TC Legend Homes

Montlake Modern
Seattle, WA

BUILDER PROFILE

TC Legend Homes
Bellingham, WA
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Montlake Modern
- Location: Seattle, WA
- Layout: 4 bedrooms, 3.5 baths, 2 floors
- Conditioned Space: 3,192 ft^2
- Climate Zone: IECC 4C, Marine
- Completion: May 2014
- Category: Custom

Modeled Performance Data:

- HERS Index: without PV 42, with PV -1
- Projected Annual Utility Costs: without PV $797, with PV $21
- Projected Annual Energy Cost Savings (compared to a home built to the 2012 IECC): without PV $1,002, with PV $2,326
- Builder's Added Cost over 2012 IECC: without PV $20,00, with PV $60,000
- Annual Energy Savings: without PV Electric (kWh) 15,367, with PV 25,067 kWh

After two years of searching for their dream home, a Seattle couple turned to zero energy home builder Ted Clifton of TC Legend Homes, who built them a modern two-story with a mother-in-law suite and views of Lake Washington from the roof-top deck. Clifton calls the home a positive energy home, one that produces more energy than the home itself consumes. In fact, the home should produce enough electricity to power an electric car with the charging station set up in the garage.

The home's modern asymmetrical design lends itself to the extra-large south-facing roof, which holds 36 solar photovoltaic panels for the 9.7-kW PV system. The home achieved a Home Energy Rating System (HERS) score of -1 with the PV or 42 without the PV; a home built to the 2012 International Energy Conservation Code (IECC) would score about a HERS 70.

The home meets all of the high-performance requirements of the U.S. Department of Energy's Zero Energy Ready Home program. To be certified as a DOE Zero Energy Ready Home, the builder must meet ENERGY STAR Certified Homes Version 3.0, the U.S. Environmental Protection Agency's Indoor airPLUS and WaterSense requirements, the insulation requirements of the 2012 International Energy Conservation Code, additional DOE Zero Energy Ready Home efficiency requirements, and have renewables or "renewable-ready" measures installed.

Clifton has made a reputation for himself with zero energy construction in Seattle and Bellingham. This home was part of the 2014 Seattle Green Home tour. The home features many of the elements that have helped him meet zero energy on other projects, starting with a slab-on-grade foundation with insulated concrete form (ICF) stem walls that provided R-28 of insulation to the sides of

The structural insulated panel walls and roof came together quickly providing a sturdy, highly insulated, and airtight structure for this modern two-story home constructed in Seattle by TC Legends of Bellingham, Washington.

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

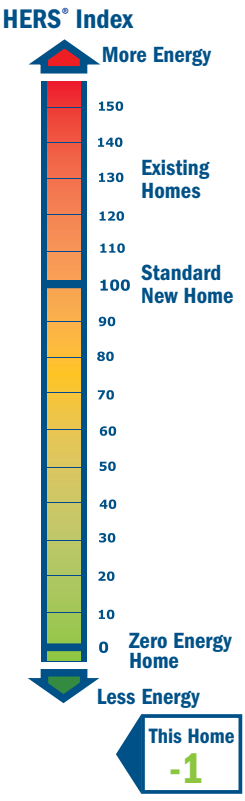
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



the slab, while a 4-inch-thick layer of rigid high-density EPS foam under the slab provided an additional R-20 of protection from the ground below. This highly insulated slab helps retain the heat of the radiant floor heating loops installed in the ground floor slab. The concrete slab was stained, sealed, and left exposed as the first floor of the home. The second floor consists of plywood subfloor over engineered floor joists. The radiant floor loops were stapled up under the subfloor.

The walls and roof of the home were constructed of structural insulated panels (SIPs), which consist of rigid foam sandwiched between two layers of OSB. The foam adheres to the OSB and hardens during the manufacturing process, creating a strong bond and a very sturdy panel. The SIPs are cut to order in the factory, providing straight, clean, and dry walls with high shear strength that come to the site ready for quick assembly. The 6-inch-thick walls provide R-26 of insulation; no additional insulation is needed. The 12-inch-thick SIP roof panels provide an R-46 insulation value in the cathedral ceiling.

The exterior walls were clad with a pre-finished smooth fiber cement siding that installs in 4-ftx8-ft panels for a very sleek modern look. Metal Z flashing was installed between the panels to direct water out at the seams. A corrugated draining house wrap provides an additional layer of protection, serving as a weather-resistant barrier under the cladding.

The home has no attics; the SIP panels provide roof deck, support, and insulation in one product making construction of the cathedral ceilings a fast and simple process. The roof was clad with standing seam metal roofing, which is highly durable and adds to the modern appearance of the home.

SIPs provide an airtight wall because SIP walls have far fewer seams than stud walls. Even so, Clifton's crews take additional steps to ensure the airtightness of the building envelope. Where the SIP panels connect to the ICF foundation wall, Clifton uses sill seal plus two beads of SIP mastic under the SIP panel. The wall-to-floor seam is caulked all along the inside perimeter of the home, then the baseboard is installed and caulked along the top and bottom edge. Before drywalling, Clifton's crews also foam the rough openings and caulk around all the windows; foam behind all the electric boxes and caulk around them; and foam and/or caulk around the electric wires and plumbing pipes. All of the SIP seams are both caulked and taped, in addition to the tape and mudding done by the drywallers.

Large south-facing triple-pane windows keep out the cold while allowing in any available sunlight to warm the stained-concrete thermal mass of the main floor. Radiant heating loops with hot water from an air-to-water heat pump provide radiant heat to the home. ENERGY STAR appliances, an induction cooktop, and 100% LED lighting help to keep energy usage to a minimum.

This attention to detail helps Clifton achieve a very airtight building envelope. When the Montlake home was blower door tested, the whole house showed air leakage of only 0.97 air changes per hour at 50 Pascals pressure difference (ACH 50), which is far more airtight than even the stringent 2.5 ACH 50 specified by the DOE Zero Energy Ready Home program requirements for the marine climate.

All of the heat for the home is provided by the radiant floor heating installed in the ground floor and second floor. The water for this radiant system is heated by an air-to-water heat pump, which operates at a COP of 4.5. This heat pump also preheats domestic hot-water, which is further heated in a 50-gallon electric storage water heater.

The home also benefits from passive solar heating since 80% of the windows face south, allowing any available sunlight to reach the bare concrete slab. The triple-paned windows have an excellent insulating value of U=0.097. Low-emissivity coatings help to minimize the radiant transfer of heat. The relatively high solar heat gain coefficient of 0.62 lets in any sunlight during the three-quarters of the year when the Northwest is cool and cloudy, while overhangs and deciduous trees that were retained on the lot help provide shading during the summer.

For ventilation in the airtight home, Clifton devised a balanced system that employs relatively inexpensive, quiet and efficient ENERGY STAR-rated exhaust fans, which are electronically controlled to work together to bring fresh air into the home and pull stale air out of the home. A 5.4-watt exhaust fan in the laundry room runs continuously at 30 cfm to meet ASHRAE 62.2 and is set on a motion sensor to ramp up to 110 cfm during occupancy. Outside air is ducted from the north side of the house through a HEPA filter to supply air to the home. Each bathroom has its own switch-operated exhaust fan. All ducting for the supply air is in the conditioned space, allowing it to warm up before being delivered. The air is drawn into the home passively when just the bathroom and laundry fans are operating. However, when the higher powered 400-cfm range hood fan is turned on, a 200-cfm inline fan on the fresh air intake duct turns on to pull in more air to keep house pressures balanced. This powered ventilation could also be timer operated to come on in the early morning hours during the hot summer periods to remove heat from the home and thus keep the thermal mass from overheating the inside space.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program, 100% commitment

Northwest ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

ENERGY STAR

Building America U.S. Department of Energy

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.

Long-lasting fiber cement siding and standing seam metal roofing provide durable exterior finishes in the often damp Northwest climate.

In addition to the high-efficiency heating and ventilation systems, Clifton also recommended ENERGY STAR appliances and 100% LED lighting for all of the installed fixtures. Low-flow plumbing fixtures also reduced water heating demands. Programmable thermostats and an internet-connected monitoring system for the PVs will help the couple track their energy use and production.

These efficiencies together with the highly efficient building envelope mean that the 9.7-kW PV system will more than cover the power needs of the all-electric home. It should produce enough to power an electric car with the car charging station in the garage.

The energy-efficiency upgrades added about $20,000 to the cost of the $700,000 home (a typical price for a home in this desirable Seattle neighborhood). The PV system added another $40,000 however, the homeowners will receive the federal tax incentive of 30% of the cost of the system and because the system was manufactured in Washington state they will also get a production credit of $5,000 per year from Washington state refunded through the local power company. The family has had a negative power bill each month since living in the home.

"The incremental cost above code has resulted in a highly efficient and energy saving home. The above-code costs were mitigated by the efficiency of our construction team and the short time frame in which the home was constructed," said Clifton. "With the federal and state solar incentives and the zero power bills, the upgrades should pay for themselves within 5 years."

Homeowner satisfaction may be the biggest sign of success. "Our old house used to have some rooms that were too hot if you turned the heat on all the way, while other rooms were too cold. It is great to have a place where I just don't even notice the temperature - it is always comfortable. We have a toddler and another one on the way. It is great peace of mind to know that the air quality is good, and we don't have to worry about her health. Whether you are environmentally conscious or not, having a comfortably heated home, negative energy bills, and great air quality is something that everyone can enjoy," said the homeowners.

Photos courtesy of TC Legend Homes.

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance
- **Walls:** R-6, 6-inch SIP walls; pre-finished fiber cement siding; draining house wrap
- **Roof:** R-46, 12-inch SIPs; metal standing seam roof
- **Foundation:** R-28 ICF slab edge, R-20 rigid foam under slab
- **Windows:** Triple-pane; vinyl-framed; low-emissivity; U=0.097, SHGC=0.62
- **Air Sealing:** 0.97 ACH 50
- **Ventilation:** 5.4-watt exhaust fan in laundry runs continuously at 30 cfm to meet ASHRAE 62.2, switch-controlled bath exhaust fans. HEPA-filtered fresh-air intake with fan for passive makeup air but controlled to power on when 400-cfm range hood is turned on
- **HVAC:** Radiant floor heat
- **Hot Water:** 5-ton air-to-water heat pump, COP 4.5 provides hot water for radiant floors and pre-heats domestic hot water; 50-gallon electric tank stores water and boosts temperature
- **Lighting:** 100% LED
- **Appliances:** ENERGY STAR refrigerator, dishwasher, clothes washer
- **Solar:** 9.7-kW PV system
- **Water Conservation:** Low-flow fixtures
- **Other:** PV monitoring system; programmable thermostats; electric car charging station; low/no-VOCs glues, adhesives, and paints