U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

DOE ZERO ENERGY READY HOME™

U.S. DOE ZERO ENERGY READY HOME 2015 WINNER Housing Innovation Awards

KB Home

Double ZeroHouse 3.0
El Dorado Hills, CA

BUILDER PROFILE

KB Home, Roseville, CA
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Rater: Energy Inspectors
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Double ZeroHouse 3.0
- Location: El Dorado Hills, CA
- Layout: 3 bedrooms, 2 baths, 1 floor
- Conditioned Space: 2,612 ft^2
- Climate Zone: IECC 4B, mixed-dry
- Completion: September 2014
- Category: Production

Modeled Performance Data:

- HERS Index: without PV 44, with PV -2
- Projected Annual Utility Costs: without PV $2,114, with PV $-73
- Projected Annual Energy Cost Savings (compared to a home built to the 2012 IECC): without PV $262, with PV $2,449
- Builder's Added Cost Over 2012 IECC: without PV $19,000, with PV $38,000
- Annual Energy Savings: without PV 1,312 kWh, with PV 12,250 kWh

KB Home, one of the nation's largest home builders, completed construction of its second Double ZeroHouse in California in October 2014. The single-story 2,612-ft^2 3-bedroom home, which is located at KB Home's Fiora at Blackstone community in El Dorado Hills, earns its "Double" ZeroHouse title through its dual emphasis on water conservation and energy efficiency.

Like KB Home's previous ZeroHouse 2.0 models, the Double ZeroHouse 3.0 at Fiora is designed to achieve net-zero energy usage, producing as much electricity as it consumes annually. This is the result of a whole-house approach to first reduce the energy load of the home by incorporating advanced features and systems like increased insulation; upgraded HVAC units; high-performance windows; and LED lighting. Once these energy-saving features are in place, solar electric panels are added. With the inclusion of solar technology, together with the home's other energy- and water-efficient elements, KB Home's Double ZeroHouse 3.0 at Fiora provides an estimated energy and water savings of up to $4,500 annually compared to a typical resale home.

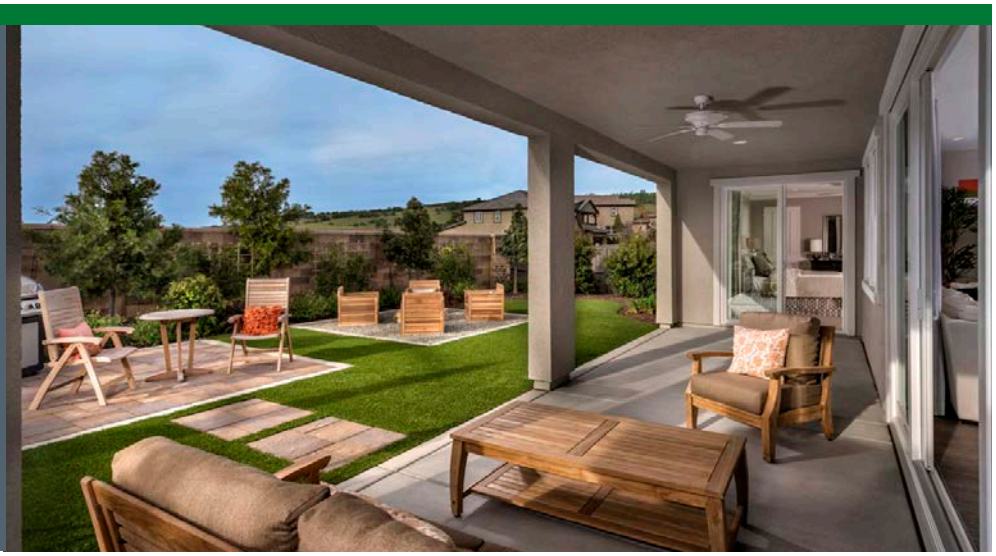
The KB home meets the rigorous energy-efficiency requirements of the U.S. Department of Energy's Zero Energy Ready Home program including certification to ENERGY STAR Certified Homes Version 3.0, the U.S. Environmental Protection Agency's Indoor airPLUS program, the hot water distribution requirements of the EPA WaterSense program, and the insulation requirements of the 2012 International Energy Conservation Code. In addition, homes are required to have solar electric panels installed or have the conduit and electrical panel space in place for it.

The home is also labeled through the EPA's WaterSense program. The house is equipped with an integrated home water and energy recycling system. Warm grey water from showers, which studies have indicated may account for two out of

ZERO ENERGY READY HOME U.S. DEPARTMENT OF ENERGY

The U.S. Department of Energy invites home builders across the country to meet the extraordinary levels of excellence and quality specified in DOE's Zero Energy Ready Home program (formerly known as Challenge Home). Every DOE Zero Energy Ready Home starts with ENERGY STAR Certified Homes Version 3.0 for an energy-efficient home built on a solid foundation of building science research. Advanced technologies are designed in to give you superior construction, durability, and comfort; healthy indoor air; high-performance HVAC, lighting, and appliances; and solar-ready components for low or no utility bills in a quality home that will last for generations to come.

KB Home built this single-story home in El Dorado Hills to the performance criteria of the DOE Zero Energy Ready Home program. KB Home designed the landscape to minimize any site water runoff, using vegetation and ground cover to slow excess water and help it percolate into the ground to replenish aquifers. The home features California-friendly plants, drought-tolerant landscaping, and ground cover that reduces site water runoff. Weather-sensing irrigation controllers minimize water usage.



What makes a home a DOE ZERO ENERGY READY HOME?

1 **BASELINE**
ENERGY STAR Certified Homes Version 3.0

2 **ENVELOPE**
meets or exceeds 2012 IECC levels

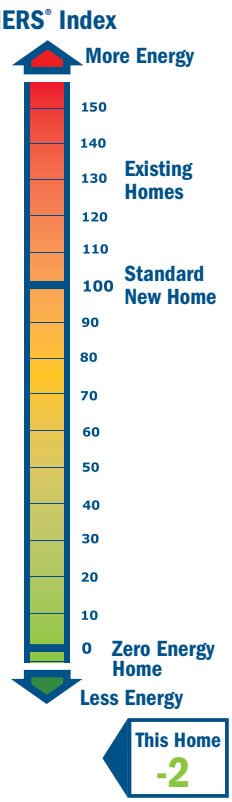
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



every three gallons of indoor water, is normally treated as waste and sent straight to the sewer. The water recycler uses the energy in this warm water and treats the water on-site for reuse in non-potable applications. In the case of the Double ZeroHouse 3.0 at Fiora, the water recycler will supply recycled drainwater to all of the home's toilets, meaning they will use zero fresh water in a household of four or more. They will also transfer heat from the recycled water to heat the home's fresh water. The home also has a real-time water meter that allows home owners to track water usage. Other water-conserving features in the home include a first-of-its-kind water-recycling dishwasher, WaterSense-labeled bathroom fixtures, and a water-efficient touchless kitchen faucet, a water-saving clothes washer, and water-wise landscaping.

With all of these water-saving features together, KB Home estimates that the Double ZeroHouse 3.0 at Fiora can conserve as much as 70% of the fresh water that would traditionally be used in a typical resale home.

The 7.0-kW photovoltaic solar electric system has helped this home achieve net-zero energy by providing clean, renewable solar power to offset the power needs of the home, including the electric car charging station in the garage. The Double ZeroHouse 3.0 home also has a solar-integrated energy storage system designed to power the critical parts of the home using backup solar/battery electricity. The advanced systems extend the solar system's existing capabilities by storing excess solar power generated during the day for use in the event of a power outage.

The home includes other state-of-the-art features like a renewable energy production tracking and energy storage management system that can be accessed via a smartphone app. Also, load management features are built into the programmable thermostat and systems that work with the thermostat, including a high-efficiency clothes washer and dryer. Both the washer and dryer can keep clothes fresh if a cycle ends while the consumer is not at home. The dryer can also switch into a slightly longer, more energy-efficient cycle if the resident is away. In addition, the washer and dryer can automatically delay the start of a cycle during high-demand energy periods.

"Our Double ZeroHouse 3.0 demonstrates what is possible when like-minded companies come together with the shared goal of pioneering a more sustainable future - a 'smarter' home that is water smart, energy smart, and systems smart," said Chris Apostolopoulos, president of KB Home's Bay Area division and regional general manager.

Netting holds the R-38 of blown fiberglass insulation up against the underside of the roof decking, providing a sealed conditioned space for the home's high-efficiency heat pump. KB Home added a moisture barrier to the netting and installed moisture sensors to track environmental data in this location, which is cooler and damper than other locations where KB Home has installed the netted insulation.

The Double ZeroHouse 3.0 at Fiora connects a host of smart home technologies into one intelligent ecosystem, enabling home owners to control much of their home's equipment from a smartphone or tablet. The "smarter' Double ZeroHouse 3.0 at Fiora shows how a typical American family can significantly reduce their electricity bills and CO_2 footprint by integrating today's smart home appliances, plug-in vehicles, and solar energy with the electric car company's proprietary database of utility rates to perform tasks when electricity costs are lower. The system works by leveraging the cloud so key energy-consuming devices in a home use less energy, while also shifting energy usage to less expensive periods.

KB Home celebrated completion of the Double ZeroHouse 3.0 with an event at the home that included officials from the State of California, El Dorado County, its trade partners, and students from Sacramento State University.

"The energy performance this home achieves is truly remarkable, and we commend KB Home for continuing to champion the use of clean, renewable energy and cutting-edge technologies to help meet California's growing demand for highly-efficient homes," said California Energy Commissioner Andrew McAllister, who was present at the ceremony.

"It is a pleasure to be able to join KB Home and its partners to unveil this incredibly resource-efficient home," said California Energy Commissioner David Hochschild. "Renewability will play a critical role in California's energy future, and thanks to forward-thinking companies like KB Home and those present today, we are one step closer to building a stronger, more sustainable California."

All KB homes at Fiora, even those that are not at the Double ZeroHouse 3.0 standard, will be built to ENERGY STAR® and WaterSense for New Homes criteria. All of the homes also have solar PV systems. KB Home's Double ZeroHouse 3.0 at Fiora far exceeds WaterSense and ENERGY STAR efficiency standards, and is Indoor airPLUS certified.

The highly efficient Double ZeroHouse 3.0 achieved a Home Energy Rating System (HERS) score of 44 without PV or -2 with PV. The highly efficient home starts with a slab-on grade foundation wrapped with R-20 of rigid foam insulation around the slab edges.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program, 100% commitment

ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

EPA WaterSense

GreenPoint Rated, platinum level

"The DOE program's best practices were invaluable in guiding KB Home in the construction of the Double ZeroHouse."
—Jacob Atalla, Vice President of Sustainability for KB Home.

Every DOE Zero Energy Ready Home combines a building science baseline specified by ENERGY STAR Certified Homes with advanced technologies and practices from DOE's Building America research program.

A greywater recycling system is one of many innovative features in the Double ZeroHouse 3.0.

The 2x4 16-inch on-center framed walls used advanced framing details like 2-stud corners, insulated headers, and ladder blocking at intersecting walls to provide more space in the walls for the R-15 dense-packed cellulose. A continuous layer of 1-inch-thick (R-4) EPS foam board is installed on the exterior walls. The taped rigid foam serves as a drainage plane behind the California one-coat stucco.

The unvented attic is insulated along the underside of the roof deck with R-38 of blown fiberglass, which is held in place with netting. KB Home had tested this technique in drier climates, but wanted to try it in a mixed-dry climate like El Dorado Hills. KB Home installed sensors in the attic to track moisture and used netting with a moisture barrier to keep condensation away from the insulation. All top plate-to-drywall seams, all wood-to-wood joints, and any holes through the attic floor were thoroughly air sealed with a sprayer-applied sealant to keep conditioned air from escaping into the attic and bringing moisture with it.

Like all DOE Zero Energy Ready Homes, this home was third-party inspected and tested. Blower door testing showed that the home had an air leakage level of only 2.48 air changes per hour at 50 Pascals of pressure.

To provide fresh air to the draft-free home, an energy recovery ventilator (ERV) was installed. The ERV is connected to the return side of the central air handler and operates continuously to bring fresh air into the home. Fresh air is brought in through one duct while a separate duct takes stale air from the home. Both ducts pass through a heat exchanger where heat is transferred from the warmer air to cooler air. Humidity is also transferred from the more humid air stream to the less humid air, which helps to minimize the amount of humidity that enters the home.

The home's high-performance two-stage central air source heat pump system is located in the sealed, conditioned attic. The heat pump has a cooling efficiency of 19 SEER, far exceeding the federal minimum of 13 SEER. A heat pump water heater provides domestic hot water at a 4.0 COP or 2.5 EF.

All of the home's lighting is LED based. A lighting control system allows the home owner to adjust lighting levels remotely from any internet-connected device. ENERGY STAR certified ceiling fans were installed in the home's bedrooms. The home's refrigerator and dishwasher are ENERGY STAR rated. The water-recycling dishwasher uses 33% less water than other highly efficient dishwashers by saving water from the last rinse cycle for use in the first prerinse cycle of the next load.

Photos courtesy of KB Home

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance.
- **Walls:** 2x4; 16″ on center; high density insulation (R-15); 1″ EPS exterior foam board (R-4).
- **Roof:** Roof tile.
- **Attic:** Unvented; insulated on underside of roof deck (R-38); sprayer applied sealant at all joints at penetrations.
- **Foundation:** Slab on grade; slab insulation (R-10).
- **Windows:** Triple-pane; vinyl windows (R-5); U=0.28; SHGC=0.21.
- **Air Sealing:** 2.48 ACH 50.
- **Ventilation:** ERV connected to central air handler; MERV 8 filter.
- **HVAC:** Two-stage heat pump; 19 SEER.
- **Hot Water:** Air source heat pump.
- **Lighting:** 100% LED.
- **Appliances:** ENERGY STAR-rated refrigerator, dishwasher, and ceiling fans.
- **Solar:** 7.0 kW; battery storage.
- **Water Conservation:** EPA WaterSense-certified home; grey water recycling; drought tolerant landscaping.
- **Other:** Energy management system; battery backup tied to solar; low-VOC.

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