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

Clifton View Homes

Kaltenbach Residence, Clinton, WA

BUILDER PROFILE

Clifton View Homes
Coupeville, WA
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Kaltenbach Residence
- Location: Clinton, WA
- Layout: 3 bedrooms, 2.5 baths, 2 floors
- Conditioned Space: 2,408 ft^2
- Climate Zone: IECC 4C, marine
- Completion: August 2013
- Category: Custom

Modeled Performance Data:

- HERS Index: without PV 37, with PV -13
- Projected Annual Utility Costs: without PV $913, with PV $-187
- Projected Annual Energy Cost Savings (compared to a home built to the 2012 IECC): without PV $1,554, with PV $2,654
- Builder's Added Cost Over 2012 IECC: without PV $25,000, with PV $57,000
- Annual Energy Savings: without PV 15,181 kWh, with PV 27,168 kWh

Custom home builder Ted Clifton's reputation for quality construction has gotten him a lot of leads in and around Whidbey Island, Washington, but zero energy seals the deal. "Once home buyers realize that they can have a zero energy house for the same cost as a regular house, they don't want to go anywhere else," said Clifton.

Clifton, founder of Clifton View Homes, offers net zero energy homes and home designs. Clifton has been building high-performance homes since 2005 when the Federal tax credit was offered for homes that were 50% above code. Once he mastered the 50% efficiency level, Clifton realized he was so close to zero energy that net zero became his next goal. In 2011, Clifton built his first house that could power both the house and the car. "That is our goal now on all of our homes," said Clifton. Clifton also certifies every home he builds to the strict efficiency, durability, and health requirements of the U.S. Department of Energy's Zero Energy Ready Homes program.

The DOE Zero Energy Ready Home program is a home labeling program that recognizes builders for meeting a host of efficiency criteria to produce a home so energy efficient that a small amount of PV panels will get the home to true net zero energy. The program requires builders to meet all of the checklists of the ENERGY STAR Certified Homes Version 3.0, the insulation requirements of the 2012 International Energy Conservation Code (IECC), the U.S. Environmental Protection Agency's Indoor airPLUS and WaterSense requirements, additional DOE Zero Energy Ready Home efficiency requirements, and "renewable-ready" measures that ensure the home is ready for solar photovoltaics and water heating when the homeowner is ready to install them.

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.

Clifton View Homes used an insulated concrete forms (ICF) foundation for this sloped lot on Whidbey Island in Washington State. The R-25 ICFs, plus R-20 of rigid EPS foam under the slab provided a snug base for the thermal mass concrete slab floor, which contains radiant heating coils.

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

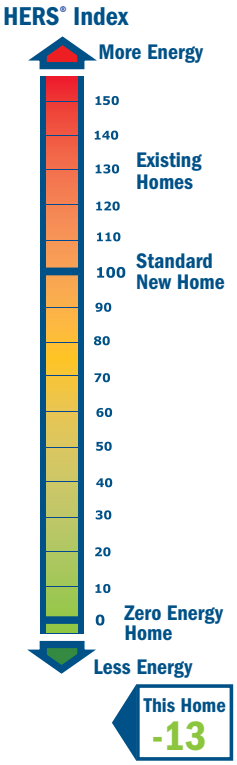
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



Clifton is head of the state green builders association, called Built Green® Washington, whose 11 local member builder associations have certified more than 32,000 Built Green homes in the state.

The custom home builder builds about two or three homes per year, in addition to teaching and designing homes. He teaches courses through the the National Association of Home Builders, the Building Industry Association of Washington, and Skagit-Island County Home Builders Association as well as at regional and national builders' conferences. In fact, it was the teaching that led to his design business. "So many participants in my classes came up to me asking for zero energy house plans that I decided to set up a website to start offering my house plans on line," said Clifton. Through www.Zero-EnergyPlans.com, Ted has gotten design and consulting projects from all over the country.

A couple from Louisiana, the Kaltenbachs, found Clifton through the website and asked him to design and build a house for them on property they had purchased on Whidbey Island. The resulting DOE Zero Energy Ready-certified 2,400-ft^2 two-story home has three bedrooms, two and a half bathrooms, two decks, the latest in appliances, cozy radiant floor heat, and breathtaking views of Puget Sound, all for \$140/ft^2 in construction costs. And, the home is so energy efficient, its 10-kW PV system is enough to power both the home and a car year round.

Clifton combined two great construction techniques – ICFs and SIPs – for a building shell with exceptional performance at the Kaltenbach residence. Clifton dug into the steeply sloped lot then constructed the foundation footings and below-grade north and west lower-level walls from insulated concrete form (ICF) blocks. The ICFs are 48x9.25x16-inch hollow blocks consisting of two 2.75-inch-thick layers of waffled rigid foam that are held apart by plastic spacers. The blocks are stacked like Legos to form a hollow wall that is then reinforced with steel rebar and filled with concrete poured at the site. The blocks create a sturdy wall insulated inside and out for a total wall R value of R-25. The ICFs also provided insulation for the edges of the 4-inch-thick concrete floor slab. Under the entire slab, Clifton employed 4 inches of high-density (2-lb) rigid foam board to provide an R-20 insulation layer under the slab.

The above-grade walls were constructed of 6.5-inch-thick structural insulated panels (SIPs). SIPs consist of two OSB panels sandwiching an expanded polystyrene (EPS) foam layer typically 4 to 9 inches thick. The panels are manufactured at a factory then cut to order for the job, with wall dimensions and knock-outs for doors, windows, electrical, and plumbing precut for quick assembly, a plus in the Northwest marine climate where precipitation can be a daily occurrence 9 months of the year. Because the walls are more airtight than

The home's walls were made of 6.5-inch (R-25) SIPs and the roof was made of 10.25-inch (R-40) SIPs for an airtight shell with almost no thermal bridging between the inside and outside. The SIPs are made in a factory and arrive at the site straight, dry, pre-cut, and ready for assembly. The SIP panels provide insulated attic spaces and cathedral ceilings. The sturdy panels are earthquake resistant and can withstand winds of 200 mph. Because the panels integrate studs, sheathing, and insulation in one product, there are materials and labor savings that balance their initial expense.

stick-built walls and because the insulation is a continuous layer through the wall, not broken up by studs, SIPs have superior thermal and sound insulating properties. Over the SIP wall panels, Clifton installed corrugated house wrap and fiber cement siding.

Clifton used 10.25-inch SIPs for the roof. These provided for an R-40 insulated attic or cathedral ceiling. They also provided a sturdy platform for the photovoltaic panels. Over the SIP roof panels, Clifton laid breathable 30# felt underlayment and then installed architectural-grade composition shingles.

The first floor of the home uses the concrete foundation slab as the flooring. The second story also has a concrete floor, consisting of a 3-inch slab poured over an I-joist and plywood platform. While the stained and sealed concrete slabs look beautiful, they also serve two important functions for regulating temperatures in the home—thermal mass and radiant heating. The exposed concrete provides thermal mass for passive heating of the home. Most of the home's windows face south allowing daylight to warm up the slabs. Because heat always moves from hot to cold, this heat radiates out during the evenings to heat the air. In the winter, this space-heating effect gets a boost from radiant heating pipe loops embedded in the slabs. In the summer, the heat radiating from the slab is carried out of the home by a nighttime ventilation system that keeps the home from overheating.

The radiant floor loops consist of PEX tubing, which circulates liquid that is heated by a ground-source heat pump. The 2-ton heat pump uses two ground loops for its heat source. The two 150-foot loops are buried about 5.5 feet deep around the perimeter of the lot and pull heat from the ground in the winter when the ground is about 55°F while the outside air averages about 40°F. The heat pump operates with an efficiency of 4.5 COP. The heat pump has a desuperheater that provides domestic hot water to the home during the heating season.

The home has no installed cooling equipment. The highly insulated shell helps keep the home from overheating. Roof overhangs were designed to keep the high overhead summer sun off the windows and Clifton kept the glazing area on the west side to a minimum.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program, 100% commitment

ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

DOE Zero Energy Ready Home Quality Management Guidelines

Skagit/Island Counties Builders Association Built Green, 4-star level

"All of our designs are net zero energy. It would be doing my customers a disservice to do anything less."
—Ted Clifton, owner, Clifton View 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.

The thermal mass of the slabs helps to regulate summer indoor temperature as well. Clifton shares a story to illustrate this concept. "Owner Reed Kaltenbach called me shortly after moving in. The painter had opened up all the windows on an 83-degree day while putting the final coat of paint on some trim. Of course, the home had heated up to 83˚F by the time the painter left. Reed closed the windows, and called me excitedly about 45 minutes later: 'Ted, this house is amazing! The thermal-mass floors just sucked the heat right out of the room and it is now only 71˚F!' Because heat wants to move from hot to cold, the heat from the air moved into the cooler thermal mass floors.

Clifton uses a novel approach to ventilating the home that also keeps the thermal mass from overheating. He has installed two vents in the gable ends of the home. These vents are ducted to fans that are equipped with HEPA-level, MERV 19 filters. When the fans are running, they draw fresh outside air in through the filters and push it through ducts to supply registers in the bedrooms, great room, and downstairs family room. The 240-cfm fans are controlled with a speed control, to allow whatever level of ventilation is desired. Each supply register is dampered so that individual rooms can be ventilated as needed. The HEPA-filtered fans act passively to supply make-up air when the home's 80-cfm bath exhaust fans are running but come on full speed when the 206-cfm kitchen range hood fan operates to provide a balance between the amount of air flowing into and out of the home. Clifton usually replaces the fan that comes installed in the kitchen range hood assembly with a quieter, more energy-efficient ENERGY STAR rated fan. In the Kaltenbach residence, this fan was installed on the outside of the home in the exhaust duct so when people are in the kitchen they don't hear the fan. One bathroom fan is set to exhaust continuously at a low speed to provide ASHRAE 62.2-required indoor ventilation. Both intake ducts are equipped with passive intake dampers to close off the vents when they are not drawing in air.

To keep the thermal mass from heating up over the summer, the fans are set to come on in the early morning hours on summer days to pull heat out of the home. The fans can change all of the air in the home in about an hour, bringing in cool outside air, which causes the slab to give up heat. Thus, the indoor air is kept at an even, comfortable temperature.

The 9.945-kW PV system installed on the roof should supply all of the home's electricity needs over the course of the year, with about 3,200 kW left over that could power an electric car over 10,000 miles. A 40-A, 240-V receptacle was installed in the garage to provide for future electric car charging.

Clifton said his actual costs to the customer, including time and materials, came to \$137/ft^2 on the home. This does not include the cost of the \$32,000 PV system or the land, but nor does it include incentives like the 30% federal tax rebate on PV and ground-source heat pumps or Washington state's generous solar incentive of 15.6 to 54 cents per kWh produced, depending on how much of the PV equipment was made in Washington.

Photos courtesy of Clifton View Homes.

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance
- **Walls:** ICF (R-25) below-grade walls; 6.5-in. (R-25) SIPs above-grade walls; draining house wrap; fiber cement siding
- **Roof:** 10.25-in. (R-40) SIPs roof, 30# felt, composite shingles
- **Foundation:** ICF (R-25) below grade up to main floor level on the north and west sides of the house, 4 inches of 2-lb (R-20) EPS under 4-in. slab. 2nd floor is 3-in. slab over I joist and plywood platform
- **Windows:** Triple-pane, low-e, U=0.23, SHGC=0.24
- **Air Sealing:** 0.65 ACH 50
- **Ventilation:** Balanced ventilation with two timer-controlled MERV 19 filtered fan-powered fresh air intakes balanced to kitchen exhaust fan
- **HVAC:** 2-ton ground-source heat pump for radiant floor heat; desuperheater for domestic hot water
- **Hot Water:** Desuperheater, COP=4.5, backup electric tank
- **Lighting:** 100% CFLs and linear fluorescents
- **Appliances:** ENERGY STAR dishwasher, washing machine, refrigerator, 3 ENERGY STAR ceiling fans
- **Solar:** 9.945-kW PV system installed
- **Water Conservation:** 100% low-flow fixtures, 1.28-gal toilets; rain gardens double as vegetable gardens
- **Other:** Garage wired for electric car charging station

"The ventilation system provides fresh air and cooling to the home for pennies a day, about \$3 per year. This is far less expensive initially and long term than an HRV, which costs about \$70 a year to operate in our climate zone, not counting initial installation costs."

—Ted Clifton, owner, Clifton View Homes

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