

**DOE CHALLENGE HOME
CASE STUDY****KB
Home**

San Marcos, CA

**BUILDER PROFILE****KB Home**

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FEATURED HOME/DEVELOPMENT:**Project Data:**

- Name: Haciendas at Rancho Santalina, ZeroHouse 2.0
- Location: San Marcos, CA
- Layout: 4 bedrooms, 2.5 baths, 2 floors
- Conditioned Space: 2,778 ft²
- Completion: March 2013
- Climate Zone: 3
- Category: Production

Performance Data:

- HERS Index without solar PV: 52
- HERS Index with solar PV: -4
- Projected annual utility costs: without solar \$1,601, with solar \$-182
- Projected annual energy cost savings (compared to a home built to the 2006 IECC): without solar \$2,000
- Builder's added cost over standard construction: with solar \$50,000
- Annual energy savings: 13,751 kWh, 192 Therms

KB Home, based in Los Angeles, CA, has made a corporate commitment to build all of its homes nationwide to meet the ENERGY STAR for Homes Version 3 specifications. In 2012 this resulted in more than 6,200 new ENERGY STAR-certified homes for the builder, who ranked fifth in the nation on *Builder Magazine's* 2012 Top 100 ranking of U.S. home builders based on number of housing starts. In 2013 KB Home took high performance to the next level by building its first U.S. Department of Energy (DOE) Challenge Home. The home is one of KB Homes' ZeroHouse 2.0 models, a net-zero-energy home that produces more energy each year than it consumes.

"It is an honor to have built the first U.S. Department of Energy Challenge Home in California, where KB Home is headquartered and where we are the largest home builder by sales," said Steve Ruffner, president for KB Home's Southern California division. "Working with the Challenge Home is a natural progression for KB Home as we strive to further differentiate ourselves as a leading environmentally friendly company."

With its stucco finish and Spanish Colonial detailing, this 2-story, 2,778-ft² home blends in with its neighbors at KB Home's Haciendas at Rancho Santalina development in San Marcos, CA. However, behind this traditional facade, a high-performance building envelope, state-of-the-art energy-saving technologies, and a 5.52-kW solar photovoltaic system combine to save the homeowners so much on their electric bill, they are actually estimated to receive an annual credit of \$182.

"Our ZeroHouse 2.0 model in San Marcos, CA, combines the best of energy and water efficiency as stipulated by the U.S. Department of Energy's Challenge Home program," said Ruffner. "It is the result of a whole-house approach that begins with increased insulation, upgraded HVAC systems, and high-performance windows, and ends with solar panels on the roof."



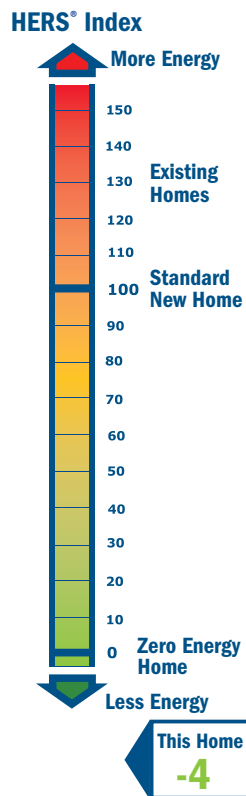
DOE Challenge Home builders are in the top 1% of builders in the country meeting the extraordinary levels of excellence and quality specified by the U.S. Department of Energy. Every DOE Challenge Home starts with ENERGY STAR for Homes Version 3 for an energy-efficient home built on a solid foundation of building science research. Then, even more advanced technologies are designed in for a home that goes above and beyond current code to give you the superior quality construction, HVAC, appliances, indoor air quality, safety, durability, comfort, and solar-ready components along with ultra-low or no utility bills. This provides homeowners with a quality home that will last for generations to come.

KB Home's first DOE Challenge Home has solar thermal water heating, air-tight construction, well-insulated walls, and a highly efficient HVAC system located in the home's insulated attic. The home is so energy efficient that with the solar photovoltaic panels on the roof it produces enough power to meet all the home's electricity needs with some left over to power an electric car charging station in the garage.



CHALLENGE HOME CERTIFIED:

- 1 **BASELINE**
certified ENERGY STAR for Homes Version 3.0
- 2 **ENVELOPE**
meets or exceeds 2012 IECC levels
- 3 **DUCT SYSTEM**
located with the home's thermal boundary
- 4 **WATER EFFICIENCY**
meets or exceeds the EPA WaterSense Section 3.3 specs
- 5 **LIGHTING AND APPLIANCES**
ENERGY STAR qualified
- 6 **INDOOR AIR QUALITY**
meets or exceeds the EPA Indoor airPLUS Verification Checklist
- 7 **RENEWABLE READY**
meets EPA Renewable Energy-Ready Home.



The whole-house approach includes tightly sealed and highly insulated walls. The 2x4 24-inch on-center stud walls are air sealed with a non-hardening sealant that is applied with a proprietary powered applicator. A ¼-inch bead is applied along the surfaces of all top and bottom plates, corner studs, and door and window framing to form a compressible gasket-like seal between the studs and the drywall. The sealant is also used to seal holes around piping and wiring and joints at rim joists and between top and bottom plates and exterior sheathing.

To insulate the walls, the wall cavities were filled with R-15 fiberglass batts then covered on the exterior with R-4 of continuous rigid foam insulation. This rigid foam was covered with a breathable house wrap product with a grooved surface specifically designed to serve as a drainage plane under stucco. The house was clad with one-coat stucco. To adequately accommodate and insulate plumbing pipes, a few walls are 2x6 and insulated with R-19 batts.

Rather than piling insulation onto the attic floor, the builder chose to insulate the attic along the underside of the roofline. Netting was attached to each rafter and the rafter bays were filled with R-22 of blown insulation. This insulation protects the attic from heat gain and provides a conditioned space for the HVAC equipment and ducts. Any holes through the attic floor for ducts, wiring, plumbing, and flues are sealed with the applicator-applied non-hardening sealant. The roof deck was covered with a liner and flashing then topped with special “smog-eating” concrete roof tiles that help offset the air pollution from cars and trucks. Each roof tile contains an embedded material that, when exposed to sunlight, speeds up oxidation and reduces the nitrogen oxide pollution that creates smog.

The foundation is slab-on-grade. The between-floor cavities are filled with R-30 fiberglass batts.

The home's windows are highly efficient dual-pane glass. The space between the panes is filled with argon gas and the frames are insulated. The windows have an insulation U value of 0.28 and a solar heat gain coefficient (SHGC) of 0.27. The windows are coated with a low-emissivity coating that reduces radiant heat loss in winter by up to 30%, minimizes solar heat gain in the summer, and protects against UV glare. The builder is careful to integrate the flashing around the windows and doors with the house wrap and other layers of water protection.



All of the lighting in the Challenge Home uses highly efficient LEDs. All of the plumbing fixtures are EPA WaterSense labeled. The home's dishwasher, clothes washer, and refrigerator all carry the ENERGY STAR label, as does the home itself. It is one of more than 75,000 ENERGY STAR rated homes across the country that have been built by KB Home.

Like all homes that are certified as DOE Challenge Homes, this house had to undergo extensive third-party testing and visual inspections at key points during construction. A blower door test was conducted to determine whole-house air leakage, or how much air might be leaking through unintended cracks and crevices in the building shell. KB Home's Challenge Home achieved an air tightness score of 1.74 air changes per hour at 50 Pascals of pressure (ACH50), well within the 2.5 ACH50 maximum for Challenge Home.

Within this tightly sealed and well insulated envelope, a right-sized heat pump provides heating with an efficiency level of 9 HSPF and cooling with an efficiency level of 16 SEER. Ducts, which are sealed and insulated to R-6, are located within the conditioned space in the attic. Exhaust-only ventilation is provided with continuously operating ENERGY STAR bathroom exhaust fans to ensure that humidity is removed from the home.

Hot water is provided by a solar thermal system. The two solar panels (54.1 ft²) mounted on the south-facing side of the roof heat water for a 75-gallon storage tank. In the unlikely event that this system does not provide enough hot water, the backup is a tankless gas water heater (with an energy factor of 0.82).

With all of the energy-efficiency measures installed, but without including the renewable-ready technologies, the home earns a Home Energy Rating System (HERS) score of 52, which is 48 points better than a comparably sized home built to code. "From our work with ENERGY STAR, we have continued to raise the bar by offering homes with solar power systems, and now we have solar power as standard at select KB Home communities," said Ruffner.

For this Challenge Home, the south-facing solar panels are installed on a 5:12 pitch roof at a 181-degree azimuth. The system includes 24 230-watt modules, which are rated at 18.5% panel efficiency. The system uses a 6000-watt-capacity inverter with 97% peak efficiency.

In the Southern California climate, this solar assembly produces more power than it consumes for a total HERS score of -4 (4 points below zero). One use for the excess power is the electric vehicle charger, which is located in the garage and is connected to an energy management system for in-house energy monitoring. The system enables the homeowner to track energy and water usage and energy production from a computer or smart phone.

HOME CERTIFICATIONS:

DOE Challenge Home

ENERGY STAR Version 3

EPA WaterSense



Every DOE Challenge Home combines building science specified by ENERGY STAR for Homes and advanced technologies and practices from DOE's Building America research program.

KB Home estimates that an additional \$50,000 takes a code-built home to a net zero-energy home. San Diego Gas and Electric is working with KB Home to carefully evaluate the incremental cost of building a net zero-energy home.

For the first time, KB Home included grid-connected ENERGY STAR Smart appliances in this home. When integrated with a utility program, these appliances can shift energy consumption to off-peak times, which can lower electric bills for homeowners that have time-of-use rates while helping the utilities to manage electricity loads. The appliances can also be controlled by the homeowner while away from the house. Other features that can be controlled remotely from a cell phone or computer are the thermostats, 100% LED lighting, front door lock, and the home security system. The home owner can also remotely view activity around the front door.

The Challenge Home has a weather-based smart irrigation system. The landscaping is done with drought-tolerant and non-invasive plants. This home earned an EPA WaterSense label by installing WaterSense-labeled faucets, toilets, and showerheads, which use up to 30% less water than standard models and an on-demand hot water recirculation system.

In 2012, KB Home expanded the nationwide rollout of its ZeroHouse 2.0 to Lake Forest, California; Las Vegas, Nevada; Denver, Colorado; Houston, Texas; and Washington, D.C. ZeroHouse 2.0 options are now available in nearly all of its divisions as a whole-home package as well as a la carte choices at the KB Home Studio.

To achieve the ZeroHouse 2.0's full net-zero energy level of efficiency, KB Home uses an approach it refers to as "reduce before you produce," starting with advanced building techniques and higher efficiency products, thus "reducing" the energy required to live in the home. In most cases, this means achieving a HERS score between 40 and 50, without solar. Once the energy consumption is reduced, solar is added to "produce" whatever energy is still needed. ZeroHouse 2.0 a la carte options that home buyers have selected include solar power systems, solar thermal water heaters, upgraded windows, enhanced insulation and weatherization systems, LED lights, and higher efficiency HVAC systems.

In addition to achieving superior levels of energy efficiency and net-zero energy status, the ZeroHouse model homes are also proving grounds for new technologies, techniques, and sustainable products, such as water-efficient features and recycled materials. KB Home is working with Oak Ridge National Laboratory, through the DOE Building America Program, to monitor energy production and usage at the Challenge Home in San Marcos.

"Partnering with the U.S. Department of Energy's Challenge Home program has helped guide our company's sustainability initiatives and provided a rubric for increasing our home's energy and water efficiency, quality, and durability," said Ruffner.

KEY FEATURES

- **Path:** performance
- **Above-Grade Walls:** 2x4 24-inch on-center framing; R-15 fiberglass batts; R-4 rigid foam; corrugated housewrap; one-coat stucco
- **Roof:** R-22 blown-in insulation netted at underside of roof deck, cement "smog eating" tiles
- **Foundation:** slab on grade
- **Windows:** low-E, dual-pane, argon gas-filled windows (U=0.28, SHGC=0.27)
- **Air Sealing:** 1.74 ACH 50
- **Ventilation:** exhaust-only, continuous
- **HVAC:** 12 EER/9 HSPF/16 SEER air source heat pump; R-6 ducts in sealed insulated attic
- **Water Heating:** solar thermal with a 75-gallon tank; backup tankless gas (.82 EF)
- **Lighting:** 100% LED
- **Solar:** 5.52 kW roof-mounted
- **Appliances:** grid-connected ENERGY STAR smart appliances
- **Water Conservation:** EPA WaterSense fixtures; on-demand hot water recirculation system; drought-tolerant plants; smart irrigation controller
- **Other:** energy management system; home automation system; electric vehicle charger in garage