Comparative Analysis of Homebuyer Response to New Zero Energy Homes

Timothy C. Coburn, Abilene Christian University
Barbara C. Farhar, National Renewable Energy Laboratory
Megan Murphy, University of Colorado

ABSTRACT

A new development by Shea Homes at Scripps Highlands in San Diego, California, offers zero energy homes (ZEHs)—highly energy-efficient homes with solar water heating and, in some, solar electricity as a standard feature—the first such offering in the United States. Early in 2004, mail questionnaires went to 271 homebuyers in the 306-home Scripps Highland community (ZEH and highly energy-efficient homes) and 98 homebuyers in an adjacent 103-home community (conventional homes) who had lived in their homes for at least 6 months. Two different builders offered these homes. Respondents in the conventional homes comprise the comparison sample.

The questionnaires address perceptions and preferences relative to the recent new home purchases, and the role, if any, that energy efficiency and solar features might have played in these purchases. Also investigated are willingness to pay for energy features; preferences on whether energy features should be standard or optional; preferences on energy policies; perceived problems; aesthetics; homebuyer satisfaction and the reasons for it; environmentalism; and experience with the utility company.

Respondents were asked to sign a release form for their utility company to provide data to the researchers on electricity and natural gas consumption. Utility data will be used to analyze whether statistically significant differences in energy consumption and energy costs might be attributed to the energy features of the new ZEH homes by comparing them with similar conventional homes, while controlling for climate, square footage, and number of occupants.

This paper covers the preliminary findings from the survey and the analysis comparing responses from the ZEH and comparison sample homebuyers.

Introduction

A zero energy home (ZEH) combines state-of-the-art, energy-efficient construction and appliances with commercially available renewable energy systems to reward its owner with net zero energy consumption. A ZEH, like any other home, is connected to the utility grid, but overall it produces as much energy as it consumes. With net metering, the home's electric meter runs backward when the home is producing more power than it is using. With its reduced energy needs and solar energy systems, a ZEH can, over the course of a year, give back as much energy to the utility as it takes. Zero energy homes are thought to have a number of advantages, including improved comfort, protection against electricity price spikes, and environmental sustainability.

The SheaHomes Scripps Highlands development, for example, comprises the first offering of its kind in the United States. The homes provide homeowners with the potential to reduce their utility bills by 30% to 50% over a conventionally built home. The development

involves a partnership between SheaHomes, the ComfortWise program supplied by ConSol, Inc. (providing quality control for the energy-efficient design and construction), Sun Systems, Inc. (providing the solar water heating systems), and AstroPower, Inc. (providing the solar electric systems).

The current study being conducted by the National Renewable Energy Laboratory (NREL) is based on an earlier qualitative investigation of new homebuyers in two adjoining residential communities—San Angelo and Tiempo—developed by SheaHomes, Inc. in the Scripps Highlands area of San Diego. The earlier qualitative study centered on the homeowners' reasons for purchase and their perceptions of the energy features of their new homes (Farhar, Coburn, and Collins, 2002). The present research has three specific objectives:

- To provide credible findings that will increase understanding of the customer response to ZEHs, as compared with customer response to similar conventional housing
- To compare the electricity and gas consumption of the SheaHomes with that in the comparison community
- To develop a research protocol that can be adapted and applied by others to assess local-area markets for new ZEHs.

Although the homes built by SheaHomes at Scripps Highlands are not, strictly speaking, zero energy homes, they are 38% more energy efficient than the strict California Title 24 guideline, and 293 of the 306 homes have solar water heaters. In addition, 120 of the homes have solar electric (photovoltaic, or PV) systems interconnected with the utility grid (thus, GPV systems). A key question of the research is how attractive these homes are to new homebuyers and whether they represent a marketing advantage for builders.

The study's findings are intended to inform state, federal, and utility policies and incentive programs concerning the production and purchase of ZEHs as well as to inform builders of the market perception of desirability and importance of energy efficiency and solar features in a new home. No quantitative studies currently address consumer response to ZEHs; therefore, this investigation begins to fill a significant gap in this field of knowledge.

This paper presents a preliminary analysis of selected variables from the study using partial data. Discussed are comparative findings from the two samples on respondent characteristics, increases in property value, reasons for purchase, reported utility bills, expectations about utility bills, homebuyer satisfaction measures, and behavioral intention.

Methods

The universe of study is twofold: all households in the 306-home SheaHomes San Angelo and Tiempo developments at Scripps Highlands in San Diego, and all 103 conventional homes in an adjacent comparison community of conventional homes constructed by a different builder. A mail survey of homeowners in the San Angelo and Tiempo communities was conducted early in 2004, along with a corresponding survey of homeowners in a nearby comparison community developed by a different builder. The comparison community was chosen because of its proximity to San Angelo and Tiempo and the similarity of price range, housing type, and climate between the communities. The homes in the comparison community do not, however, have energy efficiency and solar features (although they were constructed under California's Title 24 energy efficiency codes). Questionnaires were sent to the entire

universe of potential respondents who had lived in their homes 6 months or longer: 271 homeowners at San Angelo and Tiempo and 98 homeowners in the comparison community. The restriction on time of residence was imposed to ensure that all respondents had experienced living in their homes for at least two seasons of the year. Respondents to the questionnaires represent heads of household in a newly constructed homes in either the SheaHomes' San Angelo or Tiempo communities or in the comparison community.

Household data were gathered from four sources—the public records on home sales, SheaHomes records on energy features, the completed questionnaires, and San Diego Gas & Electric Company (SDG&E). This paper reports on partial data from all sources except the utility company.

Four different questionnaires were designed to streamline data collection while providing comparable information from different groups. The homeowner groups of interest are:

- ***SheaHomes homeowners with solar electric systems*** (the questionnaire for this group was termed the "PV" questionnaire)
- ***SheaHomes homeowners without solar electric systems*** (those who purchased homes for which they could have selected a GPV systems and chose not to—the questionnaire for this group was termed the "main" questionnaire)
- ***SheaHomes homeowners without solar electric systems*** (those who were not given the opportunity to purchase a system because (a) the home planned for the site they selected had been designated by Astropower as technically unsuitable for a solar electric system or (b) they were among the first 13 homebuyers to whom neither solar water heating nor solar electric systems were made available by the builder—the questionnaire for this group was termed "black/early" questionnaire)
- ***Comparison homeowners*** (the comparison community adjacent to Scripps Highlands; homes were not advertised as energy efficient nor as offering any solar energy features—the questionnaire for this group was termed the "comparison" questionnaire).[1]

The questionnaires included general questions permitting comparisons across the groups as well as questions specific to each group.

NREL sent the appropriate questionnaire to each household. Five mailings were sent in stages in an effort to maximize the survey response rate: an initial postcard alerting potential respondents that they were part of a sample, a questionnaire package including a crisp new $10 bill and utility release form, a reminder postcard, a reminder letter, and a final package containing a second copy of the questionnaire. Data collection began January 22, 2004, and continued for 12 weeks. As of this writing, a total of 148 (121 from homeowners in the SheaHomes communities, and 37 from homeowners in the comparison community) responses have been received, representing a response rate of approximately 38%. Although this response rate is lower than desired, it does not yet represent the full complement of responses anticipated for the study.

In addition to a questionnaire, each homeowner was requested to sign and return a utility release form that could be used to obtain accurate information from SDG&E about monthly

[1] The first 13 homes built at Scripps Highlands, (termed "early"), were highly energy-efficient homes but had no solar water heating or GPV systems. AstroPower designated another 33 sites as unsuitable for PV because of orientation or roofline (termed "black" because they were marked as black on the site map). These 46 homes together did not have GPV systems and are termed "black/early."

utility bills. To date, forms have been received from approximately 63% of all those responding to the questionnaires.[2]

Respondent Demographic Characteristics

Respondents were asked to select one head of household for answering demographic questions about themselves and their households. There is no statistically significant difference between respondents who are homeowners in the SheaHomes communities and those who are homeowners in the comparison community.

The following information summarizes the demographic nature of all respondents combined:

- Respondents (heads of households) are predominantly male (male, 57%; female, 43%).
- The largest percentage (42%) of respondents are 25 to 39 years old (29% are 40 to 49 years of age, 26% are 50 to 64 years of age, and three percent are 65 or older).
- 95% percent of respondents are married.
- In terms of household composition, 54% have two adults living with children and 26% are two-adult households; the balance are either single adults (3%), single-parent families (1%), or extended families with three or more adults (16%).
- Reported household size ranges from 1 to 11 people, with a mean of 3.56 occupants (78% of all respondent households are comprised of 2 to 4 residents).
- The respondents are a highly educated group: 97% have completed at least some college; 79% have at least a Bachelor's degree; 20% have a Master's degree; and 17% have doctoral degrees.
- Reported occupations included business owners, investments/financial, health care, engineers, managers, and professionals.
- As expected, respondents report high household income levels, with the modal range for gross annual household income being $100,000 to $149,000 (81% report an annual household income of $100,000 or more; 18% report an annual household income of $200,000 or more).
- One third of all respondents indicate they are planning to stay in their homes permanently, whereas 41% do not know how long they will live in their new homes; the remainder of the data suggests a bimodal pattern with peaks at 7 and 10 years.
- Most respondents (92%) moved to Scripps Highlands from elsewhere in the San Diego area. This means that most buyers had been exposed to the publicity concerning the electricity price spikes in San Diego and the California energy crisis during 2000-2001.

Increases in Property Values

Homes in the SheaHomes communities, which closed between April 26, 2001, and November 21, 2003, originally ranged in price from $437,900 to $840,938. The mean price was $601,984. Homes in the comparison community were somewhat more expensive. They were

[2] Although utility release forms have been signed and returned by 93 respondents, the utility bill data had not yet been gathered at the time of this writing.

sold from May 22, 2001 to November 10, 2003, and ranged in price from $473,990 to $875,000, with the mean price being $615,029. As of February 20, 2004, 16 homes had been resold by their original owners (10 in SheaHomes communities and 6 in the comparison community). Table 1 shows the original and resale prices for the two developments.

Table 1. Original Sales Prices and Resale Prices of Homes in the SheaHomes and Comparison Communities

Sample of Resale Homes	Original Price	Resale Price
Resale Homes in SheaHomes Communities (n = 10)	Range: $482,900–$636,730 Mean: $549,672	Range: $559,842–$930,000 Mean: $777,264
Resale Homes in the Comparison Community (n = 6)	Range: $572,303–$711,887 Mean: $624,204	Range: $655,000–$865,000 Mean: $787,833

Both the SheaHomes and the comparison homes have increased markedly in value, but, based on this very small sample, the SheaHomes have increased *more* in value. The increase in value for the SheaHomes averaged $227,592, or 42%, whereas the increase in value for the comparison homes averaged $163,629, or 26%.

The data in Table 2 show that, despite the fact that the homes in the comparison community were owned by their original owners for a longer period than the homes in the SheaHomes communities at the time they were resold (a mean of 21.8 months and 18.7 months, respectively), they gained a good deal less in value. More strikingly, the data show that the greatest single gain in value was $309,505 for a house in the SheaHomes communities with a GPV system owned for 14 months (a 56% increase in value). In comparison, the single largest gain for a home in the comparison community was $208,410 for a house owned for 24 months (a 35% increase in value).

Data are not available on many factors that can affect property values. However, information about the energy features of the resold SheaHomes is available. The mean percentage gain in value of SheaHomes with PV installations was 49.3%, whereas the mean percentage gain for those without PV installations (but on which PV could have been installed) was 31%, and the mean percentage gain for the black/early homes was 47.6%. Therefore, in mean percentage terms, all types of homes in the SheaHomes communities increased in value, and more so than homes in the comparison community.

Table 2. Comparisons of Gains in Property Values and Length of Ownership for Homes in the SheaHomes and Comparison Developments

Variable	Homes in SheaHomes Communities	Homes in the Comparison Community
Length of ownership before resale (mean in mos.)	18.7 mos.	21.8 mos.
Length of ownership (range in mos.)	10–29 mos.	17–25 mos.
$ gain in property value (mean)	$227,592	$163,629
Percentage of $ gain in property value (mean)	42%	26%
Range of percentage $ gain in property value	6%–56%	13%–35%
Range of $ gain	Hi = $309,505, PV, owned 14 mos. Lo = $31,942, Main, owned 16 mos.	Hi = $208,410, owned 24 mos. Lo = $76,089, owned 18 mos.

Given these findings, it seems fair to conclude that, at a minimum, energy-efficient homes and ZEHs not only hold their value, but increase their value at a faster rate than do conventional homes.

Reasons for Purchase

All four types of questionnaires asked respondents to rate a set of characteristics about their homes with the following question: "How important were each of the following features in your decision to purchase your new home?" Respondents were asked to rate characteristics on a 1 to 5 scale (where 1 = not at all important and 5 = very important). SheaHomes respondents were asked to rate 23 characteristics, including four items specifically dealing with energy features. Respondents in the comparison sample were asked to rate 20 items, including a single item pertaining to energy. They were asked to rate how important "energy use of the home" was to their purchase decision. In addition, all respondents were asked to indicate the top three most important reasons for purchase.

The questions were phrased in this manner to allow energy as a factor in the home purchase decision to rise or fall to the level of importance it actually had within the context of the many variables known to affect housing purchase decisions. Most of the reasons for purchase were rated the same by the SheaHomes and the comparison sample buyers. However, a difference pertinent to this study is that the SheaHomes buyers were more concerned about the home's energy use than were the comparison buyers. It may be possible to conclude that homebuyers who are already concerned about residential energy use constitute a stronger market for ZEHs.

Table 3 details the ratings of the specific features for which average (mean) ratings were computed. The features with the highest mean scores with respect to both respondent groups include "safe area/secure feeling," "no Mello-Roos taxes," "quality of neighborhood/ community," and "overall home value." Other characteristics with a mean rating of 4 or higher on the 5-point scale include "desirability of area," "investment potential," "freeway access," and "exterior designs."

The two respondent groups differ significantly in their average rating of three reasons for purchase:

- "Desirability of area" was rated higher by respondents from the comparison community (mean = 4.67) than by the SheaHomes respondents (mean = 4.36; $t = -2424$; $df = 142$; $p \leq .017$)
- "Quality of schools" was rated higher by the comparison respondents (mean = 4.32) than by the SheaHomes respondents (mean = 3.91; $t = -1.936$; $df = 84$; $p \leq .056$)
- "Reputation of builder" was more highly rated by the SheaHomes respondents (mean = 3.94) than the comparison respondents (mean = 3.33; $t = 3.440$; $df = 141$; $p \leq .001$).

Table 3. Most Important Reasons for Home Purchase Ranked by Mean Scores[a]

Feature	Mean Score, SheaHomes Sample	Mean Score, Comparison Sample	SheaHomes % Responding Very Important (5)	Shea Homes % Responding Important or Very Important (4,5)
Safe area/secure feeling	4.66	4.65	70	96
Quality of neighborhood/ community	4.58	4.46	61	95
Overall home value	4.50	4.54	58	93
No Mello-Roos taxes[b]	4.49	4.38	63	88
Investment potential	4.37	4.35	49	91
*Desirability of area ($p \leq .017$)	4.36	4.67	50	94
Freeway access	4.09	4.00	39	74
Exterior designs	4.01	4.11	25	82
Access to services, shopping, and entertainment	3.97	3.95	28	75
*Reputation of builder ($p \leq .001$)	3.94	3.33	27	61
*Quality of schools ($p \leq .056$)	3.91	4.32	52	73
Closeness to work	3.88	3.89	37	65
Availability of very energy-efficient home (for SheaHomes) or energy use of the home (for comparison sample)	3.86	3.41	21	64
Helpfulness and knowledge of sales staff	3.83	3.43	26	61
Prior familiarity with the area	3.79	3.59	28	61
Great view	3.68	3.64	32	56
Feeling of community spirit	3.67	3.60	20	59
The package of energy features taken together	3.58	--	12	63
Availability of solar water heating	3.50	--	18	52
Discount or other incentive	3.46	3.31	18	51
Availability of GPV system (main and PV only)	3.29	--	9	48
Closeness to friends/ family members	3.20	3.11	18	41
Closeness to parks/ playgrounds	2.98	3.16	11	29

[a]Mean scores are ranked from low to high with regard to the SheaHomes respondent group.

[b]Mello-Roos taxes are a form of property taxation for new home developments passed by the legislature; these taxes provide for the development of new infrastructure such as roads and schools. Certain land holdings, including the Scripps Highlands parcel owned by SheaHomes, were exempted from Mello-Roos taxes at the time the bill was passed.

*Statistically significant difference.

In addition, "availability of very energy-efficient homes" (the item for SheaHomes respondents) was more highly rated (mean = 3.86) by them than was "energy use of the home" the item for comparison respondents) rated by them (mean = 3.41). However, because these items are not identical in wording, a difference of means test could not be run on them.

After rating the importance of each of 23 listed reasons for the purchase decision, the SheaHomes and comparison respondents selected the three most important ones. Although a few respondents mentioned every one of the 23 reasons as one of their very most important reasons for purchase, the most frequently identified reasons were: overall home value (cited by 48% in the top three reasons), safe area/secure feeling (33%), closeness to work (27%), desirability of area (25%), investment potential (24%), and no Mello-Roos taxes (22%).

In summary, then, the reasons for purchase were quite similar between the two samples. The idea that the neighborhoods were safe and secure fits in with the age range and household composition of the families buying homes there—a majority of them younger married couples with children. The reputation of the builder was a more important factor to the SheaHomes than to the comparison buyers. The availability of energy features was a relatively low priority in the purchase decision for both respondent groups, but energy considerations were more important to the SheaHomes than to the comparison homebuyers.

Comparison of Reported (Perceived) Utility Bills

Because they are billed separately for electricity and natural gas, respondents with GPV living in ZEHs were asked: "Approximately what is your household's average monthly electricity bill now?" and "Approximately what is your household's average monthly natural gas bill now?" Other respondents were asked to state their household's "average monthly utility bill now." These questions result in self-reported data representing point-in-time perceptions of the homeowners; they may not accurately reflect actual monthly amounts.[3]

On average, the SheaHomes respondents report significantly lower-average monthly utility bills than respondents from the comparison community, but the amounts are more variable. The mean of the average monthly utility bills (gas and electricity combined) reported by SheaHomes respondents is $151.71 with a standard deviation of $92.94 (range of $17 to $475), and the mean of the average monthly utility bills reported by respondents from the comparison community is $193.62 with standard deviation of $108.69 (range of $55 to $540). The difference in the two mean values is statistically significant ($t = -2.038$, $df = 121$, $p = .044$), despite the fact that the standard deviation in reported amounts for both groups is quite high. Indeed, the coefficient of variation of average monthly utility bills reported by SheaHomes respondents is 61.3%, and the corresponding coefficient of variation of average monthly utility bills reported by respondents from the comparison community is 56.1%.

If GPV owners are omitted from the SheaHomes respondent pool, the results are somewhat different. The mean of the average monthly utility bills reported by the remaining SheaHomes respondents is $168.06 with a standard deviation of $94.54 (range of $50 to $450). The difference in mean values associated with the restricted pool of SheaHomes respondents and the respondents from the comparison community is not statistically significant ($t = -1.145$,

[3] As previously noted, 63% of the respondents completed a utility release form that will enable researchers to obtain actual energy consumption and cost data for their homes.

df = 89, p = .255). This result suggests that PV systems may have a marked impact on the perception of lower average monthly utility bills in these types of homes.

The mean reported monthly gas bill for SheaHomes respondents who are PV owners is $41.63 (range of $6 to $125) and the mean monthly electricity bill is $81.27 (range of $5 to $350). The mean-reported total utility bill (gas and electricity combined) for SheaHomes respondents who are PV owners is $118.66 (range of $17 to $475). The broad range of values may be the result of differences in respondent perceptions or actual household energy usage attributable to differences in household composition, energy usage behaviors, or appliance installations. It is possible that a few of the GPV households may not have signed their interconnectivity agreements with SDG&E, which means that their systems are not functioning. This would almost certainly result in higher electricity bills than if the GPV system were functioning.

Table 4 summarizes the percentages of responses with respect to three intervals of average monthly utility cost reported by homeowners from the SheaHomes communities and the comparison community. The three intervals are (1) less than $100 a month, (2) $100 to $199 a month, and (3) greater than or equal to $200 a month. The percentage of SheaHomes respondents (31%) reporting average monthly utility bills in the lowest cost interval (under $100) is more than double the percentage of respondents from the comparison community (14%) who report having average monthly utility bills this low. The distribution of percentages among the three intervals for SheaHomes respondents and respondents from the comparison community is significantly different (Chi square = 6.814, df = 2, p = .033).

Again, if the GPV owners are omitted from the SheaHomes respondent pool, the distribution of percentages among the three intervals for the two respondent groups is not statistically significant (Chi square = 2.732, df = 2, p = .255). However, it is still the case that a higher percentage of SheaHomes respondents report average monthly utility bills in the lowest cost interval than respondents from the comparison community (Table 5), and, as will be seen, SheaHomes respondents perceive their homes to be more energy efficient than do comparison respondents. Future analyses will contrast respondents' perceived monthly utility costs with actual utility bills and will compare actual electricity and gas consumption by households in the SheaHomes and the comparison communities.

Table 4. Comparison of Average Monthly Utility Bills Reported by SheaHomes and Comparison Respondents

Monthly Utility Cost Interval	Homeowners in SheaHomes Communities (n=98)	Homeowners in Comparison Community (n=58)
< $100 a month	31%	14%
$100–$199 a month	45%	38%
≥ $200 a month	24%	48%
Total	100%	100%

Table 5. Comparison of Average Monthly Utility Bills Reported by the Two Respondent Groups (PV Owners Omitted)

Monthly Utility Cost Interval	Respondents from SheaHomes Communities (n=124)	Respondents from the Comparison Community (n=58)
< $100 a month	26%	14%
$100–$199 a month	42%	38%
≥ $200 a month	32%	48%
Total	100%	100%

Expectations for Utility Bill Savings

SheaHomes respondents were asked about the extent to which they agreed or disagreed with the following statement: "The savings on our utility bills have met or exceeded our expectations."[4] Thirty-eight percent responded "agree" or "strongly agree," 43% were unsure, and 19% responded "disagree" or "strongly disagree." These overall results do not represent a ringing endorsement for the perceived efficacy of the homes from the standpoint of energy savings, particularly in light of the findings described above, and may reflect (1) a lack of knowledge about potential energy savings on the part of new homebuyers or (2) absent or ineffective communication about the potential for energy savings on the part of sales staff.

GPV owners are more convinced that their solar energy systems (both GPV and solar water heating) are saving them money on their utility bills than are non-GPV owners. On this point it is informative to consider the differences in answers from respondents whose homes include GPV and those whose homes do not. Table 6 summarizes the results. Among the SheaHomes respondents who are also PV owners, 53% responded "agree" or "strongly agree" that their utility bills met or exceeded expectations, 30% were unsure, and 17% responded "disagree" or "strongly disagree." Among the SheaHomes respondents whose homes do not include GPV, 29% responded that they "agree" or "strongly agree" with the statement, 50% were unsure, and 21% responded that they "disagree" or "strongly disagree." There is a statistically significant difference in the two distributions of percentages (Chi-square=6.025, df=2, p=.049), suggesting that PV owners experience greater satisfaction that their expectations for energy savings were met or even exceeded.

Table 6. Percentage Comparison of Respondents from Homeowners in the SheaHomes Communities Regarding Their Expectations about Savings on the Utility Bills[a]

Response	All Shea Homes Respondents (n=108)	SheaHomes Respondents with PV (n=40)	SheaHomes Respondents without PV (n=68)
Agree/strongly agree	38%	53%	29%
Unsure	43%	30%	50%
Disagree/strongly disagree	19%	17%	21%

[a] Item: "To what extent do you agree with the following statement: the savings on our utility bills have met or exceeded our expectations."

In addition, GPV owners were asked the extent to which they agreed with the statement "Our electricity bills are lower than they would have been without our solar GPV system." Seventy-five percent of the GPV owners agree or strongly agree that their electricity bills are lower than they would have been without their GPV systems; 15% were unsure; and 10% disagree.

Almost all SheaHomes respondents have homes having solar water heating systems (all but the first 13 homes, as previously noted). Because GPV owners are billed separately for electricity and natural gas, they were asked the extent to which they agreed or disagreed with the

[4] This question was not asked of the comparison sample because their homes were not sold as energy efficient and did not contain solar features.

statement: "Our natural gas bills are lower than they would have been without our solar water heating system." SheaHomes respondents who are non-GPV owners were asked about the extent to which they agree or disagree with the following statement: "Our utility bills are lower than they would have been without our solar water heating system."

Table 7. Percentage Comparison of Responses from Homeowners in the SheaHomes Communities Regarding Their Perception of the Impact of Solar Water Heating Systems on Utility Bills

Item	SheaHome Owners with GPV (n=39)	SheaHome Owners without GPV (n=65)
Our natural gas bills are lower than they would have been without our solar water heating system	64%: Agree/strongly agree 21%: Unsure 15%: Disagree/strongly disagree	N/A
Our utility bills are lower than they would have been without our solar water heating system	N/A	54%: Agree/strongly agree 29%: Unsure 17%: Disagree/strongly disagree

Of the GPV owners, 64% indicate that they "agree" or "strongly agree" that their natural gas bills are lower than they would have been without the solar water heating systems, whereas 15% indicate they "disagree" or "strongly disagree," and 21% say they are unsure. Of the respondents who do not have GPV installations on their homes, 54% say they "agree" or "strongly agree" that their utility bills are lower than they would have been without the solar water heating systems. About 17% say they "disagree" or "strongly disagree," whereas 29% are unsure. These results suggest that most homeowners in the SheaHomes communities that have solar water heating systems, especially GPV owners, believe those systems contribute to lower energy costs, though a somewhat higher percentage of homeowners without GPV systems are unsure.

Homebuyer Satisfaction with Home

There is every reason to believe that, because of cognitive dissonance,[5] homebuyers would be inclined to say they are satisfied with their new home purchases. Studies of buyer satisfaction are known to be fraught with difficulties in measurement and interpretation. In this instance, homebuyers have lived in their homes for at least 6 months, so the "honeymoon" is assumed to have worn off. The measures of satisfaction are straightforward—the homeowners were asked to what extent they agreed with the following statement: "We would buy our same house again if we had it to do over." The intent of this question is to distill the essence of all the pluses and minuses of home ownership. Table 8 summarizes the responses.

Although a high percentage of both groups indicate they would buy their homes again (77% of SheaHomes respondents; 72% of respondents from the comparison community), there is significantly more disagreement among the respondents from the comparison community (Chi-square = 6.087; df = 2, $p \leq .048$). One in five of the respondents from the comparison community disagree that they would buy their homes again, compared with 6% of SheaHomes respondents.

[5] The basic principle of cognitive dissonance is that buyers are psychologically inclined to remain favorable to their purchase decisions once they are made to reduce the emotional discomfort resulting from the thought of having made the wrong decision. However, this concept fails to account for the phenomenon of regret.

Table 8. Percentage Comparison for the Two Respondent Groups with Regard to Repeat Home Purchase

Response	Respondents from SheaHomes Communities (n=109)	Respondents from Comparison Community (n=36)	Total (n=145)
Agree or strongly agree	77%	72%	76%
Unsure	17%	8%	14%
Disagree or strongly disagree	6%	20%	10%

In addition, respondents were asked to rate the overall comfort of their homes on a 1 to 10 scale (1 = "not at all comfortable" and 10 = "very comfortable"). Most indicate that their homes are comfortable, with no significant difference between SheaHomes respondents and respondents from the comparison community. The mean score regarding home comfort for SheaHomes respondents is 8.31, and for the respondents from the comparison community it was 8.49.

Respondents were also asked to rate the overall energy efficiency of their new home on a 1 to 10 scale (1 = "not at all energy efficient" and 10 = "very energy efficient").[6] The mean score for SheaHomes respondents is 7.25 on the 10-point scale, and the mean score for the comparison respondents is 6.29. This result is statistically significant ($t = 2.964$; $df = 61$; $p \leq .004$).

Behavioral Intention

One way of gauging acceptance of energy efficiency and solar features is to ask respondents whether their next home would have these features. Each of the questionnaires asked respondents to indicate agreement or disagreement with the following statements:

- "If we buy another new home it will be a very energy-efficient home."
- "If we buy another new home, it will have solar water heating."
- "If we buy another new home, it will have solar PV to produce electricity."

Differences are found between the two groups of respondents. Table 9 summarizes the differences in response to these items by SheaHomes buyers and the comparison homebuyers. Most of the SheaHomes buyers (89%) agree or strongly agree that if they buy a new home, it will be very energy efficient, compared with 58% of the comparison buyers, a difference that is statistically significant. A significant difference also exists between the SheaHomes and the comparison buyers on whether a new home they might buy would have solar water heating: two-thirds of the SheaHomes compared with just over one-fifth of the comparison buyers agree. Finally, the two samples differ significantly on whether any new home they might purchase would have a GPV system. More than half (55%) of the SheaHomes buyers say it would, whereas 22% of the comparison sample say they would choose a new home with a GPV system.

[6] The item was: "Overall, how energy efficient do you believe your home to be?"

Table 9. Differences in Response to Behavioral Intention Regarding Energy Features

Energy Feature	SheaHomes Buyers % Strongly Agree	Comparison Homebuyers % Strongly Agree	Significance
Very energy-efficient home	43	22	Chi-square = 17.295; df = 3; $p \leq .001$
Solar water heating system	32	11	Chi-square = 24.293; df = 4; $p \leq .000$
GPV system	30	7	Chi-square = 15.083; df = 4; $p \leq .005$

These findings suggest that the experience of living in a very energy-efficient home with solar water heating, and, in many cases, GPV, has proven positive enough for SheaHomes residents to want to include these energy features in any new housing they might purchase. These results represent a significant positive endorsement for the energy features on the part of SheaHomes buyers.

Conclusions

Many similarities exist between the SheaHomes and comparison homeowners in demographics, reasons for purchase, and preferred home features. There is no difference between the samples in the perceived comfort of the home.

Nevertheless, certain key differences have emerged from the preliminary partial analysis of selected variables. One of these is the much higher gain in the resale value of SheaHomes compared with the conventional comparison homes, despite the similarities between the two groups of homes in location, original sales price, and square footage. It seems reasonable to attribute this difference in resale value at least partially to the energy features of the SheaHomes.

Both groups of homeowners are quite satisfied with their new homes in general, as would be expected. The evidence suggests that SheaHome owners seem to be somewhat more satisfied with their homes than the comparison sample is with theirs. The comparison home owners report significantly higher average monthly utility bills than do the SheaHome owners, although these results need further verification through analysis of actual utility bill data. GPV owners are significantly more likely to report lower utility bills than other SheaHome owners.

A higher percentage of GPV owners than non-GPV owners agree that the savings on their utility bills have met or exceeded their expectations. They might perceive this because they actually have lower utility bills, which remains to be determined by future analysis of utility bill data. A higher percentage of GPV owners than non-GPV owners also perceive a positive impact of solar water heating on their utility bills. To speculate, they might be paying more attention to their utility bills than other new homeowners. It may be the case that the more energy technology these homeowners are exposed to, the more they perceive benefits in reduced energy costs. It is consistent with this conclusion that SheaHome owners also are significantly more likely than the comparison sample to perceive their homes as energy efficient.

References

Farhar, Barbara C., Timothy C. Coburn, and Nancy Collins. 2002. "Market Response to New Zero Energy Homes in San Diego, California." In *Proceedings of the 2002 ACEEE Summer Study on Energy Efficiency in Buildings*. Washington, D.C.: American Council for an Energy-Efficiency Economy, pp. 8.41-8.54.