

Clifton View Homes

Leganza Residence,
Greenbank, WA



BUILDER PROFILE

CVH Inc. DBA Clifton View Homes
Coupeville, WA

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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Leganza Residence
- Location: Greenbank, WA
- Layout: 2 bedrooms, 2 baths, 2 floors
- Conditioned Space: 1,955 ft²
- Climate Zone: IECC 4C, Marine
- Completion: October 2013
- Category: Custom

Modeled Performance Data:

- HERS Index: without PV 37, with PV -5
- Projected Annual Utility Costs: without PV \$828, with PV \$77
- Projected Annual Energy Cost Savings (compared to a home built to the 2012 IECC): without PV \$1,409, with PV \$2,161
- Builder's Added Cost over 2012 IECC: \$44,000
- Annual Energy Savings: without PV 12,259 kWh, with PV 19,459 kWh

Custom home builder Ted Clifton continues to innovate even though he's already set a standard for himself so high that most builders would only dream of aspiring to it. The Whidbey Island, Washington, founder of Clifton View Homes and Zero-Energy Plans, LLC, strives to go beyond net zero energy construction so that every home he designs and builds can produce enough electricity to meet all of the home's electricity needs and power an electric car. 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 requires builders to meet the energy efficiency and durability checklists of the ENERGY STAR Certified Homes Version 3.0, the insulation requirements of the 2012 International Energy Conservation Code, 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 photovoltaic and water heating when the homeowner is ready to install them.

The DOE program's performance path lets builders experiment with various options as they seek to meet the target performance level. Clifton embraces this freedom to experiment, combining established but less common construction techniques like SIPs, insulated slab foundations, ground-source heat pumps, and PV panels, with simple, solar-optimal designs and his own ingenuity to come up with unique homes that capitalize on the natural beauty of their settings, while achieving exceptionally high performance at a reasonable price.

The custom home builder builds two or three homes per year in the Puget Sound area of western Washington state, but spends much of his time designing and consulting on zero energy homes for home buyers and builders across the



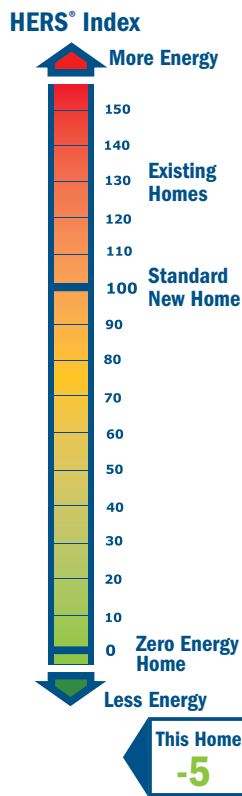
The U.S. Department of Energy invites home builders across the country to meet the extraordinary levels of excellence and quality specified in DOE's Zero Energy Ready Home program (formerly known as Challenge Home). Every DOE Zero Energy Ready Home starts with ENERGY STAR Certified Homes Version 3.0 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 constructed this slab-on-grade home with structural insulated panels. The SIPs provide continuous insulation and air sealing along with excellent sound-proofing, and earthquake and wind resistance. The 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 fast assembly on the job site, so interiors have less chance of getting soaked during construction despite western Washington state's frequent precipitation.



WHAT MAKES A HOME DOE ZERO ENERGY READY HOME-CERTIFIED?

- 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.



country through his Zero-EnergyPlans.com. Clifton fell into the design business as a consequence of teaching energy-efficient home construction through the local and state home builders' associations and at regional and national builders' conferences, where class participants continually came up to him asking if they could buy his house plans.

On one of his latest homes, completed in October 2013 in the community of Greenbank on Whidbey Island, Clifton engineered a unique hot water system that takes advantage of the home's ground-source heat pump for year-round domestic hot water produced at 450% efficiency, using a double-tank arrangement that even the ground source heat pump manufacturer hadn't thought of.

The home in Greenbank is a 1,955 ft² two-bedroom, two-bath home with 1 3/4 stories. A couple from Colorado found Clifton through the website when they were looking for house plans. When they realized he lived on Whidbey Island, the very place they hoped to build, they asked him to construct the home as well.

The homeowners found an 11-acre site. Clifton cleared a level space in a meadow on the lot to excavate for the home's slab-on-grade foundation and the 450 feet of trenches for the home's two-ton ground-source heat pump. Over the leveled clearing, Clifton laid out a 100-foot-long storm water infiltration trench across the three ground loops to help with the transfer of energy from the ground to the loops, while infiltrating 100% of the storm water on-site.

Footing drains around the foundation help remove surface water from the perimeter, while a layer of pea-gravel and 6-mil poly sheeting help to keep the slab-on-grade finished concrete floor dry. Four inches (R-20) of XPS rigid foam board provides an insulating layer under the entire slab. The stem-wall is insulated on the outside with two inches (R-10) of XPS rigid insulation board.

The above-grade walls were constructed of 6.5-inch-thick structural insulated panels (SIPs). 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 home won best kitchen award on the Skagit/Island Counties Builders Association's 2014 tour of homes. The home sports triple-pane windows, ENERGY STAR appliances and ceiling fans, LED and CFL lighting, low-flow plumbing fixtures, and a stained concrete floor to maximize heat transfer from the ground-source heat pump-heated radiant floor loops. All paints and finishes are zero-VOC, and all cabinets and trim are certified no added urea formaldehyde. A motion-sensor-operated fan keeps garage fumes out of the house.

The first floor of the home uses the sealed, stained concrete foundation slab as the flooring. The exposed concrete provides thermal mass for passive heating of the home. Most of the home's windows face south, allowing any available daylight from the wintertime sun, which is lower in the sky, to enter and warm up the slab. Because heat always moves from hot to cold, this heat radiates out during the evenings to heat the air. This space-heating effect gets a boost from radiant heating pipe loops embedded in the slab.

The second-floor rooms are heated with the natural convective loop designed into the home. As the slab warms the air, the warm air rises up to the top of the cathedral ceiling at the center of the house. The window surfaces are colder, so the air at the front of the house will cool and drop back down to the floor, where it is heated again in a continuous loop. A second convective loop is working at the back of the house, using the north wall as the cold surface causing the air to drop back to the floor. Where these two loops interface in the central open area of the home, the heat is transferred from the south loop to the north loop.

The radiant floor tubing circulates liquid heated by a ground-source heat pump. The 2-ton heat pump uses three 150-foot ground loops buried 5.5 feet deep in trenches on the south side of the home where they pull heat from the 55°F ground. Rather than using a desuperheater, which only provides hot water when the heat pump is heating the home in the winter months, Clifton's system uses a buffer tank to store the 120°F water from the ground-source heat pump. The electric water heater draws this preheated water to the heater tank for further heating but so little electricity is needed that the water heater operates at 450% efficiency year round.

The home has no installed traditional 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. The thermal mass of the slab also helps to regulate the summer indoor temperature. Because heat wants to move from hot to cold, the summer-time heat from the air moves into the cooler thermal mass floors during the day. At night this heat radiates into the rooms and is carried out of the home by a nighttime ventilation system.

Clifton uses a novel approach to ventilating the home that provides fresh air and cooling for about \$3 a year, far less than an HRV, which Clifton considers

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program

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

"This home cost about 15% more than a code-minimum home, but delivers complete freedom from future housing-related energy bills. If an additional 7 kW of PV were installed on the porch and garage roofs, the home could power two electric cars for 20,000 miles per year, saving the owners more than \$3,000 per year in gasoline costs, not to mention the pollution savings! How could we in good conscience give them anything less?"

— Ted L. Clifton, Owner, Clifton View
Homes and Zero-Energy Plans



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 SIP panels provide insulated attic spaces and cathedral ceilings.

unnecessary in the mild marine climate. One bathroom fan is set to exhaust continuously at a low speed to provide ASHRAE 62.2-required indoor ventilation. Makeup air is provided by a HEPA filtered vent duct. The intake duct has a damper that will open passively whenever the 80-cfm bathroom exhaust fans are operating. The ventilation duct is also equipped with its own fan to push fresh air into the home. The fan will come on full speed when the 206-cfm kitchen range

hood fan is operating, to provide a balance between the amount of air flowing into and out of the home. Clifton usually replaces the fan in the kitchen range hood with a quieter, more energy-efficient ENERGY STAR rated fan. In the Leganza residence, this fan was installed on the outside of the home at the end of the exhaust duct, so when people are in the kitchen they don't hear the fan.

In the summer, the fresh air intake fan is timer controlled to operate as a night ventilation cooling system. On hot days it will turn on in the early morning hours when the outside temperatures are the coolest, bringing cool air into the home while the exhaust fans pull hot air out of the home, which helps to cool down the thermal mass concrete floor. Using this ventilation method, 100% of the home's indoor air can be exchanged in about 1.5 hours. Thus, the indoor air is kept at an even, comfortable temperature. Adequate ventilation is a necessity in the airtight home, which achieved an air leakage level of only 0.96 air changes per hour at 50 Pascals pressure difference (ACH 50), well below the 2.5 ACH 50 limit required for IECC climate zone 4 by the DOE Zero Energy Ready Home program.

Clifton posts the DOE program checklists on the work site so they are easy for contractors to see and follow. This includes checklists for the EPA Indoor airPLUS and ENERGY STAR programs (as well as for Built Green, which is not a DOE requirement). "We meet at the start of each week with our crews and sub-contractors to discuss the processes and issues that will be involved in the coming week," said Clifton.

The 7.140-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 kWh left over, enough to power some models of electric cars for over 10,000 miles. Additional unobstructed south-facing roof area on the main roof, the covered front porch, and the garage would support over 7-kW more of PV panels. A 40-Amp, 240-Volt receptacle was installed in the front corner of the garage to provide for future electric car charging.

The Home Energy Rating System (HERS) score for the home, with the PV installed, was calculated at -5 HERS. However, according to Clifton, the homeowner told him the home had already produced 5% more electricity from the PV in the first 11 months than it was projected to produce for the entire year.

Photos courtesy of CVH Inc.

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance
- **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:** Slab on grade, with 2-inch (R-10) XPS rigid foam slab edge insulation board; 4 inches (R-20) XPS rigid insulation board under full slab
- **Windows:** Triple-pane, low-e, U=0.18-22, SHGC=0.22
- **Air Sealing:** 0.96 ACH 50
- **Ventilation:** Exhaust fan in bathroom for ASHRAE 62.2. Outside fresh air ducted through HEPA filter for passive makeup air or fan-powered to provide nighttime ventilation cooling.
- **HVAC:** 2-ton ground-source heat pump for radiant floor heat on main floor, plus passive solar heating of downstairs via thermal mass concrete walls and upstairs via natural convective loop
- **Hot Water:** Ground-source heat pump preheats water for electric tank heater year round at a COP of 4.5
- **Lighting:** 100% LEDs and CFLs
- **Appliances:** ENERGY STAR-dishwasher, washing machine, refrigerator, 2 ENERGY STAR ceiling fans
- **Solar:** 7.140-kW PV system installed; south-facing roof area available for 7 kW more
- **Water Conservation:** 100% low-flow fixtures, 1.28-gallon toilets; gutter run-off drains to trench above ground-source heat pump loops
- **Other:** 40-Amp, 240-Volt receptacle in garage for future car-charging station. All zero-VOC paints and finishes, no added urea formaldehyde cabinets, trim, etc.