

TC Legend Homes

Lynden Powerhouse
Lynden, WA



BUILDER PROFILE

TC Legend Homes
Bellingham, WA
tclegendhomes.com
Ted Clifton, Jake Evans
jake@tclegendhomes.com

FEATURED HOME/DEVELOPMENT:

Project Data:

- **Project name:** Lynden Powerhouse
- **Location:** Lynden, WA
- **Layout:** 5 bdrm, 5 bath, 2 fl, 2,391 ft²
- **Climate:** IECC 4C, mixed-marine
- **Completed:** September 2023
- **Category:** Custom

Modeled Performance Data:

- **HERS Index:** without PV 33; with PV -24
- **Annual Energy Costs:** without PV \$1,100; with PV \$100
- **Annual Energy Cost Savings:** (vs typical new homes) without PV \$1,850; with PV \$3,700
- **Annual Energy Savings:** without PV 11,650 kWh; with PV 31,950 kWh
- **Savings in the First 30 Years:** without PV \$77,550; with PV \$155,600

It seems that the more advanced TC Legend Homes becomes, the more they value simplicity. Simplicity of design has been a key to success for this 12-time winner and now 6-time grand winner in the U.S. Department of Energy (DOE)'s Zero Energy Ready Housing Innovation Awards competition, according to company founder and president Ted Clifton. "It's what enables us to make homes that are both affordable and incredibly high performing," said Clifton. While the going rate for custom homes in the Bellingham, Washington, market is \$350-\$550 per sq ft, Clifton is building for \$300k/sq ft. Clifton achieves this low cost with a tried-and-true building envelope and consistent HVAC package that also meets the criteria of the DOE Zero Energy Ready Home certification and provides home owners with net zero power bills through a combination of solar panels and battery storage that can power the home and an electric vehicle or two.

The Bellingham, Washington, custom home builder has been constructing homes in the northwest corner of Washington state since 1991, honing construction methods he learned from his father Ted Clifton of Clifton View Homes in Coupeville, WA. Like his father, Clifton has sought to achieve DOE Zero Energy Ready Home certification on every home he builds since founding TC Legend Homes in 2015.

This year's award-winning home, like all homes certified through the DOE Zero Energy Ready Home program, meets several high-performance home criteria. The DOE program has ENERGY STAR and Indoor AirPlus home certifications and the latest energy codes as its baseline so every home provides its home buyers with the health, resiliency, and utility bill savings these programs offer. Other Zero Energy Ready Home requirements help ensure water savings; HVAC and water heating efficiencies; and third party-verified air sealing to minimize drafts and keep out bugs, dust, smoke, and pollens. While homes aren't required to have solar electric panels, this voluntary program specifies installation of the electrical infrastructure and space in the home for future installation of PV, as well as electric vehicle chargers, heat pumps,



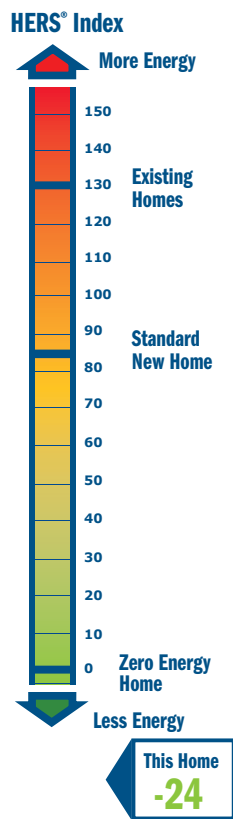
The U.S. Department of Energy invites home builders across the country to meet the extraordinary levels of excellence and quality specified in DOE's Zero Energy Ready Home program. Every DOE Zero Energy Ready Home starts with ENERGY STAR Certified Homes Version 3.2 for an energy-efficient home built 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 Homes constructed this 2,391-ft² home in Lynden, WA, to the high performance criteria of the DOE Zero Energy Ready Home (ZERH) program. The home's 17 kW of solar panels and 30 kWh of battery storage should provide the homeowner with \$0 electric bills and enough electricity to power the home, two cars, and an RV year round. ENERGY STAR-labeled lighting and appliances and triple-pane U-0.16 windows with triple-low-emissivity coatings add to energy savings.



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.



and heat pump water heaters, offering homeowners the option and ease of future installation should they choose it.

One way Clifton simplifies construction is to use the same construction methods from home to home. He constructs every home with a structural insulated panel (SIP) wall and roof assembly and an insulated concrete form (ICF) foundation.

The walls consist of 6.5-inch-thick SIP panels (two half-inch layers of OSB sandwiching a fully adhered 5.5-inch layer of graphite-enhanced expanded polystyrene (GPS)) that provides a wall with an R-29 insulation value and exceptional wind and seismic resistance. Some builders use dimensional lumber to connect their SIP panels but Clifton uses insulated splines which, together with the continuous layer of GPS in the panels, provide a wall with almost no thermal bridging, or transfer of heat between the inside and outside of the home. Clifton did install a plastic mesh rainscreen product on this home at the homeowner's request but his preferred method of water management is a carefully applied draining house wrap with taped seams and correctly installed siding over flanged, caulked windows with no window or corner trim. "With all that trim, you just have more seams to caulk. We design in big eaves and keep it simple," said Clifton.

Thicker 10.25-inch R-48 SIPs are used to construct the roof. The panels are covered with a fully adhered membrane underlayment that prevents air and water leakage but is highly vapor permeable to reduce condensation in this otherwise unvented roof assembly. The locally made 24-gauge standing-seam metal roof has a lifetime warranty and allows for simple photovoltaic panel installation with very few roof penetrations. 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.

Clifton's signature house assembly also includes a slab-on-grade foundation with an exposed insulated concrete slab floor, wrapped in an ICF stem wall. This foundation assembly encompasses three components that serve multiple functions for simplicity, labor, and cost savings. Under the 4-inch concrete floor slabs, four inches of high-density expanded polystyrene (EPS) provides R-20 of insulation value as well as a vapor barrier, eliminating the need for a vapor retarder and capillary break under the slab. The EPS also provides a warm bed for the radiant heating coils that are covered with the poured concrete slab. The slab is surrounded by 11.23-inch-thick ICFs consisting of two 2.625-inch layers of rigid foam providing an insulation value of R-24 and a stay-in-place form to hold the steel rebar and 6 inches of poured concrete.



The SIP walls and roof and ICF-wrapped slab-on-grade foundation provide exceptional insulation to the home which was cleverly designed to include the main living space with master bedroom, a 1-bedroom accessory dwelling unit (ADU) with full kitchen (shown here), and a 3-bedroom guest space all in one structure. Taped seams, low-expansion foam around rough openings, and a whole-house aerosolized air-sealing process also make the home exceptionally tight. At 0.45 air changes per hour, it is much tighter than the 3.0 ACH 50 required by code.

The foam separates the concrete slab from these concrete stem walls, virtually eliminating heat transfer through the slab edge. The concrete floor slabs themselves are usually sealed, stained, and polished to serve as a durable, water-resistant flooring. The exposed concrete slab also provides thermal mass that absorbs sun through large south-facing windows to provide a passive heating source. Extended roof eaves on the south side of the home allow in low winter sun while keeping out high summer sun.

Reasonably priced vinyl-framed triple-pane windows from a nearby British Columbia manufacturer complete the high-performance thermal envelope. “The window package only costs us about \$5 to \$10K more than double-pane windows but provides a lifetime of energy savings and internal thermal stability, which is going to make the home more comfortable and reduce mold issues around the window from condensation, which is a notorious problem in the Pacific Northwest,” said Clifton.

Three heat recovery ventilators (HRVs) were installed—one for each living area—to enable separate controls when one or more spaces is unoccupied and to prevent the spread of viruses. Air quality and humidity sensors can boost air flow through the HEPA-filtered HRVs. The kitchen has its own exhaust fan balanced with a HEPA-filtered fresh air intake powered by a fan located outside with a silencer for quiet operation “so it will get used” said Clifton.

The ventilation system also supports the heating system. The main supply duct for each of the three HRVs contains a coil from the air-to-water heat pump that cools or heats the air before distributing it throughout the home depending on the temperature needs of the home. The air-to-water heat pump is equipped with a variable-speed compressor and provides very efficient heating and cooling (at 4.62 COP) to the home via the radiant loops in the floor, fan coil units in each of the main living spaces, and the HRV supply ducts which are ducted to both the living areas and bedrooms. “When paired with the highly insulated envelope and thermal mass floors, the home stays remarkably consistent in temperature, both across the home and throughout the year. There is no need for daytime setbacks. Set your desired temperature once and the home will maintain it round the clock,” said Clifton. “This HVAC and envelope design work together to reduce overall energy demands and are easily replicated, creating efficient and comfortable buildings time and again.”

“We use the same mechanical closet in every house we build,” said Clifton. “I have a cut sheet (layout) so the electrician knows exactly where to put the electrical and the plumber knows exactly where to put the piping. I’ve gotten the cost down to \$35,000 for everything in the mechanical room. That’s the same price I paid for a much less

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program - 100% Commitment

ENERGY STAR Certified Homes Version 3.2

EPA Indoor AirPlus

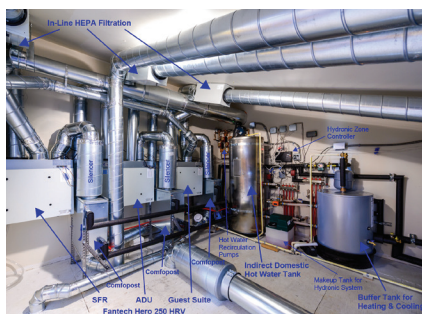
BuiltGreen, 5-Star

“When I started out working for other builders, you’d lose money on every house with a complicated design and make up the money on every simple house. We built two similar sized houses side-by-side in a neighborhood in Seattle. One cost \$700,000 to build and the other cost \$800,000. The extra \$100,000 was for labor and materials costs for all the trim and craftsman details added to the \$800K home. Both homes sold for the same amount and the simple one didn’t take any longer to sell than the other.”

– Ted Clifton,
President of TC Legend Homes



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.



TC Legend designed a standard utility closet layout that they use in every home with minor variations. The closet contains the HRVs, tanks for the air-to-water heat pump, fan silencers, HEPA filters, and other wiring, piping, instrumentation, and controls.

room, and two baths were added above the ADU for visiting family members. “The Lynden house was a fun design challenge,” said Clifton. “We tried several designs starting at \$2.4 million for construction costs and got it down to \$1.2 million.”

Simplifying the design often means reducing the number of corners, which reduces costs and energy losses. “Adding a corner can easily add \$30,000 to the cost of construction,” said Clifton. “You have more air sealing and water management details, more thermal bridging, more exterior wall surface, and more risk of failures.”

Clifton also advocates simple roof lines with a monoplane shed roof, a symmetrical gable, or an asymmetrical gable, which enables clerestory windows to bring sunlight into the interior of the home. “You can add details to differentiate the house but add them outside of the thermal envelope, like decks and porches. I’d rather stick to the rectangle and put a cool timber-framed porch on the outside. Instead of putting our money into complicated wasteful shapes and expensive tricky details, we put our money into PV and EVs,” said Clifton.

Clifton is so passionate about design that he started his own design company, Powerhouse Designs, and now does all of the design work for his custom homes inhouse. In typical custom construction, an architect draws up the plans, then hands them to an engineer who specifies materials to meet structural load, and then hands the plans and specs to the builder. “The problem,” said Clifton, “is the architect and engineer have no idea how much things cost. When we used to build other people’s designs, it used to frustrate me so much. The architect or engineer might specify a \$2,000 glue-lam beam when \$600 worth of lumber could carry the load. Could reducing the window size 10% save a lot without sacrificing view? We went through one house that had been designed by someone else and specified it as drawn, then started making changes and were able to save \$50,000 on construction costs by making tradeoffs,” said Clifton.

“We work with our homebuyers and show them the costs of different options so they can see where they can save and choose where they want to spend more money,” said Clifton. “And they still get all the performance benefits of a DOE Zero Energy Ready Home.”

efficient system in 2011. Equipment costs have gone up \$10K but our labor has gone down \$10K. All of the equipment is in the same spot every time. I use the same materials list too. We can do it in a day. On other builders’ homes, you’ll sometimes see the HVAC guys there for a week.”

For Clifton, the biggest energy and cost savings come from the design of the building itself. Most of his homes are a basic rectangle. The 2024 award-winning home was essentially three side-by-side rectangles. The homeowners wanted to get two families and their guests under one roof. The house and an ADU are on the main level and three bedrooms, a rec

KEY FEATURES

- **Walls:** SIPs, R-29 total. 6.5" graphite SIPs, self-adhered breathable weather-resistant membrane, plastic mesh, fiber cement siding.
- **Roof:** SIPs gable roof, self-adhering breathable vapor barrier. Metal roofing.
- **Attic:** Unvented vaulted ceilings: 10.25" R-48 graphite EPS SIP panels.
- **Foundation:** Slab on grade with 11.25" R-23.6 ICF stem wall. R-20 foam under slab.
- **Windows:** Triple-pane windows, U=0.16, SHGC=0.45, Low e, argon-fill, vinyl-framed. Extended roof and eaves.
- **Air Sealing:** 0.45 ACH50. All SIP panel joints are double-bead mastic sealed. Interior panel seams are taped. Window and door rough openings are foamed. All penetrations are sealed with foam. The whole house is air sealed with aerosolized acrylic.
- **Ventilation:** 3 HRVs, one for each living space, pull from baths and laundry, supply to bedrooms and living areas. HRVs are tied to a CO₂ sensor for boost and motion sensors for auto turn off. Kitchen has separate fresh air intake fan balanced to range hood fan mounted outside for quiet operation. All air intakes have HEPA filters. Stand-alone air quality monitor has phone app for alerts.
- **HVAC:** Air-to-water heat pump, radiant floor heating, 3 fan coils, 4.62 COP.
- **Hot Water:** Air-to-water heat pump for combined domestic hot water and space heating, 80-gal, 4.62 COP. Adaptive recirculation. WaterSense-labeled fixtures.
- **Lighting and Appliances:** LED lighting, ENERGY STAR appliances.
- **Solar:** 17-kW PV, 30.7-kWh batteries.
- **Energy Management System:** IAQ monitoring. Filter replacement alerts.
- **Other:** Two EV chargers and an RV charger. 5,000-gallon rainwater cistern for irrigation.

Photos courtesy of TC Legend Homes