Building America SM
U.S. Department of Energy
Research Toward Zero Energy Homes

High-Performance Home Technologies: Solar Thermal & Photovoltaic Systems

Case Study: Centex Avignon

Pleasanton, CA

The 1st Zero-Energy New Homes Community in Alameda County

Centex, one of the nation's largest home builders, is constructing the first, zero-energy community to be built in Alameda County. The development called Avignon, is located in Pleasanton, California. Model homes opened in June 2006. All 30 homes in the development feature energy-efficient construction topped by a 3.5-kW photovoltaic system on every roof.

Centex worked with ConSol, leader of the BIRA Building America consortia, on the energy-efficient design and the PV systems. The PV panels are integrated as part of the roof and are similar in depth to the cement roof tiles they replace. The panels are a product called SunTile,® provided and installed by PV manufacturer PowerLight (now called SunPower).

"By first constructing the most energy-efficient homes and then adding state-of-the-art renewable resources, each home in Avignon will be constructed to be 25% more energy efficient than required by the strict California energy codes; have a 70% energy savings on the annual electric bill; and draw no more than 1kW from the utility during summer peak time (the hottest time of the day)," said Jeff Jacobs, Director of Community Development, Centex Homes, Bay Area Division.

Solar Systems

"We commend Centex's vision in providing solar electric systems as a standard feature on all of their new homes at the Avignon community in Pleasanton. Solar seamlessly powers homes and dramatically reduces a homeowner's electric bills, while producing completely emissions-free energy. High quality, newly built homes provide the absolute best time to install solar," said Howard Wenger, Executive Vice President of SunPower, which is based in Berkeley, CA.

SunPower installs the integrated roofing system and predicts the 3.5-kW DC photovoltaic power should provide most of the home's annual electricity needs. The homes are hooked up to the local utility grid so homeowners can draw electricity when they need it. Any excess electricity produced by the system is sold back to the utility for homeowner credit. A unique feature of the SunPower system is an ongoing monitoring service that SunPower provides, enabling the company to track each home's power output to ensure everything is in working order. Homeowners can track the progress themselves through a website that posts each home's power production data.

BUILDER PROFILE

Builder's Name:
Centex, Northern California Division

Where:
San Francisco Bay Area, California

Founded: 1950, Dallas, Texas

Development:
Avignon, Pleasanton, California

Size: 30 units

Square Footage: 3,671-4,035 square feet (4 to 5 bedrooms, 3 to 4 baths)

Price Range:
Around $1,000,000

Centex Avignon

(left) J.D. Power rated Centex as the top builder in customer satisfaction in the San Franciso Bay area.

(right) All Avignon homes will incorpoprate 3.5 KW PV systems.

KEY FEATURES

- 3.5-kW DC photovoltaic integrated roofing system from SunPower™
- ComfortWise® package by ConSol
- Properly designed heating and air conditioning systems
- Andersen 400 Series HP Low-e spectrally selective glass windows
- Tightly sealed air ducts
- Independent inspection of insulation, caulking and sealing, windows, and heating and cooling ductwork
- R-49 attic insulation with R-30 above garage/cantilever
- R-15 wall insulation
- Two on demand tankless water heaters with .82 energy factor
- 3 Ton and 3.5 Ton 14 SEER AC with TXV
- .92 AFUE furnace

Energy Efficient Features

The homes at Avignon meet the rigid energy-efficiency guidelines of ConSol's ComfortWise® program with properly designed heating and air conditioning systems, Andersen 400 Series HP low-emissivity spectrally selective glass windows, and tightly sealed air ducts. The homes are independently inspected for quality and performance of the insulation, caulking and sealing, windows, and heating and cooling ductwork. Inspections and tests are performed by ComfortWise home energy raters who are certified and monitored by either CalCerts or the California Home Energy Efficiency Rating System (CHEERS), both certified by the California Energy Commission.

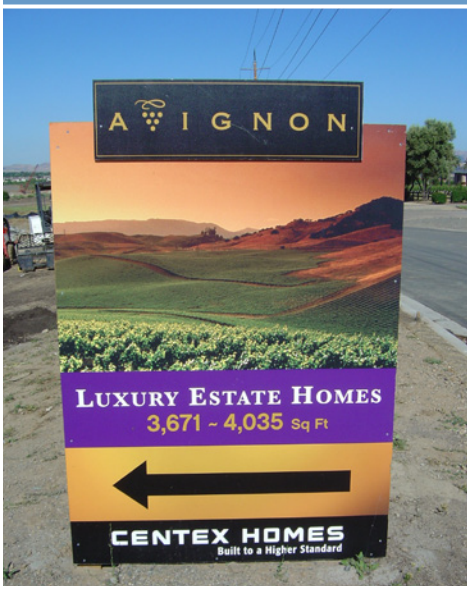
Additional energy-saving features at Avignon include R-49 attic insulation, with R-30 above the garage and within cantilevers, and R-15 wall insulation. Mechanical systems include two 14 SEER ACs with TXV (a 3-ton unit and a 3.5-ton unit) and a .92 AFUE furnace. Two on-demand tank-less water heaters with .82 energy factor should produce up to 8.5 gallons of hot water per minute, while saving up to 30% in energy costs per year over a standard water heater.

This is not the first time Centex has worked with ConSol. The Building America partner worked with Centex on several past projects including Windemere development in San Ramon where Centex is building 800 homes to the ComfortWise energy efficiency standards. According to ConSol, other Centex ComfortWise developments include communities in Paso Robles, Atascadero, San Luis Obsipo, Hanford, Claremont, Lake Elsinore, Corona, Murieta, and Fontana.

Centex has also worked with the Davis Energy Group, another Building America partner, to build three high-performance demonstration homes in Livermore and San Ramon. The experience taught the builder how to integrate solar thermal, PV, and energy efficiency into production buildings.

Rob Hammon, a principal at ConSol, pointed out that energy efficiency is a key element in designing a near-ZEH. "The house's overall energy use first must be dramatically reduced through a combination of super-efficient features and advanced construction practices. The use of these energy-saving building methods ensures that the addition of a relatively small photovoltaic (PV) solar system (typically 2.4 kilowatts in capacity) can effectively lower the electricity usage of a house by half or more compared to a typical new home," Hammon said in a *Solar Today* article (May/June 2005).

Hammon noted that a typical house has 20% to 30% duct leakage. In a near-ZEH, ductwork is sealed and super-insulated or placed in the conditioned space. Spectrally selective glazed windows reflect the sun's heat in summer and reduce heat loss in



About Centex Homes

Dallas-based Centex Homes (www.centexhomes.com) is one of the nation's leading home builders, operating in more than 90 U.S. markets in 25 states and delivering 33,387 homes in the United States in 2005. The company is a subsidiary of Centex Corporation (NYSE: CTX), a Fortune 250 company. Centex Corporation (www.centex.com), founded in Dallas in 1950, is one of the nation's premier companies in home building, financial services, home services and commercial contracting. Centex ranks No. 1 in its industry on FORTUNE magazine's 2005 list of "America's Most Admired Companies." Centex has been ranked "highest in customer satisfaction with new home builders in the San Francisco Bay Area" by JD Power and Associates in both 2005 and 2006.

winter. Carefully designed HVAC systems account for bends and turns in ductwork, register locations, duct length, connections and airflow. Other ways to "tighten up" residential energy consumption include improved ceiling and wall insulation, energy-efficient appliances and the use of fluorescent lighting. "All of these efforts are combined in a whole-house approach to designing and building the ZEH," said Hammon.

Dollars and Sense

Incentives are available to builders and to home owners. In January 2006, the California Public Utilities Commission (CPUC) adopted a program—the California Solar Initiative (CSI)—to provide more than $3 billion in incentives for solar projects with the objective of providing 3,000 MW of solar capacity by 2017 from residential and commercial projects combined. Homeowners will receive $2.50/Watt AC for residential systems, with the incentives awarded as a one-time, up-front payment based on expected system performance. Several counties offer incentives to builders including free technical advice and waiving of fees on solar projects; some counties offer rebates to homeowners on solar equipment.

There is also the federal $2,000 tax credit for homeowners who purchase solar electric and solar water heating systems as well as a $500 tax credit for those who purchase energy-efficient equipment like furnaces, air conditioners and water heaters. Also, many utilities in California offer a rebate for energy-efficient construction, usually $500 per house.

"We are typically spending $1,000 to $1500 per house to get to 20% above code. But we can market these homes at a premium," said Jacobs. Centex predicts homeowner energy bills at Avignon will be reduced by up to 70% each year.

"I don't expect any builder to lose money," said Jacobs. "You may have a desire to be a good steward of the environment but you also have to be responsive to your stockholders. There are strong environmental and societal reasons for building energy-efficient homes. But strong, sustainable building practices also help a builder differentiate themselves in a competitive marketplace, while still keeping focused on the bottom line. The American public has proven over and over that they are willing to pay more for it (energy-efficient construction)."

"We need to educate the buyer. If you are building houses and you start including photovoltaics, and tankless water heaters, and high-performance construction, your buyers are going to enjoy living in those homes because of lower operating costs, increased comfort, etc. We just need to educate homeowners to see what they are getting. The message they need to hear is 'You pay more but you get more,'" said Jacobs.

About SunPower

SunPower Corporation (formerly known as PowerLight) is a leading global provider of grid-connected solar electric power systems. SunPower's turnkey solutions for commercial, government and residential customers feature a full line of proprietary solar products and technologies designed to optimize energy output and project economics. Recognized by *Inc. Magazine* for five consecutive years as one of the 500 fastest growing privately held companies, SunPower designs, builds and operates many of the largest solar electric systems in North America and Europe. For more information about SunPower and its products and services, please visit www.sunpower.com.

Centex Avignon

(left top) Centex built one of the nation's first ZEH in Livermore, California, in 2002. The homeowners had not had to pay an electrical bill through 2004

(left bottom) Centex included solar water heaters and PV modules in the demonstration houses.

(right) This garage display shows how a solar-thermal system, storage tank, and instantaneous water heater are combined into a water heating package.

All photos above courtesy of NREL.

The Bottom Line

"I think it's our social responsibility to do it and it's not that hard to do. It's not 20 or 30 things you have to do, it's a handful of changes you need to make," said Jacobs. "With the energy codes out there (in California) everyone is already building a good house; with a few more things you can build a great house."

With construction quality like Centex is providing at Avignon, Jacobs feels he can assure buyers, "You are going to love it the day you move in because it's a great house. You are going to love it a year from now because we thought about comfort and operating cost." Jacobs suggests to builders, "You want buyers to be happy about it 5 or 6 years from now. You want buyers who will say 'I talked to my friends who bought a house from a different builder and they don't have everything I do with this house.'" For Jacobs, word of mouth recommendations like that make zero energy construction completely worth the effort.

Centex Demonstrates Zero Energy Homes for Building America Research

Centex has conducted some cutting edge research on zero energy homes working with the Davis Energy Group, a Building America partner. With their help, Centex completed a 3,080 sq ft home in Livermore, California, in 2002. As of 2005, homeowners had yet to pay an electric bill and had 45% lower natural gas bills for space and water heating than comparable homes in the area. The Livermore home featured both PV and solar thermal systems. Two Centex model homes in San Ramon, completed in 2004, reduced energy by 70%, cutting the homeowners' annual energy bills by $1900 each. Assuming that the total cost of the zero energy package is included in the mortgage and amortized at 6% for 30 years, the incremental annual cost is $1,440, or $480 less than what the annual utility bills would have been, resulting in a positive cash flow for the home owners. All three homes featured the NightBreeze ventilation system for evening cooling, a variable-speed air handler for space heating, radiant barrier roof sheathing, extensive insulation and air sealing, a 2.4 or 3.6-kW PV array, and a solar hot water heater.

For more information visit:
www.buildingamerica.gov