



TC Legend Homes

House in the Hollow
Bellingham, WA



BUILDER PROFILE

TC Legend Homes
Bellingham, WA; TCLegendHomes.com
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: House in the Hollow
- Location: Bellingham, Washington
- Layout: 3 bdrm, 2.5 bath, 1 fl, 1,935 ft²
- Climate: IECC 4C, marine
- Completed: July 2021
- Category: Custom for Buyer <2,500 ft²

Modeled Performance Data:

- HERS INDEX: without PV: 33 with PV: -23
- Annual Energy Costs: without PV: \$600; with PV: \$-280
- Annual Energy Cost Savings: without PV: \$1,200; with PV: \$2,150
- Annual Energy Savings: without PV: 8,400 kWh; with PV: 20,350 kWh
- Savings in the First 30 Years: without PV: \$48,930; with PV: \$86,550

Builder TC Legend Homes of Bellingham, Washington, aims for quality and sustainability in every home it constructs and company founder Ted Clifton Jr. has found the U.S. Department of Energy's Zero Energy Ready Home program is an ideal way to achieve that goal.

"The DOE Zero Energy Ready Home program is a great benchmark not only for ourselves, but for all those looking to build or purchase a home that is eco-friendly. Since the program incorporates ENERGY STAR and Indoor airPLUS, holds high standards for energy efficiency, and is nationwide, it is an easy way to compare homes across the board and that reduces confusion for purchasers," said Clifton. "It's also great that the DOE program has a very low cost barrier. There are many other certification programs that charge large fees, making it difficult for small builders to participate. Or, the cost of the fees gets passed along in higher home prices, increasing the barrier to purchase for many people," Clifton added.

Since 2015, TC Legend Homes has built all of its homes to the DOE program criteria. The builder typically constructs one spec home and five or six custom homes for buyers each year and currently has nine homes under construction. In 2022, the builder was recognized by DOE for its efforts with a Housing Innovation Grand Award in the category "Custom for Buyer under 2,500 ft²."

This was the builder's third grand award from the DOE's Zero Energy Ready Home program. The 2022 grand award winner is a 1,935-ft², two-story home located in Bellingham, Washington. The home achieved a Home Energy Rating System (HERS) index of minus 23 when the solar photovoltaic panels are included. TC Legend's homes routinely achieve HERS scores of 10 to 20 below net zero. These "positive energy" homes realize enough energy savings and photovoltaic power production to run the home as well as an electric car or two with zero power bills.



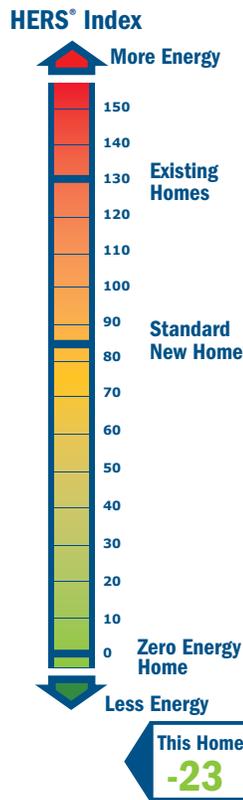
The U.S. Department of Energy invites home builders across the country to meet the extraordinary levels of excellence and quality specified in DOE's Zero Energy Ready Home program. Every DOE Zero Energy Ready Home starts with ENERGY STAR Certified Homes Version 3.0/3.1/3.2 for an energy-efficient home 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.

This home meets all of the energy-efficiency requirements of the DOE Zero Energy Ready Home program as well as all of the requirements of the EPA Indoor airPLUS program which helps ensure good indoor air quality with high-quality ventilation and low-emitting finishes and cabinetry. Efficient ENERGY STAR appliances, low-flow plumbing fixtures, and a central manifold plumbing distribution with PEX piping reduce water and energy usage. The house is also designed for aging-in-place.



What makes a home a DOE ZERO ENERGY READY HOME?

- 1 **BASELINE ENERGY STAR Certified Homes Version 3.0/3.1**
- 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.



Like all TC Legend homes, the all-electric home is constructed of structural insulated panels (SIPs) with insulated concrete form (ICF) foundation walls, slab-on grade floors, triple-pane windows, HRV fresh air systems, air-to-water heat pumps, and solar panels.

Every DOE Zero Energy Ready certified home meets the requirements of the ENERGY STAR Certified Homes program. They must also be certified to the U.S. Environmental Protection Agency's Indoor airPLUS criteria and meet the hot water distribution requirements of the EPA's WaterSense program. DOE ZERH homes must also meet IECC 2015 insulation requirements, be blower door tested for whole house air sealing, comply with moisture management guidelines, have ducts inside conditioned space, and use ENERGY STAR-labeled windows, lighting, and appliances. Homes must also have solar electric panels installed or have the conduit and electrical panel space in place for future installation of solar panels. Even without the 10.56 kW of PV panels installed on the roof of the winning home, it would achieve a HERS score of 33, well below the HERS 80 to 90 of most just-to-code new homes.

To reduce heating and cooling loads, TC Legend Homes relies on its tried-and-true base design. A four-inch slab is poured over 4 inches of R-20 high-density foam insulation. The stem walls around the slab are made of insulated concrete form (ICF) blocks consisting of a 6-inch reinforced concrete core wrapped with 2.625 inches of rigid foam on the interior and exterior for an R-23.6 total stem wall. The ICF stem walls reduce heat loss through the edges of the slab and also reduce the labor costs involved in forming the stem walls since the easily assembled foam blocks create a stay-in-place form for the concrete. TC Legend often stains and seals the concrete slab to serve as the finished floor of the home because the exposed concrete readily absorbs passive solar heat and also easily transfers warmth from the radiant floor loops.

The home's above-grade walls consist of 6.5-inch R-29 structural insulated panels (SIPs) that use a graphite-enhanced expanded polystyrene core wrapped with OSB. The walls are finished with house wrap and fiber cement siding. All seams are sealed with SIP tape and any exposed ICF foam is covered with metal flashing. The bi-level roof is constructed of graphite-enhanced SIPs, using 10.25-inch R-49 SIPs for the north-facing roof and 12.25-inch R-59 SIPs for the longer south-facing roof. The SIP roof panels are topped with underlayment and lifetime-warrantied asphalt shingles. In place of solid wood splines, foam inter-panel connection splines were used in the north roof and I-splines were used in the south roof to support the longer span of the south-facing roof.



TC Legend Homes builds all its homes with SIP roofs and walls and ICF foundations. Clifton likes SIPs for their exceptional thermal performance with no thermal bridging and very little air leakage, racking resistance to earthquakes and high winds, minimal waste, and simplicity of construction. It takes just a small crew and a crane to put the homes together.

SIP construction offers seismic category D resistance and the SIPs are rated to last 100 years. “SIPs also create less framing construction waste than traditional stick framing and are generally stronger than stick framing. On top of all that, SIPs are super quick and easy to install, making the labor much cheaper than traditional stick framing and therefore helping keep our houses more affordable. Our team has the installation down like a well-oiled machine and can install the SIPs on an entire two-story house in just 8 days. ICFs are also quick and easy to install. They create less material waste and require less concrete, which helps to reduce the home’s embodied carbon totals,” said Clifton.

SIPs also make for a very airtight structure with almost no thermal bridging. The home is slab on grade, so there is no air leakage from the floor. All SIP panel joints are double-bead mastic sealed. Windows are foamed-in and sill plates are also sealed with SIP mastic. After the mechanical trades have completed their work and all windows and doors are sealed, the builder uses a proprietary aerosolized acrylic product that is distributed throughout the home while it is pressurized with a blower door fan to seal any remaining cracks in the building envelope. The final blower door test on this home was 0.54 ACH50.

To provide mechanical ventilation for their super-tight homes, TC Legend installs heat recovery ventilators (HRV) as the standard ventilation system in all of their homes. An HRV brings in outdoor air that is tempered with outgoing stale air in a heat exchanger to warm incoming air in winter and cool incoming air in the summer. They added a MERV 17 HEPA filter unit to the fresh air intake of the HRV that includes an inline fan to pull in air that passes through the HEPA filter, which filters out 99.97% of particles down to 0.3 microns. The fan-powered filter unit is operated by the same variable-speed switch that controls the home’s powerful range hood fan, so when the range hood fan is on, instead of depressurizing the home or pulling in makeup air through cracks in the building envelope or an imperfect backdraft damper, just the right amount of makeup air is brought in through the HEPA filter. The incoming air is tempered through the heat exchanger on the HRV to minimize blasts of cold or hot air from the incoming air. The main house ventilation is always on. It can be boosted to a pre-programmed setting by timers in the bathrooms that can be set for 10, 30, or 60 minutes. There is a CO₂ sensor in the main living area that will boost the system as needed to keep CO₂ below 1,200 parts per million. There are also humidity sensors in the bathrooms.

HOME CERTIFICATIONS

ENERGY STAR Certified Homes
Version 3.1

EPA Indoor airPLUS

DOE Zero Energy Ready Home Program
- 100% Commitment

DOE Zero Energy Ready Home Quality
Management Guidelines

Built Green 5 Star

Energy Star v3.2 Washington State

Communication is the key to getting the shell
put together in 8 days or less.

- * Pre-construction meeting with the client, building inspector, trades, and TC Legend as general contractor and designer.
- * Weekly construction meetings with crews and TC Legend owner
- * Weekly meetings with office personnel, design team, and TC Legend owners
- * Weekly email update to homeowners.
- * Construction documents in cloud for 24/7 access by team.



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 split-system air-to-water heat pump provides efficient space and water heating and keeps the fan noise outside.

TC Legend uses an air-to-water heat pump for efficient space and domestic water heating at a coefficient of performance (COP) of 3.92 (i.e., the heat pump is 3.92 times as efficient at making heat or hot water as an electric-resistance furnace or water heater). According to Clifton, “This is much more efficient than a heat pump water heater and, because the compressor and fan are outside, it is not scavenging heat from the house or adding noise inside.” Space heating is delivered via radiant floor loops downstairs in the exposed concrete floor slab and via a fan coil unit upstairs, as well as via a heating unit in the supply side of the HRV. The heat pump also provides cooling with a COP of 6.75.

The home is designed to take advantage of passive solar heating and shading with a floor plan that is longer in the east-west direction and puts a majority of the windows on the south side of the house. The windows and doors are triple-pane glass with three low-emissivity coatings and argon gas fill that reduce heat transfer. The windows include fixed-glass windows with a U value of 0.15 and a solar heat gain coefficient (SHGC) of 0.46 and casement windows with a U value of 0.18 and a SHGC of 0.34. The home has only two west-facing windows and five east-facing windows and these windows have a lower SHGC thus allowing in less solar heat gain than the north- and south-facing glass. Roof overhangs protect south-facing clerestory and first-story windows from summer sun while existing deciduous trees help shade east- and west-facing glass.

Recognizing the need to maximize any daylight available in the cloudy Pacific Northwest, TC Legend often incorporates shaded south-facing clerestory windows into its designs. Clifton noted the visible light transmittance of their windows is 0.59 on fixed windows and 0.43 on casement windows. “This is almost double the light transfer of some other triple-pane windows,” said Clifton. The home’s interiors are painted white to maximize daylight and when the sun goes down, 100% LED light fixtures illuminate the interior.

“We really live by the statement, ‘If you’re not actively trying to improve the world around you, then what are you doing?’ We believe in leaving the world a better place than we found it,” said Clifton. One goal of the company is to start building larger developments of 25 or more homes that are affordable and just as eco-friendly as their current homes. “Owning a (Zero Energy Ready) house should be available to everyone, not just the wealthy,” said Clifton.

Photos courtesy of TC Legend Homes

KEY FEATURES

- **Walls:** SIPs, R-29: 6.5" graphite EPS SIPs; house wrap; fiber cement lap siding.
- **Roof:** SIP gable and shed roof: 10.25" R-49 (north) and 12.25" R-59 (south) graphite EPS SIPs, asphalt underlayment and asphalt composite roofing.
- **Attic:** No attic, vaulted ceilings.
- **Foundation:** Slab on grade: 4" R-20 EPS under slab; ICF stem walls 11.25" R-23.6.
- **Windows:** Triple-pane, argon-filled, low-e3, vinyl, U=0.15-0.18, SHGC=0.46-0.34.
- **Air Sealing:** 0.54 ACH50, all SIP joints sealed with double bead of mastic and tape. Windows have a double gasket. Whole-house aerosolized acrylic sealant.
- **Ventilation:** HRV to HVAC; timer, CO₂ and humidity sensors for boost setting.
- **HVAC:** Air-to-water heat pump with 50% central air handler, 50% radiant, 6.75 COP for cooling, 3.92 COP for heating. Passive heating design with exposed concrete floors.
- **Hot Water:** Combi air-to-water heat pump for space and water heating, 50-gal, 3.92 COP; electric tankless back-up water heater.
- **Lighting:** 100% LED, passive and shaded vertical glazing.
- **Appliances:** ENERGY STAR washing machine, dishwasher, refrigerator, exhaust fan.
- **Solar:** 10.56-kW, 33 rooftop panels, microinverters.
- **Water Conservation:** EPA WaterSense-rated fixtures. Central manifold with PEX piping.
- **Energy Management System:** CO₂ sensors, programmable HVAC system.
- **Other:** Low-VOC and recycled-content products. Aging-in-place design. EV charger installed.