Market Response to New Zero Energy Homes in San Diego, California

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ABSTRACT

A new development by SheaHomes at Scripps Highlands in San Diego, California, offers "high performance" homes. These homes, sometimes called "zero energy homes" (ZEHs), can produce as much energy as they consume, resulting in a net zero energy consumption. They feature efficiency, solar water heating and solar electricity. Although the Scripps Highland homes are not truly ZEHs, they are the closest examples of near-ZEHs being built by a large production builder. These homes enable homeowners to reduce utility bills by at least 30% to 50% over a conventionally built home. Thus, the Scripps Highlands development is an excellent research case.

Of the 306 homes being offered at Scripps Highlands, 293 will have solar water heating and 88 will have a 1.2-kW solar electric system with net metering as standard features. Buyers of another 185 homes can opt for 1.2-kW systems. Most of the buyers have the option to upgrade to 2.4 kW.

The National Renewable Energy Laboratory (NREL) is also conducting a study of consumer response to these homes. The first phase involves a qualitative investigation of the factors affecting the purchase decisions of ZEH homebuyers. This paper covers this qualitative phase, reporting results of open-ended personal interviews with a purposive sample of homeowners on their reasons for purchasing ZEHs; their preferences for standard and optional systems; perceptions of the ZEH energy features; changes in energy knowledge, attitudes, and behavior as a result of moving in; ZEH impacts on homeowner utility bills; and perceived problems, aesthetics, and homebuyer satisfaction and the reasons for it.

Introduction

SheaHomes in San Diego is building solar-powered homes in its Scripps Highlands community, located in the Scripps Ranch area of San Diego. Announced January 23, 2001, this new development offers highly energy-efficient homes with solar water heating as a standard feature. One-third of the homes also provide a portion of their own electricity through the use of solar electric (photovoltaic) panels tied to the utility grid. The Scripps Highlands development is the first offering of its kind in the United States. The homes are thought to enable homeowners to reduce their utility bills by 30% to 50% compared to a conventionally built home. The new 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 homes are priced in the $450,000 to $650,000 range. Of the 306 homes SheaHomes is offering at Scripps Highlands, 88 will have 1.2 kW (12-panel array) grid-tied solar electric (grid-tied photovoltaic, or GPV) systems with net metering installed as a

standard feature. Buyers of another 185 homes can opt for GPV. Purchasers of homes with GPV as a standard feature can also opt to upgrade their GPV systems to 2.4 kW systems (a 24-panel array). The GPV installations are rooftop systems. Thirty-three of the 306 homes are not suitable for GPV systems because of limited roof space or because of the orientation of the homes on their lots. Batteries were not offered because the space available for them in front of garages was insufficient to meet code.

The offering of this type of new home in the San Diego market, which, as fate would have it, was initiated during the recent California energy crisis, constitutes a unique opportunity to study homebuyer response to innovative zero energy homes ZEHs. ZEHs optimally combine energy efficiency and renewable-energy systems and can result in zero-net energy consumption from nonrenewable sources. Because ZEHs meet a portion of the homeowner's energy needs, they could help protect homeowners from energy price volatility. If the home has net metering, its electric meter runs backward when the home is producing more power than it uses. Electricity is, in effect, purchased by the utility from the homeowner at retail rate. Although the utility will credit homeowners for some of the electricity they produce (the meter runs backwards), it will not reimburse homeowners for the electricity they produce that exceeds their total consumption. ZEHs have an additional feature that may be attractive to utilities; during hours of peak demand, a ZEH may generate more power than it uses, thus reducing the power demand on the grid and providing more power to the grid when it is needed the most.

Prior Research

Studies have been conducted about the market for residential GPV systems among Colorado homeowners (Farhar and Coburn 2000a; Farhar and Coburn, 2000b; Farhar and Coburn 1999; Farhar 1998) and about market response to solar water heating (Angus Reid Group 1994; Hewett, n.d.; Lofland 1998a; Lofland 1998b; NAHB Research Center 1998; and Rauluk 2001). Studies on the effects of feedback on energy consumption are also (germane such as Kempton and Layne 1998 and Farhar and Fitzpatrick 1989). The reports for some of these studies can be viewed in their entirety at http://www.eren.doe.gov/solarbuildings/market.html. Although proprietary studies of homebuyers are relatively widespread in the buildings industry, no studies currently exist on customer response to ZEHs, particularly in an environment such as San Diego, California, in which volatile energy costs have been a political concern.

Objectives of the Study

In our experience, builders nationwide frequently claim that homebuyers do not seem to care about energy efficiency or solar features. A truism builders have often expressed is, "If homebuyers demanded it, we would build it." The ZEH experience in San Diego provides a rare opportunity to observe firsthand what happens when these features are routinely offered in a large development. Builders expressing concerns about whether they would be seen as too innovative in offering ZEH homes can gain empirical information from this study about how actual homebuyers respond to the ZEH concept when given the option.

This paper reports on the first, qualitative phase of a two-phase study. The qualitative phase focused on customers' responses to the SheaHomes ZEHs. The second, quantitative

phase will include systematic data collection from both SheaHomes customers and customers in a comparable development without the energy features. Results from the qualitative phase will be used to guide development of research instruments for the quantitative phase. The overall study objective is to increase understanding of the customer response to ZEHs as compared with conventional housing. The variables included in the study are:

- Why buyers selected the home
- What they most like about the home
- What they least like about the home
- Satisfaction with the sales program experience
- Attitudes toward energy efficiency
- Attitudes toward solar water heating
- Attitudes toward GPV systems
- Satisfaction with utility bills
- Prior energy-related purchases (e.g., appliances, retrofits)
- Respondent characteristics (demographics, lifestyle and values, stage in family life cycle, household structure, interests, and attitudes).

When both phases of the study are complete, a research protocol is planned that can be adapted and applied by building and energy partnerships in other locales to assess local-area markets for ZEHs.

Background Information

The two communities at Scripps Highlands—San Angelo and Tiempo—are geographically linked. The homes range in size from approximately 2,200 sq. ft. to approximately 4,000 sq. ft. in a location considered highly desirable. All homes have gas stoves, dryers, furnaces, and water heaters. The San Angelo community has larger lots and different floor plans than Tiempo, but the two communities are similar and blend together visually.

When SheaHomes was readying its development in early 2000, it put up a trailer near the construction site. There were no model homes nor homes under construction, and there was little advertising. Potential buyers noticed the trailer and began to contact SheaHomes. Such was the demand for the location that the builder put buyers on a list, based on the time their mortgage application was received by Shea Mortgage Company. Buyers in the first phases were called to a meeting and assigned a number; buyers were called forward in numerical order to indicate their preference for a house and lot. Most of the buyers had driven the area, knew which locations they preferred, and had selected floor plans.

Scripps Highlands developed in phases, beginning with the San Angelo houses, where the first 13 homes were constructed with ConSol's ComfortWise energy efficiency package, but had no solar hot water or GPV. Solar hot water became standard with Phase Two of the seven phases for the San Angelo houses. This paper includes information on the first four phases of both San Angelo and Tiempo (12 phases), with 127 homes sold through the first year of the project to January 31, 2002 (60 San Angelo and 67 Tiempo). The project could reach build-out in the early spring of 2003, depending on the pace of sales. Sales in March 2002 were brisk. All the Tiempo houses feature solar hot water as standard

equipment. These systems are passive-solar, pre-heating systems in which the solar-heated water feeds a fairly standard energy-efficient, gas-heated, water tank. The only non-standard feature is a highly visible thermometer that displays the temperature of the water arriving from the solar panel.

Beginning with Phase Two of San Angelo, and in all phases of Tiempo, all lots were evaluated to determine if the orientation was appropriate for GPV and, if so, the number of panels that could be placed on the roof—either 12 or 24 panels. Approximately 28% of the homes (34 San Angelo and 54 Tiempo for a total of 88 homes) were "pre-plotted" for GPV; that is, 1.2 kW GPV systems would be installed on these homes as standard equipment. Buyers of homes with pre-plotted systems can opt to upgrade to a 2.4 kW system (a 24-panel array) at a cost of $4,000. For other homes that were suitable and not pre-plotted, SheaHomes made GPV systems available at the homebuyer's option, at a cost of $6,000 for a 1.2 kW system and $10,000 for a 2.4 kW system.

The California Energy Commission (CEC) provides a 50% rebate for installation of residential distributed energy systems. This rebate will be collected by SheaHomes for the solar electric systems.

Methodology

Market and consumer information was obtained during two site visits to the SheaHomes Scripps Highlands communities. The first site visit was conducted in October 2001, and the second in February 2002. During the first visit, extensive interviews were conducted with SheaHomes staff to collect background data and information, including qualitative observations about sales messages and marketing methods. In addition, open-ended, focused interviews lasting approximately one hour were conducted with a purposive sample of 17 homeowners representing 11 households who had closed on their homes before October 1, 2001. These homeowners had been in their homes for approximately 3 months. While most of the homes represented in this sample had solar water heating as a standard feature, some did not, and only two were equipped with GPV systems.

The second site visit was focused almost entirely on interviews with homeowners owning GPV systems in addition to the standard energy efficiency and solar water heating features. These were the homes in the Scripps Highlands communities that most closely resembled ZEHs. The second visit was done because there were relatively few GPV owners interviewed during the first site visit. During the second site visit, 24 homeowners were interviewed representing 14 households. These homeowners had been in their homes from 1.5 to 4 months. The total size of the purposive sample from both site visits is 41 homeowners in 25 households; 16 of these households (64%) were equipped with GPV systems.

Most of the homeowners in the sample are professionals and business people. Many are younger couples (in their late 20s or early 30s) with preschool-age children. A few are older couples still working or with one or both people retired. A few are single people living in one- or two-person households (generally, two adults sharing a home). The purposive sample exhibited a high degree of racial and ethnic diversity. Moreover, at least three of the buyers of GPV homes in the purposive sample are SheaHomes' employees, who receive a discount on their home purchase and have higher levels of awareness and knowledge about the GPV systems than most buyers.

Findings from these interviews cannot be generalized to the larger population of Scripps Highlands homeowners (or to any population of homeowners) because of the purposive nature of the sample. Table 1 summarizes the kinds of homes represented in the purposive sample.

Table 1. Composition of Purposive Sample (Numbers of Respondents)

Home Type *(All homes highly energy-efficient)*	**Site Visit 1** San Angelo	**Site Visit 1** Tiempo	**Site Visit 2** San Angelo	**Site Visit 2** Tiempo	**Total N**
No solar water heating (SHW), No GPV	2	N/A	N/A	N/A	2
SHW, no GPV	3	4	N/A	N/A	7
SHW, 1.2 kW pre-plot GPV	–	1	3	3	7
SHW, 1.2 kW optional GPV	–	–	3	2	5
SHW, 2.4 kW optional GPV	–	1	–	2	3
SHW, 2.4 kW GPV (1.2 kW pre-plot plus 1.2 kW optional)	–	–	–	1	1
Total N	5	6	6	8	25

Actual Sales of SheaHomes' High Performance Homes

Included in this paper is an analysis of the 127 homes sold in the first four phases of San Angelo and the first four phases of Tiempo. The average price of homes in San Angelo was approximately $580,000, and in Tiempo $530,000. Of the 127 homes sold in the first four phases, the first 13 homes offered in San Angelo were highly energy-efficient (equivalent to 5-star Energy Star homes) but had neither solar hot water nor solar electric systems because these features were not yet scheduled into the construction process. Another 13 homes—all located in Tiempo—were not suitable for solar electric systems—a fact the respondents said the sales staff told them. Thus, of the 127 homes initially offered, a total of 101 were highly energy-efficient, had solar water heating as a standard feature and were suitable for GPV systems.

The percentage of these 101 homes suitable for GPV that actually have GPV is an important descriptive element to this project. Table 2 shows that 45% of the 101 homes sold that could have had GPV systems actually have them; 55% do not. More of the homes sold to date involve pre-plotted than optional GPV systems—28% of the homes have pre-plotted GPV systems and 16% of the homes involve an optional system purchase or upgrade. Most of the GPV systems are the smaller 1.2 kW systems.

The percentage of GPV systems sold to homeowners in the San Angelo development differs from the GPV percentage sold in the Tiempo development. Of the 60 homes sold in San Angelo, GPV systems were available (either as pre-plots or as options) on 47 (78%) of

them; 18 (38%) of these homes were actually sold with GPV systems. Of the 67 Tiempo homes sold, GPV was available on 54 (80%) of the homes; 27 (50%) of these homes actually sold with GPV systems. A few more systems were pre-plotted in Tiempo (32%) than in San Angelo (30%) but not enough to account for the 12% difference in the rate of GPV sales in Tiempo over San Angelo. This is especially interesting because homes in the San Angelo development are somewhat more expensive than in the Tiempo development.

Table 2. Number and Percentages of Homes with GPV Systems

Types of GPV Systems on Homes	**San Angelo N**	**Tiempo N**	**Total N**	**% (based on 101**
1. Pre-plotted 1.2 kW GPV systems	13	16	29	29%
2. Optional 1.2 kW GPV systems	4	7	11	12%
3. Optional 2.4 kW GPV systems	0	3	3	3%
4. Pre-plotted 1.2 kW and optional 1.2 kW systems (2.4 kW total)	1	1	2	2%
Homes with optional systems only (Categories 2 and 3)	4	10	14	14%
Homes involving optional systems (Categories 2, 3, and 4)	5	11	16	16%
Homes involving pre-plotted systems (Categories 1 and 4)	14	17	31	31%
Total homes with GPV systems	18	27	45	45%

A key question is whether more GPV systems will be installed in a development if they are pre-plotted or only offered as an option. Table 3 shows that 67% of the GPV systems sold were pre-plotted and another 5% were pre-plotted systems that included upgrades. A few more than one-third were optional or upgraded systems.

Table 3. Percentage of Pre-Plotted and Optional GPV Systems

Types of GPV Systems*	Percentage (%) (based on a total of 45 GPV systems)
GPV systems that were pre-plotted (N=31)	69%
GPV systems that included options (N=16)	36%
GPV systems that were both pre-plotted and upgraded (N=2)	4%
GPV systems that were 1.2 kW systems (N=40)	89%
GPV systems that were 2.4 kW systems (N=5)	11%

A few of the homebuyers of the first 13 homes in San Angelo would have liked to purchase GPV systems but were unable to do so either because the system was not offered, or because the construction schedule cut-off date for GPV had passed before the buyers had the opportunity to opt for it. This occurred when a house fell out of escrow and another buyer purchased it after its construction had already been started and its options selected. Also, a few other buyers who purchased a home that already had GPV under these same circumstances acquired a system that someone else had opted for but whose home had fallen out of escrow. One GPV owner said he would have upgraded his 1.2 kW pre-plotted system to a 2.4 kW system had the SheaHomes design center staff person known where on the roof the additional panels would be located; he had only a short time to make the decision. These buyers were disappointed that they couldn't get the solar electric systems or the additional options. Several buyers volunteered that a $10,000 increment in cost is not that important when one is paying $645,000 for a house.

Two of the homeowners in the sample turned down the option to purchase a solar electric system, not wanting to pay the added cost. They did not believe there would be sufficient payback over time. Conversely, many of the GPV buyers either believe there will be sufficient payback, or they do not think that payback is that important. These data strongly suggest that more ZEHs would have been sold than were actually sold had they been available from the outset.

Qualitative Findings

This summary is based on the combined results of the open-ended focused interviews of homeowners conducted during the October 2001 and February 2002 site visits. Because interviews were open-ended, responses were brought up by respondents. This discussion is organized around the types of responses the homebuyers volunteered. These are reasons for purchase, preferences for pre-plotted or optional systems, views on energy efficiency and solar energy features, satisfaction with utility bills, aesthetics, problem areas, impacts on energy-related behavior, homeowner knowledge, and overall homebuyer satisfaction.

Reasons for Purchase

ZEH features played a key role in some purchase decisions although the most commonly mentioned reason for purchase was the Scripps Highlands' location. For many of the buyers, a short commute to work was a factor. SheaHomes' reputation as a quality builder was frequently mentioned. One buyer said: "We liked all the extras that Shea provided. Many things are standard in SheaHomes that are options elsewhere. We would definitely go with Shea again." Another buyer said: "We got more for our money in comparison to buying any other new house or a used home." In part, this perception of Shea offering more features than the buyers might find elsewhere hinged on the availability of ZEH features.

Several homebuyers considered their purchases to be investment opportunities with good appreciation and resale value. Others reasons for purchase include the homes' spaciousness, the need for a larger home for a growing family or other family needs, room options (such as main-floor bedroom suites and bonus rooms), and the availability of one-story homes (appreciated both by the owners who preferred them and by the neighbors who

like the visual relief of varied rooflines). "No Mello Roos"[1] was an important factor in some decisions.

Among GPV buyers, the availability of solar features is frequently mentioned as one of the top three reasons for purchase. In fact, several homeowners mentioned that they had shopped for homes in a nearby community in the Scripps Highlands area built by another builder. Some of these buyers purchased homes in this SheaHomes community because of the GPV features. For these buyers, GPV was one of the top 3 reasons for purchase. Some of the GPV buyers say they were looking for a hedge against rising energy costs. GPV buyers, as might be expected, believe that the prices for optional GPV systems were reasonable.

Environmental values played a part in the decisions made by some buyers. One said: "Renewable energy is the greatest way to go because there's only so much fossil around. There is so much sunshine here—it's a shame not to use it. It doesn't require a polluting type of facility."

Pre-Plotted and Optional Systems

One study question concerned whether homebuyers would prefer pre-plotted or optional GPV systems. Homeowners clearly prefer pre-plotted systems. One homeowner said: "It's best to integrate the solar electric system into the entire home purchase rather than having it offered as an option in a piecemeal way. It should all be rolled into the overall price." Another homeowner with a 2.4 kW system purchased after the initial buyer who opted for the system did not close escrow said: "We're not sure we could have afforded to add the system on. We wanted to get the house because the system was already there. We didn't have to decide about it. We're glad it's here. We're lucky to have the PV."

The preference for many was that solar water heating and solar electric be offered as standard equipment rather than as options. One buyer said: "We feel the builders know what they are doing, so if they offer the solar as part of the package, there must be a reason." Some homeowners mentioned that SheaHomes is getting the rebate for solar from the CEC, and they didn't think SheaHomes was passing the rebate on to the customers; but others said they thought the energy features were "a wash" for the builder—that the builder was neither making nor losing money on the features.

Energy Efficiency and Solar Energy Features

Homeowners referred to their energy efficiency as a "bonus." In the first San Angelo phase, there was so much pent-up demand that most of the homebuyers did not know about the energy efficiency and solar energy features before they decided to purchase the homes. But beginning with Phase Two of San Angelo and Phase One of Tiempo, most buyers were aware of the homes' energy features before they made the purchase. Sales staff report that people are quite interested. Buyers are told about energy efficiency features, the standard solar water heating systems, and the standard or optional solar electric options (if any).

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[1] Mello Roos is a property tax applied to new housing to pay for infrastructure development such as roads and schools. It is named after the sponsoring legislators. The tax payment is a percentage of house price and can run as high as $500 a month in addition to property taxes. Homebuyers obtaining homes built on certain properties acquired for development before passage of the Mello Roos legislation are exempt from payment.

Virtually every homeowner interviewed approved of the energy efficiency package and the standard solar water heating system. Several said they would have been willing to pay up to an additional $1,800 for the solar water heating, although the cost was included in the price of the home.

Homeowners were even more enthusiastic about their GPV systems. One said: "PV is more of an incentive to us to buy here, especially if it's standard equipment." Another said: "We like the idea of using solar energy for our needs, and the more that comes in, it goes back to the grid. It seems like a unique thing, and we feel good about it because we're helping to conserve energy, particularly because of the crisis. It's good for society. . . . This is something our household can do to help."

Several homeowners mentioned that they see the solar features of their homes as "cool." They show their guests the PV system right away. One said: "When people come to visit, the first thing we do is show them the solar equipment." A fair amount of bragging about the energy-efficient windows also occurs. (Window sills remain cool, even in bright sunlight.)

Utility Bills

The possibility of low utility bills represents an important factor in satisfaction with the new homes. Homeowners not only paid attention to their utility bills but were pleasantly surprised by them. One homeowner charts energy usage using *Excel*. Those with solar electric systems, which are net-metered, usually receive separate gas and electricity bills. Utility bills ranged from $6 per month (the monthly electric bill for a home with a 1.2 kW system—with a total combined gas and electric monthly cost of only $17) to $130 per month (for a ComfortWise home with no solar features).

Some homeowners compared their current utility bills to those they were paying before they moved to Scripps Highlands. For example, one household paid up to $200 per month in a 1,200 sq. ft. condo and is now paying $80 per month for gas and electricity in an approximately 4,000 sq. ft. house with solar water heating but without solar electric. Others told similar utility bill stories. However, October respondents noted that it had been an unusually cool summer. Although the outside temperatures were in the 80-degree-F range during both the October and February interviews, interior thermostats read 72 degrees F without air conditioning. October respondents wondered how their comfort and utility bills would do in the coming winter, and February respondents wondered about their bills during the coming summer. Relative to energy features, homeowners said: "They are finally listening to what consumers want." "All the builders should be doing it." "It's good for society."

Several GPV owners report that SheaHomes staff told them to expect a 35% reduction in utility-provided electricity use with a 1.2 kW system; 2.4-kW system owners are extrapolating that to an expected 70% savings. Because most had not received utility bills at the time of the interview, it remains to be seen whether their expectations will be met. Among the few who had received utility bills, GPV owners reported (and showed us) electricity bills of, for example, $6, $12, and $19 a month.

By curtailing their electricity consumption to achieve a lower utility bill, some GPV owners have an ultimate goal of zero net electricity use or even to generate more electricity

than they use. They are engaging in conservation behavior and retrofits to accomplish this, and this seems spurred on by ownership of a GPV system.

Aesthetics

Although builders seem concerned that the aesthetics of solar panels are an issue, none of the homeowners raised the issue of aesthetics in response to an open-ended query about any problems or any experience they liked least. Most homeowners have no problem with the look of the solar features. In particular, the solar water heating systems look like skylights. When we finally asked respondents point blank about how the solar energy systems looked, many seemed puzzled, as if to say, "Why are you bringing this up?" One commented: "Satellite dishes are more offensive." People believe that the solar features fit in and that they become familiar quickly. Residents have already become accustomed to them.

Problem Areas

Homeowners have only a few complaints about the functional or operational aspects of their homes or about their relationship with the builder. Some mentioned that repricing to reflect higher home prices in the San Diego market added significantly to the cost of the house during the purchase process.

Interestingly, some of the more frequently mentioned complaints have to do with comfort, and are thus energy-related. A few homeowners have comfort problems with heat in the upper levels of their homes. These homeowners own one of two floor plans constructed with single-zone heating and air-conditioning systems. A few homeowners are retrofitting their homes (at a cost of $1200) with dual-zone thermostat and damper systems to recirculate heated or cooled air within the house.

Energy Behavior

Owning a ZEH definitely affects many homeowners' energy behavior. Many of the homeowners upgraded their appliances and received rebates from San Diego Gas and Electric for new highly energy-efficient appliances, some of which are high-tech in appearance. Some did it for aesthetics and some for increased energy efficiency. One homeowner said: "If the government rates these Maytag Neptunes so high, they must be worthwhile." Homeowners seem to be especially proud of their energy-efficient appliances.

The Scripps Highlands area is still under construction, and there is a lot of dust. Homeowners report they have seen neighbors rinsing the dust off their solar collectors to optimize their water temperature and electricity production.

Because the houses are so large, it takes several minutes for hot water to reach bathrooms located far away from the water heater. A few of the homeowners blame their problems with getting hot water in their bathrooms on their solar water heating system. Experts say this is not the case, however. A few homeowners have installed circulating pump systems, which are upgrades, to keep hot water available on demand throughout the house. The circulating pump increases electricity usage. One or two others installed timers on their water heaters to avoid circulating hot water through the house during the night.

Homeowners try various behavioral changes and then watch the results on their energy gauges and meters. All the GPV homeowners go outside and watch their electric meters run backwards. The solar electric systems come with a digital display panel often installed near the door between the house and the garage. Two digital readouts show in Watts the amount of electricity the house is currently using and the amount of electricity the solar electric system is currently producing. It can also be set to show cumulative production and consumption. In a home with a solar electric system, a homeowner can turn off the lights and watch their digital displays show the results. One homeowner said: "We isolate things to see what the electricity hogs are. We're already more energy conscious because of the feedback device." A few mention switching their laundry to different times to maximize their solar energy gain and minimize their utility-supplied energy use.

Homeowner Knowledge

Although a few homeowners are sophisticated about energy features and energy consumption, the general homeowner's understanding of these energy features is not high, but appears to be growing. For example, homeowners most often did not look at or understand the EnergyGuide labels on their appliances, water heaters, and air conditioners. Also, they were not sure what to expect from their high performance homes by way of utility bill savings, although, as noted above, they explain that SheaHomes staff provided them with a possible range.

Homebuyer Satisfaction

In general, the buyers of the SheaHomes high performance homes at Scripps Highlands say they are satisfied and they would make the purchase again. But indicators of satisfaction can be misleading because of the newness of the situation. These homebuyers are essentially early adopters who can be expected to be highly positive and proactive about their purchases. Nonetheless, their feedback provides important keys to their likely responses in more formal research settings. A more formal assessment of satisfaction will be undertaken in the quantitative phase of the study after some period of time has elapsed.

In response to open-ended questioning, the features homeowners said they appreciate most include location, low utility bills, quiet, customer service, and high number of features. The owners of GPV systems are satisfied with their systems, although many of them are awaiting more experience with their utility bills. Some of the GPV homeowners, having lived in their homes less than 4 months, are already talking about retrofitting their homes with additional panels to increase the size of their GPV systems.

Conclusions and Next Steps

A number of important preliminary conclusions can be drawn from the findings of this qualitative research. These findings and conclusions will guide the development and implementation of additional research activities, and they will hopefully spur additional interest in ZEHs within the building industry.

Conclusions

Most new homebuyers are probably happy with their new home choice, so the ZEH homebuyers are not unique in this respect. This fact that they *are not* unique among new homebuyers—their response is normal and to be expected—is significant. New homebuyers do not appear to know enough about energy efficiency and solar features to "demand" them, yet the Scripps Highlands experience shows that once homebuyers have moved into their new homes, they accept, tolerate, and even enjoy those features. Customers cannot demand what they do not understand and do not have time to learn. Some of the buyers selected the ZEH homes over similar up-scale homes nearby because they had these features. The study's findings suggest that ZEHs designed as desirable, up-scale homes will be accepted—or even pursued—by homeowners in today's market, and will not be treated as weird aberrations from normal housing patterns. There is strong evidence that pre-plotting GPV systems rather than simply offering them as an option results in far more use of GPV as well as higher homeowner satisfaction with homes and the builder. The qualitative evidence shows that most people like their GPV systems, and, at a minimum, they initially tolerate them and learn to appreciate the systems more as they live with them.

Homeowners are also appreciative of their solar water heating systems and note the positive impact on the gas bills. They are pleased with the energy efficiency aspects of their homes, as well.

Understanding of energy features is limited among many of the homeowners; a few knew more. Most had no understanding of the EnergyGuide labels on their appliances, but a few did and raised questions in the interviews about the energy efficiency ratings of their appliances, water heaters, furnaces, and air conditioners. Interest in electricity usage varied, but among those who have digital displays showing their real-time electricity consumption and production patterns, interest is increasing. Behavior to reduce electricity consumption is increasing among those with GPV systems and digital displays, which provide immediate feedback. This finding provides further empirical support to the hypothesis that feedback can effectively reduce electricity consumption.

It will be at least a year before homebuyers will know how satisfied they are with the energy features of their new homes. This is because they are learning how their energy systems work and how to interact with them, and they need to experience their homes in all seasons of the year. They need a year's experience with utility bills, as well, before they will understand the performance of their homes and the impacts of their lifestyle changes on that performance.

Because the San Angelo and Tiempo developments are so innovative, SheaHomes has received unusual benefits, such as broadcast and print media coverage worth approximately $1 million of paid advertising. At the same time, embarking on a non-routine venture has involved costs for the builders in areas such as staff training in energy efficiency and solar features, maintaining solar industry partnerships, providing staff time for applying for CEC rebates, and dealing with reporters and researchers. It remains to be seen whether SheaHomes will realize its investment in the ZEH learning curve in its future developments.

The conclusions of this qualitative study based on a purposive sample cannot be generalized to all homebuyers in the United States, California, San Diego or even Scripps Highlands. This study is intended to provide the basis for creative thinking about potential market response to ZEHs, to provide evidence that offering the solar portion of ZEHs as an

option rather than as a standard feature makes it more difficult for homebuyers to adopt it, and to provide an empirical basis for quantitative analysis that will follow.

Next Steps

The next step is to develop a research design for the more formal, quantitative phase of the research. The research design will be greatly influenced by findings from the two site visits of the qualitative phase reported here. A survey instrument—probably a mail questionnaire—will be prepared and an optimum time for collecting data will be determined. Timing is a critical issue to data collection because of the staged manner in which homes are being sold and occupied. Data will be obtained from a comparison community as well to obtain systematic measures of homeowner motivation, experience, and satisfaction against which to judge the responses of Scripps Highlands homeowners. In addition, plans are being made to conduct qualitative interviews with individuals who declined to pursue and/or purchase homes at Scripps Highlands after their initial contacts and expressions of interest. These additional qualitative interviews are intended to provide additional information about the receptivity of prospective homebuyers to energy efficiency features.

A Final Word

One homeowner expressed it this way: "Solar electricity should be available and affordable on all housing." Regarding builders and policy makers, he said, "If they had a heart to save energy and the environment, they would find a way to make it happen."

Bibliography

Angus Reid Group. 1994. "National Survey on Energy Efficiency-Related Attitudes and Opinions of Recent and Prospective Homebuyers." Ottawa, Ontario, Canada: CABA. April 66 pp.

Farhar, Barbara C. and Timothy C. Coburn. 2000a. *A Market Assessment of Homeowner Response to Residential Grid-Tied PV Systems in Colorado*. NREL/TP-550-25383, Golden, Colo.: National Renewable Energy Laboratory. September. 209 pp.

Farhar, Barbara C. and Timothy C. Coburn. 2000b. "Some Recent Research on the Markets for Residential Renewable Energy." in *Proceedings of the 2000 ACEEE, Efficiency and Sustainability, Summer Study on Energy Efficiency in Buildings*. Washington, D.C.: American Council for an Energy-Efficient Economy, pp. 8.93-8.108.

Farhar, Barbara C. and Timothy C. Coburn. 1999. *Colorado Homeowners Preferences on Energy and Environmental Policy.* NREL/TP-550-25285. June. 37 pp.

Farhar, Barbara C. 1998. *Willingness to Pay for Renewable Electricity: A Review of Utility Market Research.* NREL/TP-555-25765, Topical Issue Brief, Golden, Colo.: National Renewable Energy Laboratory, 22 pp.

Farhar, B.C. and C. Fitzpatrick. 1989. *Effects of Feedback on Residential Electricity Consumption: A Literature Review.* SERI/TR-254-3386. January. Golden, Colo: National Renewable Energy Laboratory. 21 pp.

Kempton, W. and L.L. Layne. 1988. "The Consumer's Energy Information Environment." *Behavior and Lifestyle*, In Proceedings of the 1988 Summer Study on Energy Efficiency in Buildings II: 11.51-11.66.

Hewett, Russell, n.d. "Solar Water Heating Marketing Research Studies Conducted in FY 1998 by the DOE/NREL Solar Heat and Buildings Technologies Program." Golden, Colo: National Renewable Energy Laboratory. (See also (http://www.eren.doe.gov/solarbuildings/market.html).

Lofland, Laurie. 1998a. "National Renewable Energy Laboratory Solar Water Heating Systems for the New Home Market, Draft Final Report for Documenting Results from Analysis of Task 1 Qualitative Research, Findings, Conclusions and Recommendations to NREL and the Solar Industry." Westlake Village, Calif.: Focus Marketing Services. January 28. 40 pp.

Lofland, Laurie. 1998b. "National Renewable Energy Laboratory Solar Water Heating Systems for the New Home Market, Draft Final Report for Documenting Results from Analysis of Task 1 Quantitative Research, Findings, Conclusions and Recommendations to NREL and the Solar Industry." Westlake Village, Calif.: Focus Marketing Services. 30 pp., March 13.

NAHB Research Center. 1998. *Opportunities for Solar Water Heating*. Final Report for the National Renewable Energy Laboratory. Upper Marlboro, Md.: NAHB Research Center, Inc., January. 57 pp.

Rauluk, Valerie. 2001. *Development of Markets for Solar Water Heating Systems.* Final Report 1998-2001. Venture Catalyst Inc. report prepared for the U.S. Department of Energy, DOE/EE10357-F. Washington, D.C.: U.S. Department of Energy.