

TC Legend Homes

Everson Net Positive
Everson, WA



BUILDER PROFILE

TC Legend Homes

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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Everson Net Positive
- Location: Everson, WA
- Layout: 4 bdrm, 3 bath, 2 fls, 2,538 ft²
- Climate: IECC 4C, marine
- Completed: March 2020
- Category: Custom for Buyer <3,000 ft²

Modeled Performance Data:

- HERS Index: without PV 33; with PV -19
- Annual Energy Costs: without PV \$750; with PV -\$300
- Annual Energy Cost Savings: (vs typical new homes) without PV \$1,450; with PV \$2,450
- Annual Energy Savings: without PV 11,200 kWh; with PV 23,500 kWh
- Savings in the First 30 Years: without PV \$60,000; with PV \$103,200

Getting used to not fiddling with the heating system was the only difficulty for the homeowners of a new U.S. Department of Energy certified Zero Energy Ready Home built by TC Legend Homes in Everson, Washington.

“We were used to a forced air furnace with a nighttime setback temperature several degrees lower than the daytime temperature. But in a high-mass, super-insulated home, that simply doesn’t work. Even in cold weather, it would take several days with no heat to cause a significant temperature drop. We don’t have to touch the thermostat,” said the homeowner. So, instead of experiencing daily temperature fluctuations between 64 and 72°F, the homeowners are enjoying a constant temperature of 68°F. And thanks to the home’s exceptional air sealing and insulation, that temperature is consistent from room to room around the house as well.

The home’s highly insulated shell and rooftop solar yield a home that is better than net zero. It’s “energy positive” as the builder, Ted Clifton Jr. likes to say, producing enough power to run the home and an electric car or two. The home’s Home Energy Rating System (HERS) score reflects this; a HERS score of 0 or lower would equal a net zero energy home. The TC Legend home achieves a minus 19 when the 12.4-kW solar system is included. Even without the PV, the home would score a HERS 33, well below the HERS 80 to 90 of typical new homes.

The exceptional performance won TC Legend a grand award in the Custom for Buyer category of DOE’s 2020 Housing Innovation Awards. This is TC Legend’s sixth DOE Housing Innovation Award winner and the third grand award for the custom builder who has certified 27 homes through the program in Bellingham and Seattle since they began constructing homes in 2004.



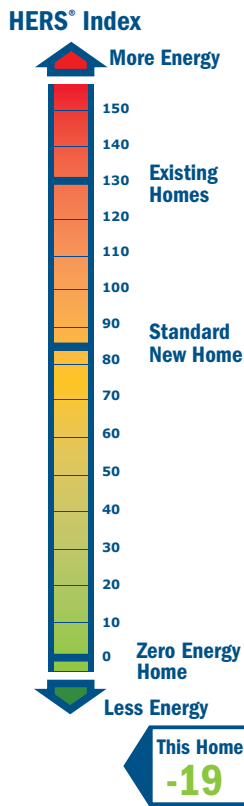
The U.S. Department of Energy invites home builders across the country to meet the extraordinary levels of excellence and quality specified in DOE’s Zero Energy Ready Home program. Every DOE Zero Energy Ready Home starts with ENERGY STAR Certified Homes Version 3.0/3.1/3.2 for an energy-efficient home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

TC Legend Home built this 2,538-ft² two-story home in Everson, Washington, to the high-performance requirements of the U.S. Department of Energy’s Zero Energy Ready Home program. Located in the Pacific Northwest, this home goes beyond net zero with a Home Energy Rating System (HERS) score of -19, thanks in part to its large south-facing roof, which is designed to hold over 80 solar and the large south-facing windows, which bring in sunlight to warm the concrete floors and provide passive solar heating.



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.



The home was built to the high performance requirements of DOE Zero Energy Ready Home, a voluntary program that earns the home a certification from DOE and incorporates other high-performance certifications as well. Every DOE Zero Energy Ready home must meet the requirements of the ENERGY STAR Certified Homes checklists. They must also be certified to the U.S. Environmental Protection Agency’s Indoor airPLUS criteria. All DOE ZERH homes are required to meet the hot water distribution requirements of the EPA’s WaterSense program. Homes must also meet above-code insulation requirements, be blower door tested for 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.

All of these requirements contribute to a home that is energy efficient, durable, and comfortable, with higher indoor air quality and lower risk of mold and moisture issues.

Jake Evans, a project manager for TC Legend, says his company likes the DOE program because it offers “a legible and powerful migration pathway to ensure our progress along the ZERH scale to carbon neutral.”

For TC Legend, that nearly always starts with a super-insulated SIP wall and roof over an ICF foundation. The 2020 award-winning home is a two-story, 2,538-ft² home constructed on a slab-on-grade foundation with 5.25-inch insulated concrete form (ICF) stem walls that provide an insulating R-24.3 perimeter around the structure.

The walls are constructed of 6.5-inch R-29 structural insulated panels (SIPs) consisting of two layers of OSB sandwiching a graphite-enhanced expanded polystyrene core. SIPs offer many benefits for the builder. TC Legend’s in-house crew can assemble the walls and roof in three days, because the panels come to the site measured and precision cut to the house plan dimensions for doors, windows, and wall sections. Almost no framing is required, just caulking and taping seams, installing windows and doors, house wrap, and siding, in this case with fiber cement lap siding.

TC Legend uses insulated splines to connect the panels. Thicker 12.25-inch R-59 SIPs are used to construct the roof. The panels are covered with a three-layer durable breathable membrane underlayment and topped with a 24-gauge standing-seam metal roof, that makes PV panel installation a snap.



A very efficient air-to-water heat pump provides warm water for the in-floor radiant heating system. It also supplies hot or chilled water to a coil within the supply side duct of the heat recovery ventilator (HRV), which distributes conditioned air through the HRV's ducts. The heat pump also provides hot and cold water to fan-coil units located in the first-floor master bedroom and the second-floor library, which is open to the first-floor living space. The air-to-water heat pump also provides heat to an 80-gallon tank for domestic hot water.

The rigidity of the two adhered layers of OSB provides exceptional shear strength for the walls and roof, making SIPs an excellent choice for structural stability in areas prone to high winds and earthquakes, both of which occur in western Washington state. Because of the structural strength of the walls and roof, no roof trusses are needed and all interior walls can be nonloadbearing, providing for cathedral ceilings and greater design flexibility for interior spaces.

Although SIPs are known to provide draft-free construction, the home was further air sealed with the Aerobarrier process, in which atomized particles of acrylic are sprayed into the rooms of the house while the home is pressurized with a blower door. The pressurized air will seek any leaks in the envelope through which to escape, carrying with it the tiny acrylic particles, which adhere to and seal off the leaks. This process is done before final finishes are installed or with finishes covered and can seal a home in just a few hours. In this case, the home was sealed to 0.47 air changes per hour at 50 Pascals, tighter than the 0.60 ACH 50 required by Passive House Institute USA.

Triple-pane, argon-filled vinyl-framed windows complete the thermal envelope. The windows have three low-emissivity coatings to slow heat transfer. The casement style windows have a U-factor of 0.16 and the fixed windows have a U-factor of 0.14. Most of the windows are south facing to allow in welcome sunlight to warm up the exposed sealed concrete floors for intentional passive solar heat gain in the winter. A wrap-around porch and overhangs help to limit unwanted solar heat gain in the summer. Automated blinds on the south and east windows can be scheduled through the home automation system to help control heat gain, heat losses, daylight, and views. The large south- and east-facing windows and clerestory south-facing windows bring daylight into the main level as well as into the upper loft-level bedrooms to supplement the 100% LED light fixtures. The lighting is controlled by the same internet- and voice-activated system that controls the window blinds, the HVAC, and ventilation systems, which are also controlled by humidity and CO₂ sensors. Echo Dots were installed in most of the home's ceilings to accept commands and to provide intercom and music.

One of the most unique aspects of the home is its HVAC system, or perhaps we should say systems. The home's primary space conditioning system is a highly efficient (COP 3.92 heating, 6.75 cooling) air-to-water-source heat pump that provides space heating and cooling in three ways. It supplies hot or chilled water to a coil within the supply side duct of the heat recovery ventilator (HRV). The HRV distributes the heated or chilled air via ventilation ducts. The air-to-water heat pump

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program - 100% Commitment

ENERGY STAR Certified Homes Version 3.1

BuiltGreen 5star

2005 EPACT

EPA Indoor airPLUS

DOE Zero Energy Ready Home Quality Management Guidelines

"The temperature throughout DOE Zero Energy Ready Homes does not change. Even on the hottest days we stay cool and on the coldest winter nights we stay warm."

Homeowner



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.



This home's Heat Recovery Ventilator (HRV) system keeps indoor air fresh and temperatures consistent.

The air-to-water heat pump also provides heat to an 80-gallon tank for domestic hot water. The system includes a 40-gallon buffer tank to prevent heat pump short-cycling.

The HRV unit provides ventilation throughout the house by drawing stale and moist air from the bathrooms and laundry and supplying fresh conditioned air to the living and sleeping rooms. The air is filtered through MERV 13 filters. The HRV has wireless controls and can be operated remotely through the home's automation system. It has humidity-triggered sensors in the shower rooms and CO₂-triggered sensors in the living room. It can also be set for timed or continuous operation. The air intake damper can be closed in the event of smoke or bad outdoor air quality. The boost setting can be activated to remove forest-fire smoke or other contaminants that might come in when doors are opened.

ENERGY STAR appliances limit electricity use and all of the home's power needs are more than met by the 12.4-kW PV panel array. The inverters are wired to accept batteries when the price comes down.

The home meets all of the indoor air-quality guidelines of EPA's Indoor airPLUS and it was designed for aging in place including having a first-floor master and laundry room, 36-inch doors, and wide hallways.

For the new homeowners, the home is all they hoped for and more. "I am astonished almost every day with how well this house 'works' for us. It is a very efficient, real-world design. We are both delighted with living here and really enjoying all the features."

also provides hot and chilled water to fan-coil units located in the first-floor master bedroom and the second-floor library, which is open to the first-floor living space. There is also a third heating system, an in-floor hydronic system, which also uses water heated by the air-to-water heat pump. Testing of the cutting edge \$1,000 HRV coil has been so successful that the two backup systems (the fan coils and the hydronic floor heating and cooling) may not be needed.

KEY FEATURES

- **Walls:** SIPs, R-29 total: 6.5" R-29 graphite SIPs, house wrap, fiber cement siding.
- **Roof:** SIP roof: 12.25" R-59 graphite SIPs, membrane, standing seam metal roof.
- **Attic:** No attic.
- **Foundation:** 4" R-20 rigid foam under slab, 5" R-24.3 ICF stem wall.
- **Windows:** Triple-pane, argon-filled, low-e3, vinyl-frame, U=0.14 fixed, U=0.16 casement, SHGC=0.33 to 0.44 tuned to direction. Automated window blinds.
- **Air Sealing:** 0.47 ACH, all SIP seams caulked and taped. Aerosol whole-house sealant.
- **Ventilation:** HRV, ducted, MERV 13 filters, humidity and CO₂ sensed, boost setting.
- **HVAC:** Air-to-water heat pump, 3.92 COP (heat), 6.75 COP (cool), 23.02 EER. Uses HRV ducts to distribute hot and cold air, plus radiant floor.
- **Hot Water:** Combi uses space heating air-to-water heat pump, 3.93 COP. 80-gal hot water storage tank + 40-gal buffer tank to prevent short cycling.
- **Lighting:** 100% LED. Day lighting. Clerestory windows. Automated and remote controls.
- **Appliances:** ENERGY STAR refrigerator, dishwasher, and clothes washer, clothes dryer.
- **Solar:** 12.4 kW, 40 310-W panels. Roof sized for 80+ panels. Wired for future battery.
- **Water Conservation:** EPA WaterSense fixtures. Central manifold plumbing with PEX pipe. Drought-resistant landscaping. Rainwater collected to central sump for irrigation.
- **Energy Management System:** Automated, internet, and voice-controlled lighting, blinds, and HVAC. HRV triggered by CO₂ and humidity sensors.
- **Other:** EV charging, no-VOC paint, Greenguard Gold SIPs. ADA features.

Photos courtesy of Zigzag Mountain Art