference home.
SOURCE: Parker (2002).

efficiency and as such, allows a comparison of homes meeting the energy efficient standard to other new homes. The goal of this study was to determine whether the Energy Star home program as implemented in the Gainesville-area housing market is reducing energy costs relative to other homes and the extent of the savings. The savings have implications for the resources available to homebuyers for home purchase.

There were two distinct database development efforts undertaken in this project. The primary database was concerned with simple energy consumption patterns in conventional versus Energy Star homes. The second data set included information related to conditioned areas, sales dates, sales prices, mortgages, appraisals, and locations (i.e., subdivisions).

Selection of Homes

The best opportunity for fairly evaluating the impact of the Energy Star home program was a comparison at the subdivision level. This approach was possible because of a large concentration of Energy Star houses in the Mentone subdivision. The cost of the upgrade to a Mentone home was about $1,200.

Subdivisions

Several other single-builder subdivisions with similar size, single-story homes were identified, including Broadmoor, Capri, Eagle Point, and Stillwind. Like Mentone, houses in these subdivisions are slab-on-grade frame construction. Because these are all single-builder subdivisions and the styles of construction are so similar, these subdivisions are well suited for direct comparison. All of the houses have central heating and air conditioning. With very few exceptions, the homes in all of the subdivisions have natural gas furnaces for heating and natural gas hot water systems. With very few exceptions, all of the houses are equipped with electric ranges and clothes dryers. With very few exceptions, the houses do not have individual swimming pools or wells. Differences such as windows, gas furnace and hot water system efficiencies, penetration sealing, and ventilation systems could not be reliably quantified.

Energy Consumption Data

Development of the primary database was initiated by Gainesville Regional Utilities (GRU), which worked with the Alachua County Property Appraisers Office to identify all single-family detached homes built in Alachua County from January 1998 through December 1999. Using the list of registered Energy Star homes maintained by the Florida Solar Energy Center, the database was separated into conventional and Energy Star–qualified homes. Homes in Alachua County may be served by either GRU or the Clay Electric Cooperative, and the homes in each list were separated into those served by GRU and Clay Electric.

Consumption data included not only power use but also meter-reading dates. Data were converted to a calendar month basis by prorating the data during the intervals between meter readings and applying prorated values to days of individual months. The calculated monthly data for gas and electric energy consumption were aggregated to annual or seasonal averages in the subsequent analysis, minimizing the smoothing issues.

Other Data

In addition to the data obtained from the utility companies, additional data were obtained directly from the Alachua County Property

Appraiser (tax parcel identification number, conditioned areas, subdivision, and assessed value), the Florida Solar Energy Center (HERS scores), and Reality Check Information, Inc. (sales price and mortgage holder). Energy Star status, tax parcel identification number, and conditioned area were essential data for use in conjunction with the energy consumption data.

Energy consumption data were gathered for calendar years 2000 and 2001. In addition to energy consumption, each home's data set included conditioned space and Energy Star status. Finally, the database included tax parcel identification number, account numbers, physical address, and subdivision for five specific subdivisions.

Data Screening

Each home in the completed database was screened for gaps and anomalies in its energy consumption history. Homes with incomplete calendar year data sets were deleted. The data were also screened to eliminate the few Energy Star houses in the conventional subdivisions and the non–Energy Star houses in the Mentone data set.

Mentone has a single builder that constructs single-story, slab-on-grade frame houses that range from 1,500 square feet to 2,200 square feet conditioned floor area, which is very typical in the Gainesville area housing market. Because of the small size of the data set and to assure consistency across subdivisions in the type of home used for the analysis, the data were further screened to eliminate those few houses that were more than 2,200 square feet in all subdivisions. Similarly, all homes less than 1,200 square feet were eliminated from the data set.

RESULTS

The Gainesville area has a predominately cooling climate with roughly twice the cooling degree days as heating degree days for both 2000 and 2001. The cooling degree day average for the 30-year period from 1961 to 1990 was 2,570;[3] calendar years 2000 and 2001 were both fairly typical. The data are analyzed on an annual basis to allow an examination of differing results across years that may be the result of different weather conditions as well as an opportunity to explore the potential impact of homeowner use, such as not changing filters, that would not be as apparent in the first year of use in a new home. A

TABLE 1: Sample Size (number) and Average Conditioned Area (ft^2) of Houses in Each of the Five Subdivisions With Complete Electric Energy Consumption Data for Calendar Years 2000 and 2001

	Broadmoor	*Capri*	*Eagle Point*	*Stillwind*	*Mentone*
Sample (number)	56	50	48	50	25
Average Area (ft^2)	1,953	1,696	1,764	1,761	1,740

potential limitation of the results is that family characteristics that influence use in a housing unit could vary across the two samples; data on occupant characteristics were not available.

Electric Energy Consumption Data

Monthly electric consumption data for Mentone, the subdivision with Energy Star–qualified homes, and the four conventional subdivisions were analyzed using houses that had complete electric energy consumption data for both calendar years 2000 and 2001. Table 1 details the number and the average conditioned area of houses in each subdivision data set. The overall average conditioned area for the four conventionally built subdivisions was 1,794 square feet compared with 1,740 square feet for the houses in the Mentone data set.

The monthly electric energy consumption data are displayed graphically in Figures 2 and 3 for calendar years 2000 and 2001, respectively. The data are also given with supplemental calculations in Tables 2 and 3.

The data for 2000 show that in comparison with each of the other subdivisions, the electric energy consumption in Mentone was less in every month except in comparison with Stillwind in December. For the whole year on average, the conventional houses consumed 16% more electric energy annually than did the Energy Star houses in the Mentone data set. During the summer cooling season, the differences were even greater, reaching a peak in July of 23%.

The data for 2001 show that in comparison with each of the other subdivisions, the electric energy consumption in Mentone was less in every month except in comparison with Stillwind in January and Capri in November. For the whole year, on average, the conventional houses consumed 10% more electric energy annually than did the Energy Star houses in the Mentone data set. During the summer

(text continues on p. 88)

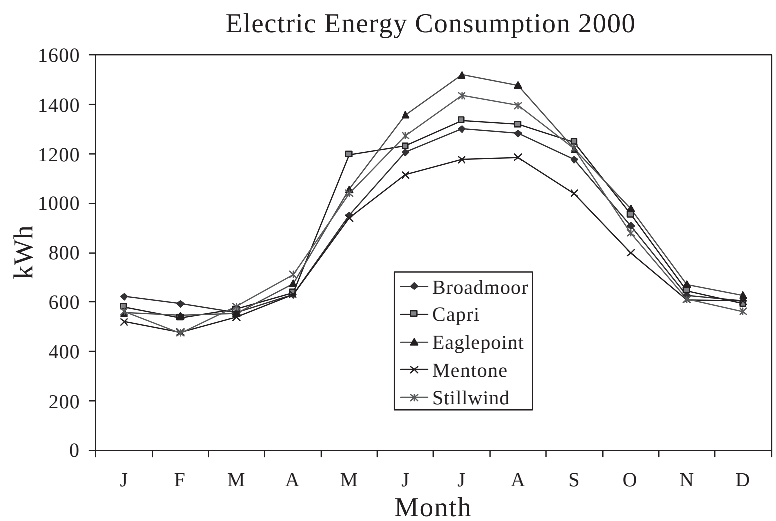

Figure 2: **Monthly electric energy consumption for five subdivisions in the Gainesville area for calendar year 2000.**

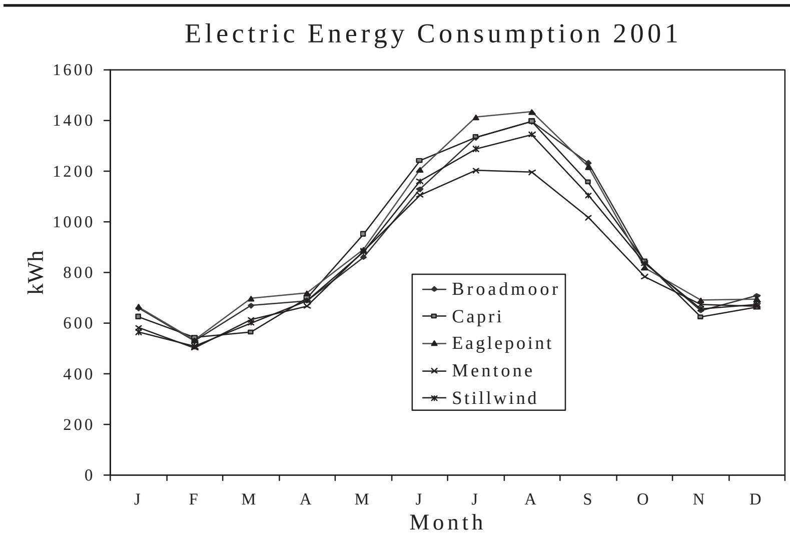

Figure 3: **Monthly electric energy consumption for five subdivisions in the Gainesville area for calendar year 2001.**

TABLE 2: Calendar Year 2000 Monthly Electric Energy Consumption (kWh) for Five Subdivisions in Gainesville, Florida

2000	*January*	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*	*Sum*
Broadmoor	623	593	557	630	951	1,207	1,302	1,283	1,177	909	626	606	10,464
Capri	580	538	571	639	1,198	1,232	1,336	1,320	1,249	955	646	594	10,858
Eagle Point	557	546	556	676	1,057	1,358	1,521	1,479	1,221	979	673	629	11,252
Stillwind	562	475	582	713	1,041	1,275	1,437	1,397	1,223	880	612	563	10,760
Average	581	538	567	665	1,062	1,268	1,399	1,370	1,218	931	639	598	10,834
Mentone	481	450	520	618	901	1,028	1,081	1,124	985	751	565	576	9,080
Difference (%)	17	16	8	7	15	19	23	18	19	19	12	4	16

TABLE 3: Calendar Year 2001 Monthly Electric Energy Consumption (kWh) for Five Subdivisions in Gainesville, Florida

2001	*January*	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*	*Sum*
Broadmoor	660	531	671	690	862	1,130	1,333	1,398	1,233	839	652	709	10,708
Capri	626	544	565	700	952	1,242	1,335	1,398	1,156	844	625	663	10,650
Eagle Point	666	534	699	720	891	1,207	1,414	1,435	1,219	820	692	696	10,993
Stillwind	566	510	602	690	883	1,162	1,289	1,346	1,105	837	658	675	10,323
Average	630	530	634	700	897	1,185	1,343	1,394	1,178	835	657	686	10,669
Mentone	569	499	602	660	860	1,053	1,173	1,183	988	755	653	656	9,651
Difference (%)	10	6	5	6	4	11	13	15	16	10	1	4	10

TABLE 4: Sample Size (number) and Average Conditioned Area (ft^2) of Houses in Each of the Five Subdivisions With Complete Gas Energy Consumption Data for Calendar Years 2000 and 2001

	Broadmoor	*Capri*	*Eagle Point*	*Stillwind*	*Mentone*
2000					
Sample (number)	54	48	47	49	30
Average area (ft^2)	1,954	1,702	1,779	1,761	1,714
2001					
Sample (number)	53	50	46	49	31
Average area (ft^2)	1,954	1,697	1,788	1,737	1,720

cooling season, the differences were even greater, reaching a peak of 16% in September.

Gas Energy Consumption Data

Similar to the electric analysis, monthly gas consumption data for Mentone and the four conventional subdivisions were analyzed using houses that had complete gas energy consumption data for calendar years 2000 and 2001. Table 4 details the number and the average conditioned area of houses in each subdivision data set for 2000 and 2001. The overall average conditioned area for the four conventionally built subdivisions in the 2000 comparison was 1,800 square feet compared with 1,714 square feet for the houses in the Mentone data set, and in 2001, the comparison was 1,794 square feet as opposed to 1,720 square feet for Mentone. The average size of units differs compared with the units report for the electricity data because of differences in the number of units for which a complete set of data on gas use for the year was available. Similarly, average unit size between 2000 and 2001 for the gas data varied because of lack of data on a small subset of homes in one of the years. Because comparisons were being made at the subdivision level, it was appropriate to include as much data as available for each year.

The data for 2000 (see Table 5 and Figure 4) show that in comparison with Mentone, there were only three instances when any of the other subdivisions consumed less gas (Capri in February, Stillwind in May, and Capri in August). For the whole year, on average, the conventional houses consumed 21% more gas energy annually than did

TABLE 5: Calendar Year 2000 Monthly Gas Energy Consumption (therms) for Five Subdivisions in Gainesville, Florida

	January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*	*Sum*
Broadmoor	69	68	28	21	18	15	14	13	14	18	34	74	386
Capri	55	43	21	14	12	10	9	8	10	13	30	57	282
Eagle Point	65	63	23	18	14	11	11	11	11	15	32	68	342
Stillwind	59	51	21	16	11	9	9	9	10	13	24	60	292
Average	62	56	23	17	14	11	11	10	11	15	30	65	326
Mentone	51	45	20	14	12	9	9	9	10	11	17	51	258
Difference (%)	18	20	14	19	13	20	16	12	11	25	43	21	21

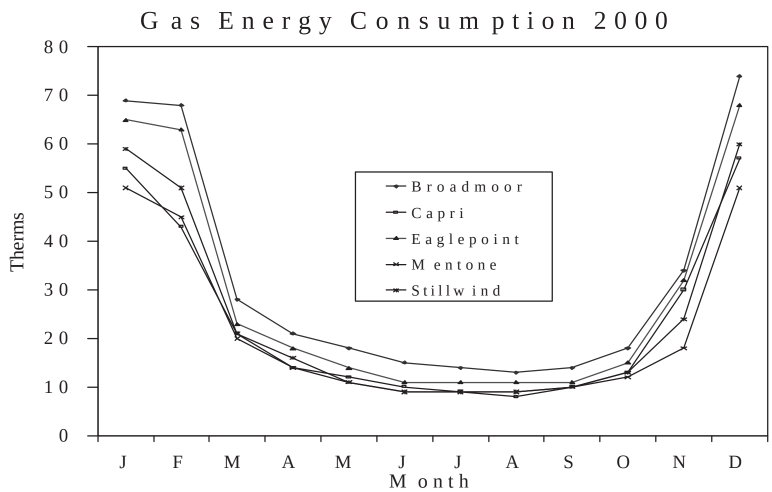

Figure 4: Monthly gas energy consumption for five subdivisions in Gainesville, Florida, during calendar year 2000.

the Energy Star houses in the Mentone data set. During the winter heating season, the differences were even greater, reaching a peak in November of 43%.

The data in Table 6 (also see Figure 5) show that in comparison with Mentone, there were only four instances when any of the other subdivisions consumed less gas (Capri in May and Stillwind in January, June, and July). For the whole year, on average, the conventional houses consumed 17% more gas energy annually than did the Energy Star houses in the Mentone data set. During the winter heating season, the differences were even greater, reaching a peak of 45% in December.

SIGNIFICANCE OF ENERGY SAVINGS

To examine the statistical significance of the observed differences in electric and gas consumption between the Energy Star homes and the other homes in the sample, the Analysis of Variance (ANOVA) method was used. The Mentone Energy Star houses were compared with the conventional houses for the 2000 and 2001 primary cooling and heating seasons.

TABLE 6: Calendar Year 2001 Monthly Gas Energy Consumption (therms) for Five Subdivisions in Gainesville, Florida

	January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*	*Sum*
Broadmoor	93	49	33	26	17	14	14	13	13	18	19	39	348
Capri	73	40	25	19	12	11	11	10	10	13	14	40	278
Eagle Point	85	44	29	21	14	11	11	10	10	15	20	36	306
Stillwind	77	43	24	19	13	9	9	9	9	13	15	31	271
Average	82	44	28	21	14	11	11	11	11	15	17	37	301
Mentone	81	33	23	17	13	10	10	8	9	13	14	20	251
Difference (%)	1	25	17	20	7	11	11	24	14	12	18	45	17

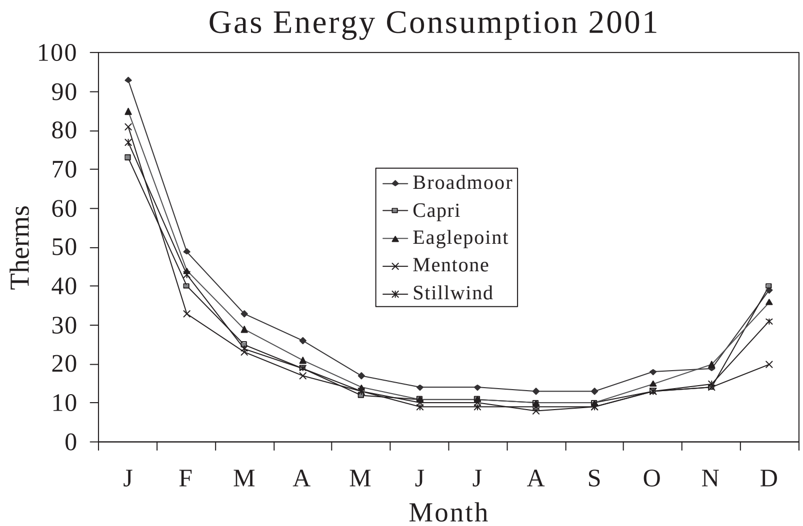

Figure 5: Monthly gas energy consumption for five subdivisions in Gainesville, Florida, during calendar year 2001.

Tables 7 and 8 show comparisons of mean energy consumption for each of the five housing developments in this study. The ANOVA results show that these differences are significant. In three of the four periods of analysis, the probability is zero that the mean of the energy consumption in the Mentone homes is the same as for the remainder of the sample (p = .000). In the winter of 2001, there is near certainty that the means differ (p = .004). In the winter, when gas consumption is relatively high, Energy Star homes averaged 9.295 units less consumption than the overall average in 2000 (range of difference = 3.101 to 22.027) and 4.841 less in 2001 (range of difference = 3.348 to 13.059). In the summer, when electricity use is relatively high, Energy Star homes averaged 206.385 units less consumption than the overall average in 2000 (range of difference = 187.680 to 340.289) and 92.49 less in 2001 (range of difference = 118.105 to 181.456).

Financial Significance of the Energy Savings

Based on billing conversion factors supplied by GRU, the annual energy use for each of the subdivisions was converted into an

TABLE 7: Comparison of Neighborhood Mean Gas Consumption During Winter Heating Months

	Mean Gas Consumption			
	Winter 2000	*(December, January, and February)*	*Winter 2001*	*(December, January, and February)*
Mentone (Energy Star)	48.76		46.97	
Capri	51.86		50.76	
Eaglepoint	65.68		54.89	
Stillwind	56.31		50.32	
Broadmoor	70.79	$F = 22.21$***	60.03	$F = 3.82$
Overall Average	58.06		51.81	$p = 0.004$
Non–Energy Star average	61.16		54.01	

***$p = .000$.

TABLE 8: Comparison of Neighborhood Mean Electric Consumption During Summer Cooling Months

	Mean Electric Consumption			
	Summer 2000	*(June, July, August, and September)*	*Summer 2001*	*(June, July, August, and September)*
Mentone (Energy Star)	1,054.57		1,137.32	
Capri	1,284.52		1,282.93	
Eaglepoint	1,394.85		1,318.81	
Stillwind	1,332.92		1,255.43	
Broadmoor	1,242.25	$F = 11.72$***	1,273.27	$F = 6.46$***
Overall average	1,260.95		1,229.81	
Non–Energy Star Average	1,313.64		1,282.61	

***$p = .000$.

estimated annual bill. Table 9 shows the annual average billing for each subdivision based on the consumption in each subdivision as shown in Tables 2, 3, 5, and 6 and the billing rate as given by the utility company. The table then calculates the average annual differences in the average annual bill for electricity and gas between each of the four subdivisions and Mentone. It can be seen that the smaller homes in Capri are the closest in average bill to the homes in Mentone, whereas those in Eagle Point have the largest variance. Averaging the 2000 and 2001 differences, the annual average total energy bill compared with

TABLE 9: Annual Average Electric and Gas Billing, All Subdivisions, and Differences Between Mentone and Other Subdivisions in Annual Electric and Gas Billing, 2000 and 2001

	Gas 2000	*Gas 2001*	*Electric 2000*	*Electric 2001*
Annual Average				
Broadmoor	399.96	449.88	1,000.44	1,074.24
Capri	318.96	375	951.84	986.64
Eagle Point	365.88	407.28	1,074.24	1,102.08
Stillwind	325.2	372.36	1,028.28	1,037.88
Mentone	295.68	358.08	873.96	973.01
Difference from Mentone				
Broadmoor	104.28	91.8	126.48	101.23
Capri	23.28	16.92	77.88	13.63
Eagle Point	70.2	49.2	200.28	129.07
Stillwind	29.52	14.28	154.32	64.87

Mentone was $212 more in Broadmoor, $66 more in Capri, $224 more in Eagle Point, and $131 more in Stillwind.

Averaging the savings across the four subdivisions, the average savings was $158 for a homeowner living in Mentone. Capitalized at a 4% rate as suggested in Nevin and Watson (1998), the savings translates into an increased home value of $3,950.[4] This cost savings compares favorably to the cost of the upgrade, $1,200. As discussed earlier, the value impact of the savings of Energy Star would likely be higher in other markets without the Florida Energy Code or with a different heating season.

The savings of $158 translates to an average savings of $13 per month. If those funds were spent in mortgage payments, the homebuyer in Mentone would be able to afford an additional $1,979 in a mortgage loan at a 7% rate for a 30-year loan.[5] Again, although not a huge impact, the savings are significant in that they represent about 2% of home value.

In northern areas that are predominately heating climates, the issue of energy costs is more significant. Annual bills for the main heating fuel exceed $2,000 (Power, 2001). The significance of the savings generated in Gainesville for the heating season of 20% to a peak of more than 40% imply savings of $400 to $800 per year in such a climate. These savings suggest a larger cost benefit to homeowners from energy efficiency in such climates and a greater incentive to achieve energy efficiency. The capitalized benefit would be $10,000 to $20,000.

Is the Energy Efficient Investment Worthwhile? A Decision Framework

The financial benefit of an investment in energy efficient construction is a function of the energy savings resulting from the investment, the additional cost that is added to the construction cost of a home, and the resultant additional mortgage cost (assuming that no benefit accrues through a lower mortgage rate). To illustrate the interplay of these factors, a spreadsheet was developed and an illustration using the results previously discussed is provided in Table 10. Although the capitalized value of the energy cost savings as reflected in the value of the home is estimated at $1,979, the value today of the energy cost savings during the 30-year life of a mortgage loan, calculated at the same 7% rate used to calculate the mortgage loan payment, is $4,337. The additional cost imposed by the higher construction cost is $1,200. Thus, the net benefit of the energy efficient construction during the 30-year life of the loan is $3,137. Assuming the house is sold after 10 years, the homeowner receives a benefit of $843 because of the shorter amortization period. That benefit may increase as a result of the higher value for the residence due to the energy-saving features. The potential benefit will vary with the climate, the interest rate available for the loan, the cost of the energy efficient improvements, the length of occupancy, and the energy cost savings. A decision framework such as that shown in Table 10 allows an assessment of the benefits under varying assumptions.[6]

CONCLUSION

The goal of this study was to determine whether the Energy Star home program as implemented in the Gainesville area housing market is reducing energy costs relative to other homes and the extent of the savings. The calculated expected reduction in total energy consumption in an Energy Star–qualified house in north Florida was determined to be 11%. Analysis of the Energy Star–qualified houses in the Mentone subdivision found that the savings significantly exceeded this goal in electric and gas consumption in both 2000 and 2001. The ANOVA technique applied to the means of the samples

TABLE 10: Financial Benefits of Energy Efficient Improvements

				Amortized Difference	
	Conventional	*Energy Star*	*Net Difference*	*(30 Years)*	*(10 Years)*
Cost of home	75,000	76,200	$1,200.00		
Mortgage amount at 10% down	67,500	68,580	$1,080.00		
Mortgage payment	$498.98	$506.96	$7.98	($1,200.00)	($687.60)
Annual energy cost	1,400	1,242	–158	$4,336.86	$1,530.47
Cost-benefit of Energy Star				$3,136.86	$842.87

found that the savings were statistically significant. The indicated energy savings resulted in annual utility cost savings for the average Energy Star household of $180 per year, which was capitalized to indicate a value increase of the average housing unit of $4,500 and the ability to afford a mortgage of $2,255 more than in the absence of the energy savings.

Energy conservation programs such as Energy Star are often advocated as public policy because of their potential to achieve energy conservation goals resulting in societal benefits. However, the energy savings achieved by the household has a potential for more direct impact for the individual household occupying an Energy Star home. The affordability of homeownership is generally examined based on the cost of the structure (the "first cost") and the amount of mortgage for which a household may qualify. Less attention has been placed on the operating costs, or life cycle costs, of a home. If the operating costs can be reduced, then the ability of a household to afford homeownership is improved. Energy is a major component of operating costs and for lower income households, may exceed the monthly mortgage payment. The operating cost savings achieved through Energy Star construction indicated by the results of the analysis of the Mentone subdivision warrant the inclusion of energy efficient construction as a component of strategies to promote homeownership. Greater efforts are warranted to educate builders and homebuyers of the benefits of energy efficient construction. Federal, state, and local housing programs that subsidize the construction or rehabilitation of housing units should consider Energy Star construction as a requirement of their construction rather than focus on efforts to reduce the construction costs of homes.

NOTES

1. See, for example, Dinan and Miranowski (1989) and Hsueh and Gerner, 1993.

2. Two technical notes providing further details on this topic can be found at the Resnet Web site at http://www.natresnet.org/codes/whitepaper.pdf and at http://www.natresnet.org/codes/iecc.htm.

3. Cooling degree days are calculated by summing the difference between the average daily temperature and 65 degrees for each day for which the temperature exceeds 65 degrees.

4. Capitalization is the process used in real estate appraisal to convert a measure of income or savings received in a year into an estimate of the value of the income. In other words, it is the amount that someone would pay to receive that income stream, assuming that the income will continue for multiple years. The formula is value = income / capitalization rate. In this case, using the capitalization rate calculated by Nevin and Watson (1998), value = $180 / .04 = $4,500.

5. If the savings is assumed to exist each month during a 30-year mortgage loan term, then the amount of mortgage that the savings can support can be calculated. The $15 is an annuity each month for 30 years. The present value of that annuity is calculated using a 7% rate: $1 - [1 / (1 + I)^n] / i$ multiplied by the annuity amount $15, where i is the interest rate and n is the time period.

6. We thank a reviewer for suggesting the development of such a framework.

REFERENCES

Colton, R. (1995). *Energy efficiency as a credit enhancement: Public utilities and the affordability of first-time homeownership*. Unpublished report, Fisher, Sheehan, and Colton, Public Finance and General Economics.

Dinan, T. M., & Miranowski, J. A. (1989). Estimating the implicit price of energy efficiency improvements in the residential housing market: A hedonic approach. *Journal of Urban Affairs*, *25*, 52-67.

Florida Building Commission. (2001). *Florida building code 2001*. Tallahassee: Florida Department of Community Affairs.

Hsueh, L. M., & Gerner, J. L. (1993). Effect of thermal improvements in housing on residential energy demand. *Journal of Consumer Affairs*, *27*, 87-105.

McCarthy, G., Van Zandt, S., & Rohe, W. (2001). *The economic benefits and costs of homeownership* (Working Paper No. 01-02). Washington, DC: Research Institute for Housing America.

Neels, K. (1981). *Families, houses, and the demand for energy, housing assistance supply experiment* (Published report prepared for the U.S. Department of Housing and Urban Development). Santa Monica, CA: RAND.

Nevin, R., & Watson, G. (1998). Evidence of rational market valuations for home energy efficiency. *The Appraisal Journal*, *66*, 401-408.

Parker, D. S. (2002, January). Research highlights from a large-scale residential monitoring study in a hot climate. In *Proceedings of International Symposium on Highly Efficient Use of Energy and Reduction of Its Environmental Impact* (pp. 108-116). Osaka, Japan: Society for the Promotion of Science Research for the Future Program.

Power, M. (2001). *The winter behind, the summer ahead: A harsh spring faces low-income energy consumers*. Economic Opportunity Studies, Washington, DC. Available from http://www.opportunitystudies.org

Struyk, R. (1984). Home energy costs and the housing of the poor and the elderly. In A. Downs & K. L. Bradbury (Eds.), *Energy costs, urban development, and housing* (pp. 35-84). Washington, DC: Brookings Institution.

Weicher, J. C. (1980). *Effects of energy conservation standards on housing markets* (Published report prepared for the U.S. Department of Housing and Urban Development). Washington, DC: The Urban Institute.