

**A New Market Paradigm for Zero-Energy Homes:  
The Comparative San Diego Case Study**

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**Executive Summary**

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# Executive Summary

## Introduction and Background

In April 2001, SheaHomes began to offer high-performance homes at Scripps Highlands in San Diego, California. This was the first such offering in the United States by a production builder. The 306 homes, sold by November 2003, were highly energy efficient; 293 had solar water heating systems; and 120 had photovoltaic (PV) systems.

*“It’s good for society.”*

*- This and other quotes are from comments made by owners in the SheaHomes Scripps Highlands communities.*

The National Renewable Energy Laboratory (NREL) used a diffusion-of-innovations theoretical perspective to follow this development over time. The study focused on the builder experience, market response to high-performance homes, increases in home values over time, and the consumption and cost of electricity and gas in the high-performance and adjacent comparison homes.

We began our work by meeting with a project advisory group to define key research questions. During the first, qualitative phase of the study, we conducted numerous interviews of executives and staff of SheaHomes, organizations partnering with the builder, and other interested parties. Field work was conducted at the SheaHomes community with early buyers and lost lookers. Researchers collected background information on the home sales processes. Qualitative interviews focused on the homeowners’ reasons for purchase and their perceptions of the energy features of their new homes. In this early phase, a total of 43 respondents in 25 households were interviewed; the information obtained was used to formulate questions for a more extensive survey of all homeowners.

We also selected a comparison community of 103 homes built by a different builder of similar vintage, size, and price adjacent to San Angelo and Tiempo. Although they were built to Title 24 building codes, thus providing more energy efficiency than conventional building codes in other states, the comparison homes were offered with no special energy or solar features standard.

The quantitative phase consisted of a comprehensive mail survey and detailed statistical analysis of the responses from SheaHomes and comparison homeowners. Questionnaires were mailed early in 2004 to all homebuyers. The overall survey response rate was 63% (65% from the SheaHomes communities and 56% from the comparison community). The survey addressed perceptions and preferences of the new homebuyers and the roles, if any, that energy played in their home purchase decisions. The survey also examined homebuyer satisfaction, willingness to pay for solar PV, preferences about energy policies, experiences with the homes, aesthetics of solar PV, satisfaction with utilities, and demographics, including environmentalism and innovativeness.

Respondents were asked to sign release forms for SDG&E to provide data on electricity and natural gas consumption and costs. The utility company provided the data to NREL, which performed analyses to determine if statistically significant differences in energy consumption and

energy costs can be attributed to the energy efficiency and solar features of the high-performance homes. These analyses controlled for an annual usage cycle, climate, square footage, number of occupants, and other variables. This unique research opportunity gave us the chance to put conventional wisdom about ZEH markets to the test; the detailed findings from our study are contained in this comprehensive 800-page report.

## Home Sales Prices

High-performance homes are competitive on the market. Based on actual sales data, per square foot, they sold for 9.2% less than comparison homes of the same vintage, on average. This difference, though small, is statistically significant. When house size is controlled for, the difference remains. Thus, even when controlling for the fact that housing prices per square foot decrease with house size, we find that the SheaHomes were competitively priced.

## Uptake of Optional PV Systems

Ultimately, 120 of the 306 SheaHomes were sold with some sort of PV system. Hence, 39% were sold with PV systems and 61% were not. However, only 260 homes were PV-eligible; hence, 46% of these were sold with PV systems. Clearly, the uptake on optional PV equipment was not as strong as it might have been. A total of only 12% of all PV-eligible homes were sold with PV systems optionally. Most of the PV systems sold came standard.

*“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.”*

However, we believe the lackluster sales of optional PV systems was the result of sales staff failure to offer the optional PV systems to buyers of PV-eligible homes. In fact, our data show that a majority (56%) of those who could have purchased optional PV systems were *not told* about the option. Thus, *the uptake rate is not 12%, but 44% of those actually offered the PV systems.* Homebuyers relied heavily on sales staff for information about PV systems, and staff were more concerned about closing home sales and less focused on sales of PV systems that might complicate the deal. Staff received no extra compensation for sales of PV systems.

*“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.”*

## Who Are These Homebuyers?

The buyers of high-performance homes and the buyers of new conventional homes share the same characteristics. SheaHomes and comparison homebuyers brought virtually identical attributes to their home purchase decisions, such as demographics, environmental attitudes, and early adopter characteristics.

As expected, residents of both communities mostly represent upper-middle class married couples with children, or mature couples. They are relatively affluent with well-paying occupations. Fifteen percent more of the SheaHomes owners (19%) than of the comparison owners (4%) enjoy an annual income of more than \$200,000. Yet, because SheaHomes' sales prices were competitive, higher income would not have influenced their decisions to buy there. No differences between SheaHomes and comparison homebuyers are found in results on measures of early adopter characteristics or environmentalism.

Three-quarters of the buyers visited both the SheaHomes and comparison communities when they were shopping for new homes. However, neither group was well informed about home energy features, although buyers of SheaHomes knew a bit more at the time of purchase. A majority of the comparison buyers were unaware that they featured energy efficiency and solar energy, even though they may have visited SheaHomes.

Variables on which the types of homeowners differ were by and large those *affected by their experiences in living in their new homes* (survey data were collected after owners had lived in their new homes for at least six months). For example, six in ten of SheaHomes owners agree that solar water heating systems are cost effective, and half of SheaHomes owners agree that solar PV systems are cost effective. The corresponding percentages of comparison homebuyers are 40% and 36%, respectively.

Despite some difficulties with interconnectivity issues, owners of SheaHomes with PV systems have more positive attitudes toward SDG&E than other homeowners. These differences are significant. A majority of PV homeowners are pleased with SDG&E's billing processes. Similarly, almost one-third of PV owners believed that electricity rates had come down since they moved in, compared with 18% of SheaHomes owners without PV systems.

It is not the qualities the homebuyers brought to the home purchase decision, but rather *the experience of PV ownership that changes attitudes and perceptions*. It also seems to change energy behavior. Living in highly energy efficient homes with solar water heating and PV systems promotes increased familiarity with and interest in those systems, which ultimately leads to heightened awareness of household energy practices. The behavioral interaction of consumers

with PV technology based on the digital display of kWh production and consumption—and to some extent the electric meter—provides feedback that seems to affect homeowner energy behavior. Feedback may be significant in bringing about behavioral changes that optimize energy and cost savings. To a limited degree, the PV owners also seem more sensitive than others to savings from solar water heating systems, even though these have no feedback devices.

*“We isolate things to see what the electricity hogs are. We're already more energy conscious because of the feedback device.”*

## Aesthetics and Resale Value

Neither qualitative nor quantitative data identified aesthetics as barriers to purchase of homes with solar panels. However, because we primarily studied homeowners who bought such homes, we cannot conclude that no one objects to the aesthetics of solar panels. It seems fair to

conclude that the new homebuying market is large enough that it does not matter if some people object; in fact, home sales at Scripps Highlands were brisk.

*Regarding aesthetics—*

*“Huh?”*

*“Satellite dishes are more offensive.”*

Similarly, based on our data, any concerns about solar panels diminishing resale value appear unwarranted. In the first 3.5 years, 13% of the comparison homes were resold compared with 5% of the SheaHomes, suggesting a more rapid turnover of comparison homes. SheaHomes experienced a mean dollar gain of 55.4% for a mean ownership length of 22.5 months. Comparison homes experienced a mean dollar gain of 44.7% for a mean ownership length of 28.1 months. The mean dollar gain per month owned was \$14,500 for SheaHomes and \$9,300 for comparison homes.

## Home Purchase Decisions

The most important reasons for purchase for both categories of buyers were the home’s location in a safe and secure quality neighborhood, the overall home value, and the investment potential. The relative rankings of reasons for purchase were the same for both categories of homebuyers. Concerns about the San Diego 2001 electricity crisis did not influence home purchase decisions. Energy was not an important factor in the purchase decisions of most of the study’s new homebuyers. The reputation of the builder was more important to SheaHomes than to comparison buyers. Buyers who were more concerned about their residential energy consumption were more likely to buy SheaHomes than comparison homes. Every home feature mentioned in our study had a higher average importance rating for those who did not purchase PV homes than for those who did, suggesting that home characteristics other than energy features were more important to those not purchasing homes with PV systems.

The findings on willingness to pay (WTP) more for PV systems suggest that \$5,000 may be a threshold for 1.2 PV systems. More than one-third of non-PV-purchasing homebuyers indicate a WTP at least \$5,000 more for PV systems that could replace 50% to 70% of their electricity needs. This level of savings would require a larger PV system. SheaHomes buyers who upgraded from 1.2 to 2.4 PV systems paid an additional \$4,000; those who purchased optional 1.2 PV systems paid \$6,000 (later raised to \$7,000). Those who purchased optional 2.4 PV systems paid \$10,000 (later raised to \$11,000). Reasons for not purchasing PV systems tend to center around the expense. Subsidies and amortization would be required to permit installation of larger 2.4 to 3+ PV systems that would be needed to reduce electricity costs by 60% to 70%.

## Satisfaction

Most buyers are satisfied with their new homes, but SheaHomes buyers, and especially buyers of homes with PV systems, are more satisfied than are comparison buyers. A significantly higher percentage of SheaHomes owners than owners of comparison homes (77% versus 67%) indicate they would buy the same houses again. Although this would not be the only factor affecting satisfaction, the comparison homeowners report significantly higher monthly utility bills than do the SheaHomes owners. Both sets of homeowners find their homes comfortable, but comparison buyers pay higher utility costs to maintain their comfort levels. Owners of SheaHomes believe their homes are energy efficient.

*“When people come to visit, the first thing we do is show them the solar equipment.”*

By owners’ estimates, living in PV homes has resulted in significantly lower utility bills than those reported by the rest of the homebuyers. Two-thirds of PV owners have bragged to others about their utility bills, compared to one-quarter of owners without PV. A majority of PV owners indicate their expectations for utility bills have been met, compared with less than one-third of other SheaHomes owners.

Three dimensions of advantages of PV ownership result from factor analysis. The first of these is “altruistic” benefits (such as helping to reduce global warming, helping the local economy, benefitting future generations, and helping to improve local air quality). The second is the financial advantage (such as reduced electricity bills, free electricity once the system is paid for, selling electricity back to SDG&E, and increasing the home’s resale value). Finally, personal satisfaction includes increased self-sufficiency, being technologically innovative, and feeling good about owning the home.

*“We brag about our windows.”*

## Policy Preferences

SheaHomes and comparison owners agreed on energy efficiency and solar energy policy preferences. For example, 92% of both sets of homeowners agree or strongly agree that “builders should build very energy-efficient homes if they cost less per month to own and operate.” Eighty-five percent of SheaHomes and 81% of comparison buyers agree or strongly agree that “the federal government should support research on highly energy-efficient homes that produce all the energy they use.” Interestingly, majorities of both sets of homeowners agree that solar water heating and solar PV systems are desirable innovations for new homes.

*“Solar electricity should be available and affordable on all housing.”*

## Are Energy and Costs Saved?

SheaHomes advertised that its homes, incorporating “the latest in solar electric home power generation, solar water heating, and energy-efficiency technology,” would enable homeowners to reduce their utility bills by 30% to 50% over conventionally built homes. *The original SheaHomes concept has been validated by our utility analysis.* Among the homes studied, SheaHomes consume less electricity and gas, on average, than adjacent comparison homes. Similarly, SheaHomes households incur lower utility costs, on average, than comparison households. For example, the combined average monthly total utility bill for homes with 2.4 PV systems is 54% lower than for comparison homes, a result that is statistically significant.

## A New Market Paradigm

The value of our study does not lie in describing the motivations of recent new homebuyers, but rather in suggesting a conceptually fresh alternative paradigm for the building and marketing of new ZEHs. When this paradigm is used, builders, new homebuyers, and utility companies will benefit. When appropriately applied to business practice and public policy, this new paradigm will help builders create the sustainable communities so necessary for our well-being and that of future generations.

*“All builders should be doing it.”*

Conventional wisdom on the markets for ZEHs, relying on a diffusion-of-innovations tradition, holds that ZEHs will appeal only to niche early-adopter markets. It posits that ZEHs cost more to build and therefore are more expensive to buy than conventional homes. It would follow that production builders should offer them optionally to buyers with unique motivations, such as environmentalism. In this view, ZEH aesthetics (in particular, the solar PV panels) are often considered barriers to most mainstream homebuyers, and as impediments to resale, negatively affecting home values. Conventional wisdom also assumes that mainstream homebuyers are motivated by economic payback on an incremental financial investment for zero-energy features for which they have opted. Homebuyers’ satisfaction, then, is considered contingent on the perceived payback of energy features.

Our results suggest a new market paradigm for ZEHs that appears to stand conventional wisdom on its head. This paradigm, though it originates from the San Diego case study, may be useful elsewhere in California and in the rest of the country, and, indeed, internationally. The table below captures some of the notions that we have termed conventional wisdom and summarize the new market paradigm along these same dimensions.

The results of this case study suggest that the markets for new housing are essentially equivalent to the markets for ZEHs standard, assuming a policy frame that provides subsidies and builder pricing similar to those in effect when San Angelo and Tiempo were built and sold. However, this does not mean that the diffusion-of-innovations approach is irrelevant to the widespread acceptance of ZEHs. Rather, the early adopters are the *builders, utility companies, and policy-makers* whose adoption of ZEHs will make these homes available standard to many willing homebuyers. For us to benefit from ZEHs, the innovative building practices for which

SheaHomes has led the way and the ZEH-supportive policies for which California is becoming increasingly famous are the innovations that must diffuse.

**Conventional and New Market Paradigms for Zero-Energy Homes**

Attributes	Conventional Wisdom	New Market Paradigm
<b>Sales Prices</b>	ZEHs cost more to build than other homes and are more expensive on the market.	Quality upscale high-performance homes with market appeal can be built by production builders and sold competitively and profitably, especially where subsidies are in place.
<b>Uptake</b>	In new developments, builders should offer ZEHs optionally, and only a few will be sold.	Builders should offer ZEHs standard; most buyers will buy them. In addition, the pace of sales may well be accelerated over that of conventional homes.
<b>Homebuyers</b>	Only innovators and early adopters will buy ZEHs (a very small percentage of the market).	High-performance homebuyers are ordinary buyers of new production homes in their price ranges; they have no special demographic attributes; their environmentalism and early-adopter characteristics are no different from those of other buyers.
<b>Aesthetics</b>	Aesthetics are major barriers to ZEH purchase for most buyers and negatively affect resale value.	Enough buyers are unconcerned about aesthetics that they purchase homes with solar panels, at least in a seller's market, at an accelerated pace. Resale homes with solar panels have higher value than comparison homes.
<b>Home Purchase Decisions</b>	Other than early adopters, buyers of ZEHs would be motivated by economic payback for an incremental financial investment for which they have opted.	ZEH buyers, for whom energy features are only "icing on the cake," may be <i>unaware</i> of any potential additional financial investment if the costs of energy systems are built into the homes' sales prices and into their mortgages. In fact, some buyers are "unwitting adopters." However, buyers <i>are</i> aware of their substantial benefits from reduced utility bills. In this model, financial incentives (e.g., rebates) go to the builder, although buyers may receive income tax credits or renewable energy credits.
<b>Satisfaction</b>	Homebuyer satisfaction is contingent on perceived payback of energy features.	Owners of high-performance homes with PV systems perceive three major kinds of benefits: (1) altruistic, (2) financial, and (3) personal satisfaction. These owners appear to become increasingly satisfied over time as they receive feedback from their systems, modify their behavior, and observe (and brag about) their utility bills.



## Recommendations and Concluding Remarks

A recommendation from our findings is that builders should offer ZEHs standard (rather than optional). Highly efficient, and with solar water heating, these homes should have at least 2.4 PV systems and should include digital feedback displays showing consumption and production of electricity. Transaction costs are too high when homes and solar energy systems are sold separately, and homebuyers have difficulty determining the value of solar features as home options when juxtaposed with other options. Our research suggests that from a marketing perspective using this standard-package approach when offering homes with specific energy packages is simply more effective.

*“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.”*

In conclusion, this study is replete with findings that support the rapid development of high-performance homes with PV systems, near-ZEHs, and ZEHs. Once offered standard, the costs of these homes to the builder appear to be manageable, the product provides differentiation on the market, and ordinary homebuyers want to buy these homes. Once they live in them, homeowners become even more enthusiastic. Policies that support the deployment of ZEHs, such as net-metering legislation, simplified interconnectivity agreements, building codes and standards, utility rebates, and subsidies for solar water heating and PV systems, will be rewarded by rapid diffusion of an idea whose time has come.

Through its pioneering work in building the nation’s first high-performance home development at the highly desirable Scripps Highlands location from 2001 through 2003, SheaHomes has provided a tremendous service to its homebuyers, San Diego, the California and U.S. housing industry, and energy professionals everywhere. The upscale homes it built are very energy efficient with solar water heating systems. Because SheaHomes offered one-third of its homes with solar photovoltaic (PV) systems standard, and left solar PV adoption for the rest up to the homebuyers, a rare opportunity for insight into the behavior of the ZEH market emerged.