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

DOE ZERO ENERGY READY HOME™

U.S. DOE ZERO ENERGY READY HOME 2014 WINNER Housing Innovation Awards

KB Home

Double ZeroHouse
Lancaster, CA

BUILDER PROFILE

KB Home
Los Angeles, CA
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Double ZeroHouse
- Location: Lancaster, CA
- Layout: 5 bedrooms, 3 baths, 2 floors
- Conditioned Space: 2,537 ft^2
- Climate Zone: IECC 3B, hot-dry
- Completion: January 2014
- Category: Production

Modeled Performance Data:

- HERS Index: without PV 43, with PV 0
- Projected Annual Utility Costs: without PV $2,049, with PV $633
- Projected Annual Energy Cost Savings (compared to a home built to the 2009 IECC): without PV $361, with PV $2,698
- Builder's Added Cost Over 2009 IECC: $50,000
- Annual Energy Savings: without PV 5,799 kWh, 570 therms; with PV 18,835 kWh, 570 therms

An electric car charging station in the garage powered by 6.9 kW of solar panels on the roof, a compressed natural gas (CNG) car fueling station, a greywater recycling system, and smart appliances mark KB Home's Double ZeroHouse located in Lancaster, California, north of Los Angeles, as a home of the future.

Since its founding in 1957, Los Angeles-based KB Homes has built more than 555,000 homes nationwide, but this is the company's first "Double ZeroHouse." The double zero refers both to the home's designation as a net zero energy home and to the fact that the home uses zero fresh water for irrigation. The home produces as much energy in a year as it uses and gets all the irrigation water it needs from an onsite greywater recycling system.

The home has also been certified by the U.S. Department of Energy as meeting all of the energy efficiency requirements of the DOE Zero Energy Ready Home program. To be certified, a home must meet the energy and durability requirements of ENERGY STAR Certified Homes Version 3.0, the insulation requirements of the 2012 International Energy Conservation Code, and the indoor air quality and water saving requirements of the U.S. Environmental Protection Agency's Indoor airPLUS and WaterSense programs. In addition, the home must have solar photovoltaics (PV) installed or have the conduit and electric panel space in place for it.

KB Home qualified its first DOE Zero Energy Ready home in 2013. That home, the "Zero House 2.0" in San Marcos, achieved a Home Energy Rating System (HERS) score of HERS 52 without PV or -4 with PV. The Double ZeroHouse in Lancaster scores a HERS 43 without PV or HERS 0 with PV.

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 installed double-pane windows that have low-emissivity coatings to reduce the amount of glare and heat that come through the windows. Low-VOC paints, finishes, and carpets keep harmful gases out of the air.

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

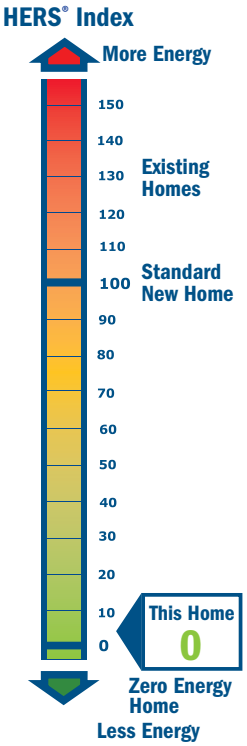
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



The Double ZeroHouse is one of 56 single-family homes KB plans to build at its Dawn Creek community in Lancaster. All of the homes at Dawn Creek will be built to the ENERGY STAR Certified Homes Version 3.0 criteria. Since joining ENERGY STAR in 2000, KB Home has built more than 85,000 ENERGY STAR certified homes nationally. All of the homes at Dawn Creek will include a 1.4-kW PV system, EPA WaterSense-labeled fixtures, and a slew of other sustainable features including ENERGY STAR-rated lighting and appliances, PEX plumbing with mini manifolds for efficient hot water distribution, low-VOC paints and carpets, and MERV 8 air filters. Homebuyers will have the option to upgrade to a larger PV system and additional energy-efficiency features to achieve true net zero energy. The greywater recycling system is also offered as an optional upgrade.

All KB Homes at Dawn Creek feature a built-in home energy management system that allows homeowners to track energy usage in real-time remotely from a smartphone or tablet. The system can be expanded with optional upgrades like smart thermostats, lighting controls, and Internet-connected door locks at additional cost. A built-in USB outlet in the kitchen provides a convenient charging station for electronics. The KB Home Design Studio offers smart appliances that can be programmed to run energy-intensive tasks at off-peak hours. Electric vehicle charging stations are another optional upgrade.

KB Home began including solar as a standard feature at select Southern California communities in 2011, and today all of the builder's new neighborhoods in Lancaster, California, feature photovoltaic systems. The builder's first solar standard community in Lancaster, Arroyo, completed in 2011, included 90 ENERGY STAR-rated homes equipped with PV panels. The homes at Dawn Creek include one- and two-story plans, ranging in size from 1,773 to 3,206 ft^2, with four to six bedrooms, two to four baths, and two-car garages. Prices begin at $244,000 to $287,990, depending on the home design. In 2013 KB Home delivered 2,179 homes in its West Coast region, which encompasses all of California.

The Double ZeroHouse at Dawn Creek was KB Home's second home certified to the DOE Zero Energy Ready Home program and its fourth DOE certified home (it had certified two homes to the previous DOE Builders Challenge). "We use the Department of Energy's Zero Energy Ready Home program to research emerging technologies and advancements in building techniques," said Jacob Atalla, vice president of sustainability at KB Home. "The program's best

KB Home's Double ZeroHouse is equipped with energy-saving lighting and appliances and water-saving fixtures. A high-efficiency tankless water heater provides both domestic hot water and space heating for the well insulated and air-sealed home.

practices were invaluable in guiding KB Home in the construction of the Double ZeroHouse and will continue to serve as important resources for future KB Home innovations."

To meet the strict DOE performance requirements, KB Home combined standard construction techniques with good installation practices and high-performance technologies. They started with an uninsulated slab on grade foundation with a properly sloped and drained site.

Most of the home's exterior walls were framed with 2x4s spaced 16 inches on center. Any walls containing plumbing were built with 2x6 framing to allow space to fully insulate behind the plumbing. Advanced framing techniques, including open or insulated headers over windows and doors, two-stud corners, and ladder blocking at interior-exterior wall intersections, were used to maximize the amount of wall cavity space available for insulation. The 2x4 wall cavities were filled with R-15 formaldehyde-free, high-density fiberglass batt insulation. Rigid polyisocyanurate foam board was installed on the exterior of the walls to provide a continuous layer of R-4 insulation, stopping any thermal bridging between the inside and outside of the home. The rigid foam was taped at the seams to serve as a drainage plane and air barrier. The home was then sided with stucco.

KB Home used a sprayer-applied sealant to seal all holes through the walls, ceiling, and top and bottom plates. A bead of the sealant was also applied to the top and bottom plates to form a pliable airtight gasket between the plate and the drywall. This sprayer-applied sealant was also used to seal all the seams in the roof decking before the attic insulation was installed. The Double Zero Home has an unvented attic that was insulated on the underside of the roof decking by stapling netting to the lower side of the roof trusses and filling the space with blown fiberglass, a technique which works in this dry climate.

The home was tested for air leakage and showed a whole-house air leakage of 2.04 air changes per hour at 50 Pa (ACH 50), far tighter than the 7.0 ACH 50 specified by the 2009 IECC. Advanced insulation and air sealing work together to form an integrated blanket and wind breaker for the home.

An energy recovery ventilator (ERV) provides continuous fresh air and ventilation to the home. The ERV has two ducts to the outside: one to bring in fresh air and one to exhaust stale air. The two air paths cross in a heat exchanger where heat is transferred from the warmer air stream to the cooler air stream. KB Home

HOME CERTIFICATIONS

- DOE Zero Energy Ready Home Program
- ENERGY STAR Certified Homes Version 3.0
- EPA Indoor airPLUS
- EPA WaterSense

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.

installed the ERV in the sealed attic with the other HVAC equipment. The ERV was integrated with the air handler for both supply and return air. The home has a 16 SEER air conditioner and fan coil heating system.

The home's high-efficiency 0.92-EF tankless water heater produces domestic hot water and supplies hot water to the fan coil for space heating. To conserve water in this water-conscious location, the home is equipped EPA WaterSense-labeled fixtures and a motion-sensing kitchen faucet. A real-time meter allows homeowners to track water usage.

The home was also equipped with a greywater recycling system that collects and cleans drain water from the showers, clothes washer, and bathroom sinks for yard irrigation. The system is expected to recycle up to 40,000 gallons of water annually for a family of four. A heat recovery device on the drain pipe enables heat from the drain water to pre-heat fresh water for the tankless water heater.

Water-recycling technology is also featured in the home's dishwasher, which uses 33% less water than other highly efficient dishwashers by saving water from the last rinse cycle for use in the first pre-rinse cycle of the next load. The dishwasher and refrigerator are ENERGY STAR-rated. All of the home's lighting is LED-based.

All of the windows in the home are dual-pane, argon gas-filled, vinyl-framed windows with low-emissivity coatings to help regulate indoor air temperature and reduce radiant energy loss, ultraviolet radiation, and glare. The windows have an insulation value equivalent to about an R-5. Specific U factors and solar heat gain coefficients (SHGC) varied depending on the use but ranged from a U factor of 0.26 to 0.29 and an SHGC of 0.19 to 0.22.

The "fuel-forward" garage features an electric vehicle charging station as well as a compressed natural gas filling station. The upgraded home energy management system allows homeowners to track their energy consumption from any internet-connected device, as well as to control door locks, lighting, the thermostat, and security functions.

"Because so many of the technologies in the home were being installed for the first time for us, we held a pre-construction conference with all of the products' manufacturers and our existing trade partners to strategize the building process," said Atalla. "While all KB Homes are quality inspected and third-party tested, several additional inspections were conducted at the Double ZeroHouse to ensure optimal airtightness and performance."

"The response to our Double ZeroHouse has been tremendous," said Atalla. "It has resulted in substantial local, national, and international media coverage, with over 213 million impressions garnered and an estimated advertising value of more than $7.1 million, in addition to generating significant interest from municipalities, nonprofits, and policy-influencing organizations, as well as the general public."

Photos courtesy of KB Homes.

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance
- **Walls:** 2x4 with R-15 fiberglass batt plus R-4 polyisocyanurate foam board; sprayer applied sealant at top and bottom plates and all holes
- **Attic:** Sealed, insulated under roof deck with netted R-30 blown fiberglass; reflective tiling
- **Foundation:** Uninsulated slab-on-grade
- **Windows:** Dual-pane, argon gas-filled low-e, U=0.26 to 0.29, SHGC=0.19 to 0.22
- **Air Sealing:** 2.04 ACH 50
- **Ventilation:** ERV
- **HVAC:** 16 SEER air conditioner, hydronic fan coil combo with domestic hot water; airhandler and ducts in conditioned attic
- **Hot Water:** 0.92 EF tankless water heater; greywater heat recovery device extracts heat from warm drainwater to preheat water for tankless water heater
- **Lighting:** 100% LED
- **Appliances:** ENERGY STAR dishwasher and refrigerator
- **Solar:** 6.9 kW PV
- **Water Conservation:** greywater recycling of shower water for irrigation; water-recycling dishwasher; real-time water meter tracks water usage; WaterSense labeled bathroom faucets, toilets, and showerheads, motion-sensing kitchen faucet
- **Other:** energy management system tracks energy consumption from any internet connected device, controls door locks, lighting, thermostat, and security functions; electric car charging station, compressed natural gas car filling station

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