

# Premier Gardens & Cresleigh Rosewood: A Zero Energy Community Case Study

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## ABSTRACT

In 2004, Premier Gardens' near-Zero Energy Homes (ZEHs) and Cresleigh Rosewood's non-ZEHs were built side-by-side, providing the opportunity to evaluate two large-scale communities of occupied single-family homes. The non-ZEHs surpass California's building code, designed to save 30% on summer cooling energy, while the near-ZEHs were designed to Building America specifications. The U.S. Department of Energy's Building America program aims at achieving cost-effective, marketable, Zero Energy Homes by 2020. Today's Building America homes utilize energy efficiency and solar energy technologies to achieve energy savings. With at least one year of electric and gas use data for each community, totaling almost 200 homes, the near-ZEHs were found to use 44% less energy than the non-ZEHs across the street. Additionally, this paper investigates and identifies the benefits of near-ZEHs for homebuilders, homebuyers, the Sacramento Municipal Utility District, and other stakeholders to understand the collective benefits near-ZEHs offer.

## 1. INTRODUCTION

As one of six national Building America teams, the Building Industry Research Alliance (BIRA), worked with partners the Sacramento Municipal Utility District, GE Solar, and Premier Homes to build and study a Zero Energy Community. The large sample of near-Zero Energy Homes and control homes combined with the amount of data collected, Premier Gardens and Cresleigh Rosewood offer a unique opportunity to evaluate the large-scale impacts of Zero Energy Homes. BIRA and the Sacramento Municipal Utility District (SMUD) have evaluated these homes from

many perspectives. This paper will serve as a brief overview of what has been done, an overview of the benefits for all stakeholders, and a look at how the Premier Gardens ZEH case study has influenced the building industry in California and beyond.

## 2. BACKGROUND

In 2004 and 2005, Premier Homes and Cresleigh Homes undertook a business agreement to divide the development of a plot of land in Rancho Cordova, CA. Rancho Cordova is located on the east edge of Sacramento. The resulting community consists of 95 Premier homes on the west side of the property, and 98 Cresleigh homes on the east. Many of the homes are right next to each other, as shown in Figure 1. Figure 2 shows an aerial view of the Premier Gardens community displaying the photovoltaic (PV) solar panels.

## 3. BUYER DEMOGRAPHICS

Research funded by and in support of the Department of Energy's Building America Program was conducted by RAND Corporation for the purpose of beginning to understand "the differences in homeowners' preferences for energy efficiency at the time of purchases, and what may account for these differences."<sup>1</sup> The research consisted of a study of prior research and a series of focus group discussions with homeowners in Premier Gardens and Cresleigh Rosewood in October of 2005.

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<sup>1</sup> RAND Working Paper "The Role of Energy Efficiency in Homebuying Decisions: Results of Initial Focus Group Discussions" Mark Hanson and Mark Bernstein

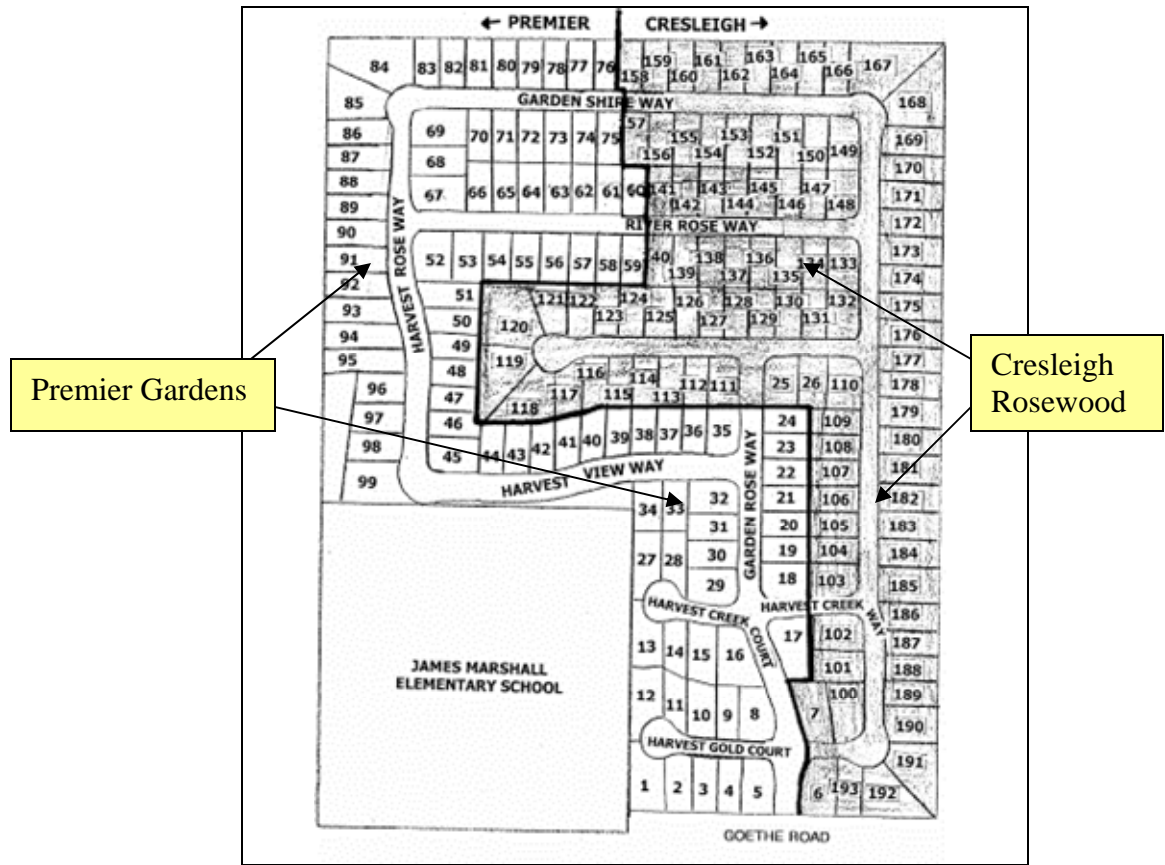


Fig. 1: Premier Gardens and Cresleigh Rosewood Side-by-Side



Fig. 2: Premier Gardens community showing PV systems on roofs (courtesy of GE).

RAND cautions that “limitations of our qualitative research approach and the small sample size in our study, our results should be considered as preliminary, and our conclusions as tentative.... This report is a “working paper” intended to share preliminary findings, invite comment, and continue progress made on better understanding the issues surrounding home buying decisions.”

The following was learned of the near-ZEH homebuyers relative to the non-ZEH homebuyers:

- Near-ZEH homebuyers are younger
- Near-ZEH homebuyers earn less household income
- Near-ZEH homebuyers are more educated (2:1 hold advanced degrees)
- Near-ZEH homebuyers viewed more homes before purchasing (more than 2:1)

#### 4. DETAILED DISCRPTION OF HOMES

The homes built in both of these developments are approximately the same size. The energy features are different in several notable ways. Premier Homes, working with support and encouragement from SMUD and BIRA, developed the first full-scale near Zero Energy Community in the Sacramento area on their half of the development. On the other half, Cresleigh built homes participating in the SMUD Advantage Program intended to reduce summer cooling by 30% and meeting the California Title 24 requirements in effect at the time of construction. The Premier Gardens’ homes are significantly more energy-efficient and include a 2.0 kW AC photovoltaic (PV) system on each house. The table below compares the as-built energy features of the two developments.

**TABLE 1: AS-BUILT ENERGY FEATURES**

Community	Premier Gardens	Cresleigh Rosewood
Energy Program	ComfortWise	SMUD Advantage
Square Footage of Each House	2,248	2,384
Plan	1,846	2,024
	1,625	2,000
	1,503	1,850
	1,285	1,720
		1,610
PV	2kW AC GE	None
AC	14 SEER	10 SEER
Heating	92% AFUE	80% AFUE
Water Heating	Tankless 0.82EF	40 Gallon 0.60EF
Ceiling	R-38	R-30
Walls	R-13 + 1in foam w/Stucco	
Windows	Vinyl Low E	
Lighting	Fluorescent	Incandescent
Ducts	Sealed, Tested, Buried	Sealed, Tested

## 5. ENERGY USE

### 5.1 Electricity Use

Before interpreting the electricity consumption, it is important to understand the differences between the near-ZEHs and the non-ZEHs. The most notable difference is the PV systems on the near-ZEHs. Beyond that, the near-ZEHs have a higher R-value ceiling insulation, higher SEER-rated A/C with TXV, florescent vs. incandescent lighting, and buried ducts.

To determine savings, the average monthly electricity use was calculated from 12 months of continual data from March 2005 to February 2006. Before the PV electricity consumption is factored in, the electricity use across the communities is very similar. The average monthly electricity use before PV for Premier Gardens is 9.3% less than Cresleigh, and 53.5% less with PV. Given Cresleigh homes meet the nation’s most stringent energy code, Title 24, and were built to reduce cooling bills by 30%, this is not surprising. The data shows that the near-ZEHs perform better than Cresleigh March through August in comparison to in the winter months. September through February use is similar where Cresleigh homes actually consume less on average in December and February. Likely this is because there is no electricity savings from the buried ducts and improved A/C compressor during the non-cooling months.

Figure 3 displays all the electric bills in each community for July 2006. The primary feature of Figure 3 is the dollar savings of Premier homeowners over both neighboring Cresleigh, and the average SMUD residential bill. A common theme among Premier owners is their happiness when they open their summer electric bills. While their highest summer near-ZEH bill may be 60 dollars, their old smaller home’s bill was over 200 dollars. The secondary feature is the variability shown between the highest and lowest bills. Figure 3 highlights what is already known; there is tremendous variability in energy use dependent on resident behavior. This variability can make it near impossible to show verifiable savings when comparing one or two homes. It is important to have a large sample of homes, as with this case study, to normalize energy consumption across the community.

### 5.2 Gas Use

Gas Savings for the Premier Garden’s homes are from buried ducts, higher efficiency furnaces, improved ceiling insulation, and a tankless water heater. The 2005 monthly gas bills, as provided by Pacific Gas and Electric, were analyzed for each community. The average near-ZEH used an average of 322 therms per year compared to 455 for the non-ZEH community, a savings of 29.3 percent.

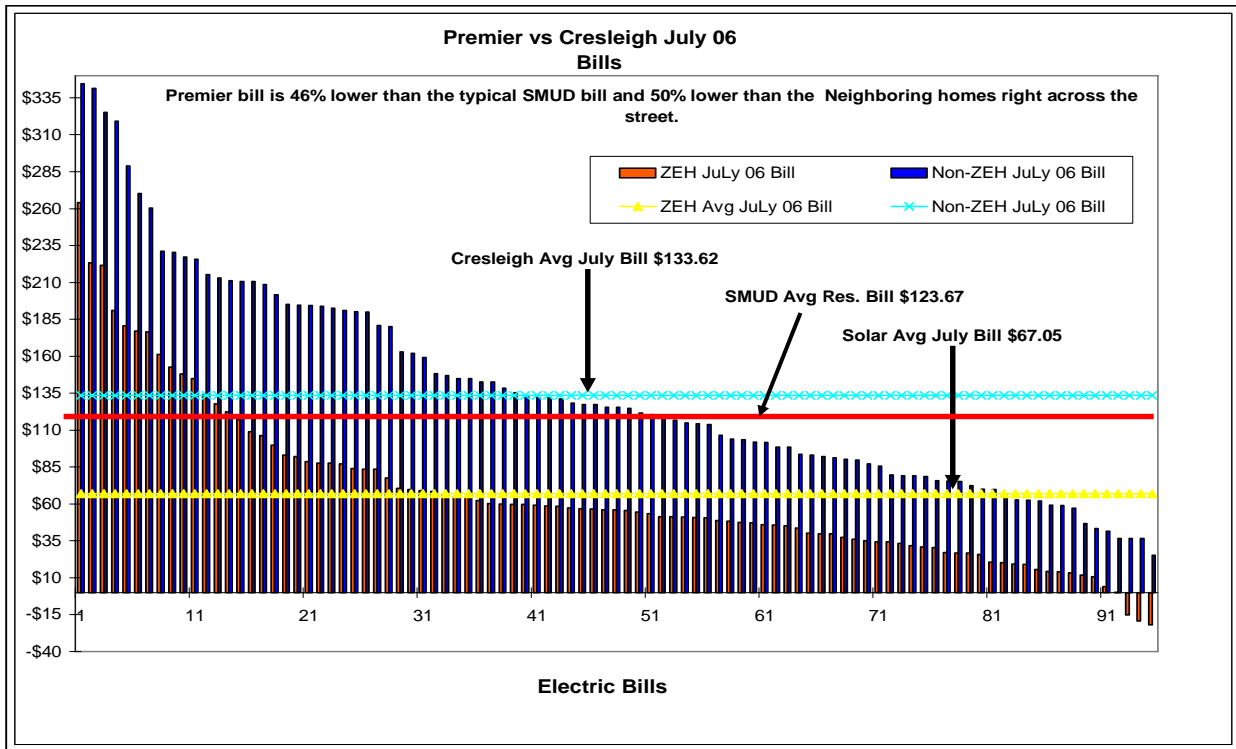


Fig. 3: Actual Electric Bills for Premier and Cresleigh Homeowners July 2006 (courtesy of SMUD)

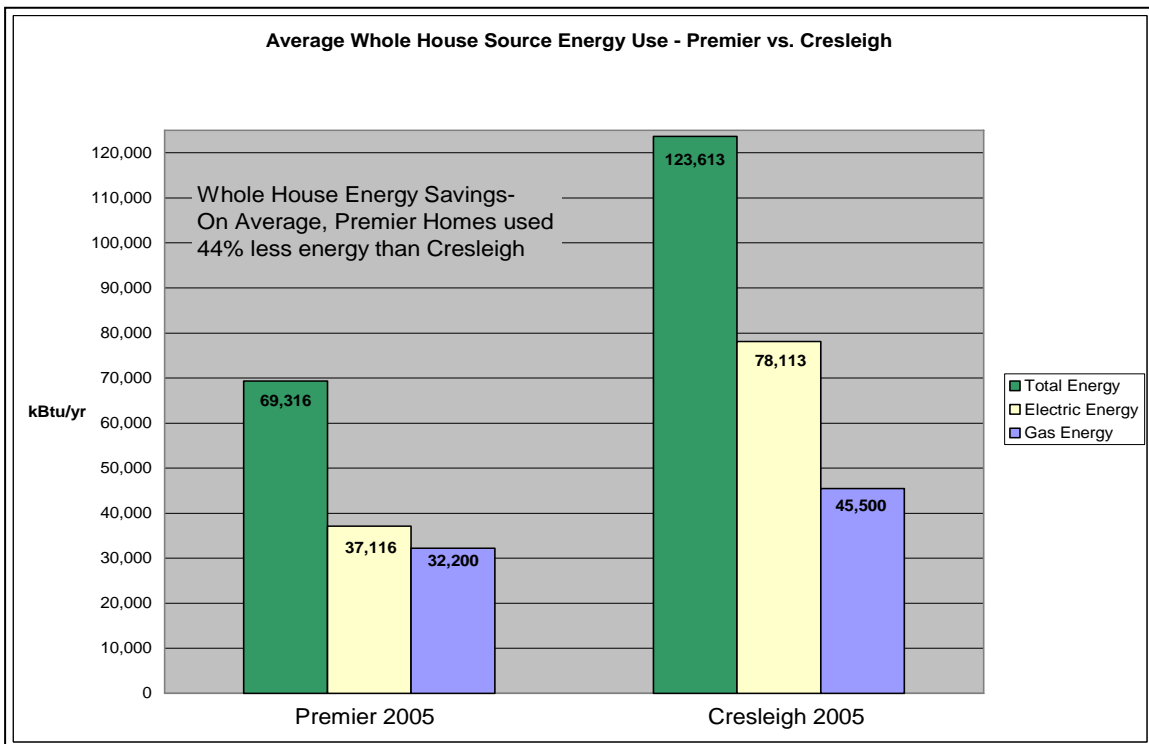


Fig. 4: Whole House Source Energy Use- Premier vs. Cresleigh

### 5.3 Total Energy Savings

On average, Premier Homes used 44% less source energy than their neighbors in Cresleigh Homes. As displayed in Figure 4, Premier used similar amounts of source gas and electric energy, while Cresleigh used 42% more source electric energy than gas, largely because Premier homes have solar electric generation. When compared to an energy-efficient SMUD Advantage Home built by Cresleigh, Premier's near-ZEH still used 44% less source energy. It is safe to say that these homes are performing well.

### 6. PEAK ELECTRICITY ANALYSIS

System peak demand is a serious concern for SMUD, many other California utilities, and utilities across the country. When speaking with Mike Keesee, Wade Hughes, or Bruce Cenicerros at SMUD, BIRA quickly learned their main objective: cut peak demand, more specifically cut residential cooling demand. Wade Hughes said "It's all about A/C."<sup>2</sup> As seen in Figure 5, the control non-ZEH's kW demand follows a similar curve to SMUD's system demand.

To study the impacts that near-ZEHs have on peak, SMUD designed a monitoring experiment using the Premier Gardens and Cresleigh Rosewood communities. SMUD set

up monitoring equipment to gather 15-minute data for a statistically significant 18 homes in each community to compare peak performance. The heat storm experienced July 2005 in Sacramento is the best opportunity to evaluate peak performance between communities. During July 2005, the average daily high was 98 degrees, and low was 65 degrees, the highest on record. SMUD set a new system peak demand July 15<sup>th</sup>, 2005 at 5pm that was 5% above the previous system high.

Peak demand data compiled from each community show that near-ZEH features have a significant impact on a home's peak demand. Figure 5 shows the average 15-minute interval peak demand from the Premier Garden's near-ZEHs and adjacent non-ZEHs for the month of July. As the graph shows, the near-ZEH peak demand was demonstrably lower than the adjacent, non-ZEHs'. During SMUD's peak, 12pm-7pm, the near-ZEH's used an average of 73% less electricity than the non-ZEHs during July 2005. This is especially significant as the non-ZEHs were SMUD Advantage Homes designed to use at least 30% less cooling energy than homes built to the Title-24 cooling energy standards. As Figure 5 displays, approximately half the peak savings are a result of efficiency, while PV generates the other half. For this project the energy efficiency features were five times less expensive than the PV panels. It is also significant that 5 of the 18 near-ZEH PV systems face east, thus providing little or no electricity during the

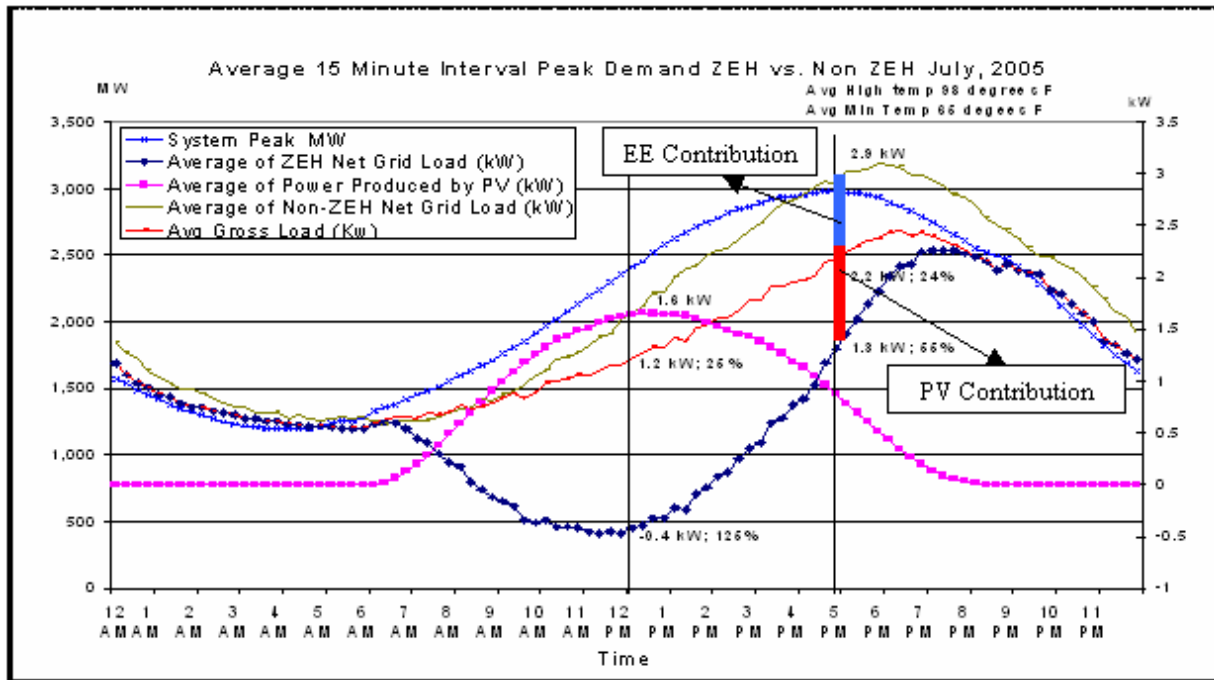


Fig. 5: Peak Demand July 2005

<sup>2</sup> Personal Interview with Wade Hughes November 7, 2006.

afternoon and evening peak periods. As SMUD's system peak occurred at 5pm, westerly-facing PVs would have provided the most electricity back to the grid at this time. An analysis was done to determine the impact of all westerly-facing PVs on Premier's near-ZEHs. This analysis shows that had the Premier Gardens development been designed to maximize westerly facing PV's, the net grid load could be shifted almost three hours. Additionally, the average demand at 5pm would have reduced from 1.3 kW as built, to 0.75 kW with all westerly-facing PV.

## 7. BUILDER BENEFITS

Premier Homes builds an average of 70-90 homes a year in the Sacramento region. Prior to the Premier Gardens project, Premier had built only two homes with PV.

There are a few important factors that may have contributed to Premier's success with this project that must be stated to understand the context in which Premier was able to achieve success at Premier Gardens. Given the lessons learned from past ZEH experiences, such as Shea Homes in San Diego, it was strongly recommended by BIRA that Premier build with PV as standard equipment. Past experience shows that selling electric solar as an option is difficult, and more costly. Premier agreed, and every home in Premier Gardens was equipped with standard PV systems. These systems were installed by a sister company that Premier Homes owns, which may have also aided them during installation.

Premier worked closely with BIRA, ConSol, and SMUD to design, build, and market the homes at Premier Gardens. As a median size builder having little experience with advanced home building, Premier did not have in-house experience or expertise to design and market Zero Energy Homes. ConSol works with production homebuilders and was able to advise Premier throughout the entire process. SMUD provided very important marketing support, and lastly, Premier's senior management was enthusiastic to build Premier Gardens, not only for business reasons but also ideological ones. This commitment to Zero Energy Homes was important for there are always set-backs in home construction, and building ZEHs may compound this.

It is difficult to judge how all these factors contributed to the success of Premier Gardens, or how important they are for other builders.

According to John Ralston, Premier Homes Director of Sales, and a driving force behind the Premier Gardens project, Premier Gardens received more media attention than was ever expected and sales were remarkable. Although brisk sales would be expected during the 2004-2005 hot housing market, Premier Gardens began

construction later and sold out earlier than neighboring Cresleigh Homes. Additionally, the Premier Gardens experience has prompted Premier to build more near-ZEHs, building over 250 as of October 2006. Premier Homes has also gained the respect of the homebuilding industry for its innovative designs and marketing success winning an Energy Value Housing Award, administered by the National Association of Home Builders Research Corporation and funded by the DOE.

Before construction began, there were numerous articles about Premier Gardens in local newspapers and in home and garden magazines highlighting the energy efficiency features. On April 21, 2004, Premier Homes completed three models and had their Grand Opening ceremony. They were interviewed and on the news of three Northern California television stations. Premier Homes felt this was a great success, and the media coverage provided good exposure of both Premier Homes and Premier Gardens to the community. In addition, the whole energy-efficient expert team participated in the ceremony including a guest speaker Robert Rivinius, CEO of the California Building Industry Association, who highly praised Premier Homes for voluntarily building the first ZEH community. Premier Homes received immeasurable benefits from the PR generated from the Premier Gardens Project. The exposure did not fade, and Premier executives continue to be interviewed and written about in national and regional news sources including Newsweek magazine.

It is difficult to assign a value to the news articles, television stories, and other PR, but they were certainly beneficial to selling homes. The media attention Premier Gardens received saved on advertising, and offered exposure Premier could otherwise not afford.

Interestingly, there is a downside to the national media attention Premier Homes received. As a regional builder, Premier gains little from media observed outside California. John Ralston says that he frequently receives calls from people all over the country asking if Premier can build homes in their area. The answer is no, but it still takes time for Premier employees to respond to all the requests. Although, John wouldn't have it any other way, and appreciates the free publicity, the national media attention is certainly more valuable for a national builder.

Through speaking with John Ralston and Premier Sales personnel, BIRA has learned how Premier approaches communicating the benefits of a ZEH to homebuyers. Because Premier allows its sales people to create their own marketing message it is hard to understand exactly how they approach it, but there are common threads. An important benefit of selling a ZEH is the element of differentiation. Most model homes in the Sacramento

region look alike. Selling a home with solar makes Premier stand out, and it gets people in the door asking questions. The challenge is having the time and proper message to communicate the benefits of a Premier home. Much of the interest from homebuyers is derived from the opportunity to save money compared to their current utility bills. John Ralston believes the most effective way to communicate this is by showing a potential homebuyer a summer electric bill from a Premier Gardens' house. Although it is a small thing, he thinks offering a \$40 electric bill is more powerful than offering a 40% reduction in monthly utility bills. This is an important nuance that Premier has learned through selling Zero Energy Homes.

For Premier Gardens, the prices of the homes were comparable to Cresleigh. The main difference, minus the homes' layout, was Premier's standard ZEH features, and Cresleigh's standard granite countertops. The task is adequately communicating the value of a ZEH, and what that means for a homeowner.

Moving forward, Premier values the ability to confidently communicate energy bill savings based on Premier Garden's results. As the building industry is not among the most trusted, Premier knows having verifiable bill savings from Premier Gardens is an asset for selling future ZEHs.

### 8. HOMEOWNER BENEFITS

The benefits of the well-built Premier Zero Energy Homes are numerous. A professionally engineered and tested HVAC system provides better comfort and indoor air quality for occupants. Low-emissivity windows provide added comfort and protect furniture and fabric from fading and wear. Better insulation and testing provide more even temperatures throughout the home and better sound insulation from outside noise. All the ZEH features provide

**TABLE 2: ENERGY BILL SAVINGS**

<b>Energy Bill Savings</b>				
Community	Avg Gas Bill	Avg Electric Bill	Total Energy Bill	Yearly Energy Bill
Premier	\$32.32	\$32.89	\$65.21	\$782.52
Cresleigh	\$46.14	\$68.29	\$114.43	\$1,373.16
Savings (\$)	\$13.82	\$35.40	\$49.22	<b>\$590.64</b>
Savings (%)	30%	52%	<b>43%</b>	<b>43%</b>
<b>Premier Residents save 43% on energy bills amounting to \$590.64/year</b>				

44% whole house energy savings over a similar home built to the then current SMUD Advantage Home requirements, and make the home more affordable.

It has been said that Zero Energy Homes have higher resale values. According to a National Renewable Energy Laboratory Technical Report, ZEHs built by SheaHomes in San Diego resold for 16.6% more than a comparable community.<sup>3</sup> Unfortunately there have not been enough homes resold in Premier Gardens or Cresleigh Rosewood to judge whether the near-ZEHs will increase in value relative to non-ZEHs. As more homes are resold, this question can be answered.

As Table 2 displays, the energy bills savings for Premier Gardens' homeowners are close to \$60 a month. Since Premier buyers paid a similar price for their homes compared to Cresleigh, the cost of ownership is lower.

### 9. VERIFIABLE RESULTS

Arguably the most important aspect of the Premier Gardens project has been the ability of BIRA and the building industry at large to prove the validity of near-ZEHs.

Until this project, high-performance building advocates have relied on computer simulation data and small samples of homes to show the large-scale impacts of high-performance homes. With almost 200 homes' electric and gas bills, the Premier ZEH case study has helped convince builders, buyers, and public decision-makers the value of energy efficiency and solar in new home construction.

#### 9.1 The New Solar Homes Partnership

The New Solar Homes Partnership is a California Energy Commission (CEC) managed program under the larger California Public Utilities Commission's Go Solar Initiative. The New Solar Homes Partnership (NSHP) is a

<sup>3</sup> "A Comparative Market and Utility Analysis of New High-Performance Homes in San Diego" B.C. Farhar and T.C. Coburn

\$350 million program aimed at creating a sustained solar market for new homes. As part of the Go Solar Initiative, the NSHP aims at incorporating solar power into 50% of all new homes built in California by 2020. The program will change the way solar incentives are allocated in all Independent Service Operator (ISO) areas, including PG&E, SCE, and SDG&E and serve as a model for the rest of the country.

The program begins a new era of state solar support with the inclusion of energy efficiency requirements for all new solar homes. Rob Hammon, of the Building Industry Research Alliance (BIRA), and Principal of ConSol, co-chaired the CEC NSHP Advisory Committee. Dr. Hammon communicated the concept that homes be equipped with all cost-effective energy efficiency measures before more expensive solar energy is added. The Premier Gardens case study provides proof, with real utility data, that combining energy efficiency with solar is the most cost-effective way to reduce homes' energy consumption and bills.

NSHP offers two tiers based on energy efficiency performance. The first tier requires a 15% increase in efficiency over California's Title 24 to receive incentives. The second tier requires a 35% improvement above Title-24 building code, and a 40% improvement above cooling requirements, which corresponds to the performance achieved at the Premier Gardens community. The second tier allocates more financial incentive for energy efficiency and solar improvements. Both tiers require third party inspections to verify proper orientation, absence of solar shading, and high performance building features. The program design was influenced by Dr. Hammon, based on Building America's research findings from analyzing utility data at Premier Gardens and Cresleigh Rosewood. BIRA's research, relying on electric and natural gas bill data provided by the Sacramento Municipal Utility District (SMUD) and Pacific Gas and Electric (PG&E), validated the cost effectiveness of energy efficiency measures, the peak reducing capacity of near-Zero Energy Homes, and the practicality of achieving south and west facing PV systems on all homes in typical production community layouts. All three of these research findings directly influenced California's new program design and acceptance. NSHP homes will be energy-efficient, cut peak electricity use, and serve as model to emulate up and down the state and across the country.

## 10. CONCLUSION

The Premier Garden's project has contributed significantly to the knowledge base for building high performance homes that deliver expected energy saving results. This case study has created evidence that shows building near-ZEHs is both

technically and practically possible for production homebuilders. All stakeholders can reference actual energy use data from Premier Gardens to prove that ZEHs work serving multiple stakeholder goals.

The Premier Gardens and Cresleigh Rosewood communities both represent well-designed homes that exceed the best building code in the country, California's Title 24. Even so, Premier Garden's near-ZEHs use 44% less source energy than Cresleigh while significantly shaving peak electricity demand as well.

With all the information gathered and analyzed, this project represents an essential case study for designers, builders, and energy analysts interested in building high performance homes with predictable results. The benefits of the Premier Garden's homes are numerous and affect multiple stakeholders. Now that many ZEH benefits have been identified, the task for future near-ZEH projects will be to appropriately communicate and assign value to all affected stakeholders.

As the building industry moves forward, building in higher levels of efficiency, the lessons learned from Premier Gardens will continue to influence the next generation of Zero Energy Homes.

## 11. ACKNOWLEDGMENTS

It should be noted that none of this research nor shaping of the NSHP would be possible without the bold leadership of SMUD. Additionally, the leadership and technical assistance from the U.S. Department of Energy and the National Renewable Energy Laboratory were critical to this Zero Energy Home Case Study. BIRA would like to thank our partners Premier Homes, SMUD, PG&E, GE, and RAND for making all this possible.

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