

Hammer and Hand

Pumpkin Ridge
Passive House
North Plains, OR



BUILDER PROFILE

Hammer and Hand, Portland, OR
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Rater: Earth Advantage
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Pumpkin Ridge Passive House
- Location: North Plains, OR
- Layout: 4 bedrooms, 4 baths, 2 floors, finished basement
- Conditioned Space: 3,599 ft²
- Climate Zone: IECC, 4C, marine
- Completion: August 2013
- Category: Custom

Modeled Performance Data:

- HERS Index: without PV 49, with PV 5
- Projected Annual Utility Costs: without PV \$1,432, with PV \$235
- Projected Annual Energy Cost Savings (compared to a home built to the 2009 IECC): without PV \$642, with PV \$1,839
- Builder's Added Cost Over 2009 IECC: without PV \$42,000, with PV \$54,402
- Annual Energy Savings: without PV 12,823 kWh, with PV 24,214 kWh

Sam Hagerman founded Hammer and Hand in Portland, Oregon, in 1995 as a residential remodeling firm specializing in restoring old homes. He is now in the vanguard of builders constructing new Passive Houses and this year built his first home certified as a U.S. Department of Energy Zero Energy Ready Home.

Hagerman helped to form the Passive House Alliance US (PHAUS) and served as its first president. PHAUS is the sister organization to the Passive House Institute US (PHIUS), which worked with Sam Rashkin, chief architect for DOE's Building Technologies Office, to establish an agreement allowing builders who qualify to the Passive House US standards to easily certify to the DOE Zero Energy Ready Home program.

"It's been a great collaboration because we've given builders more tools to build high performance. And it's great to have the recognition from DOE," said Hagerman, who added "The independent third-party verification is the lynch pin really for both programs—DOE ZERH and Passive House. Seeing that DOE's program requires third-party verification gave them a ton of credibility in the Passive House community."

The DOE Zero Energy Ready Home program requires homes to meet all of the requirements of ENERGY STAR Certified Homes Version 3.0 and the U.S. Environmental Protection Agency's Indoor airPLUS, as well as the hot water distribution requirements of the EPA's WaterSense program and the insulation requirements of the 2012 International Energy Conservation Code. In addition, homes are required to have a solar electric system installed or have the conduit and electrical panel space in place for it.



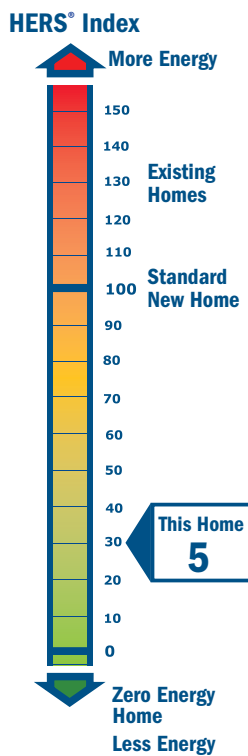
The U.S. Department of Energy invites home builders across the country to meet the extraordinary levels of excellence and quality specified in DOE's Zero Energy Ready Home program (formerly known as Challenge Home). Every DOE Zero Energy Ready Home starts with ENERGY STAR Certified Homes Version 3.0 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.

Hammer and Hand built this 3,599-ft² Passive House near Portland, Oregon, to the requirements of the U.S. Department of Energy Zero Energy Ready Home program. The home will perform at zero energy, producing as much power as it uses annually, and is expected to save its owners nearly \$2,000 a year compared to a home built to the 2009 International Energy Conservation Code.



What makes a home a DOE ZERO ENERGY READY HOME?

- 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.

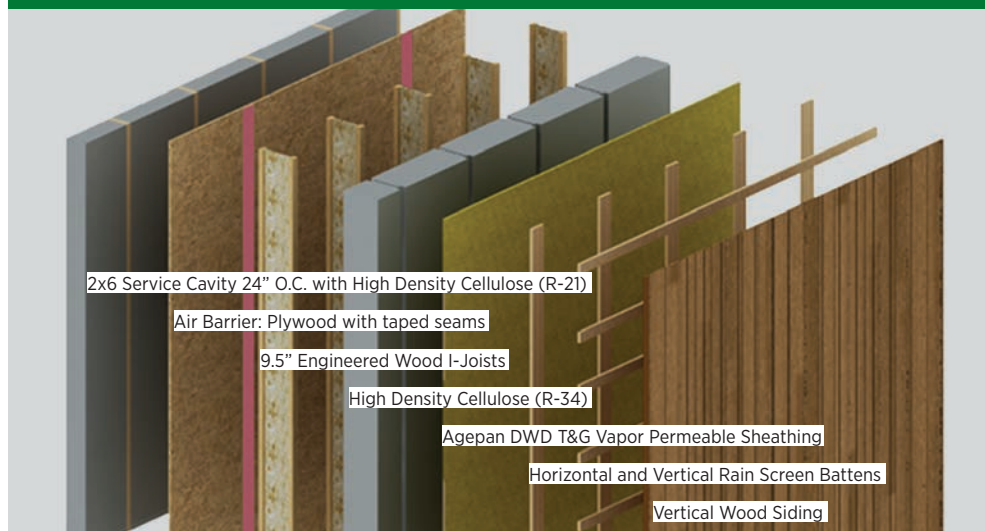


The 3,599-ft² Pumpkin Ridge Passive House, located in the country west of Portland, Oregon, was built with these criteria to achieve a Home Energy Rating System (HERS) score of 49, or 5 with the 10 kW of solar PV panels on the home's simple rectangular roof.

The home is constructed with a daylight basement with concrete foundation walls and a 4-inch basement slab. Under the slab, the builder installed 6 inches of Type II higher density EPS insulation for an insulating value of R-28.6. He also installed 6 inches of TYPE II EPS insulation on the exterior of the foundation walls. Thermal continuity at the foundation perimeter was maintained by running 4 inches of structural high-density EPS (R-16) below the footings to connect the foundation wall and slab insulation layers.

Hammer and Hand employed a unique construction technique for the walls that provided two insulation cavities for a highly insulated wall. The load-bearing 2x6 walls were framed at 24 inches on-center using advanced framing techniques and sheathed with plywood. Then the builder attached 8-inch-deep engineered truss joists to the outside of the plywood, and sheathed this with a European tongue-and-groove vapor-permeable sheathing product that is made of sawdust and a paraffin wax binder. It is water-resistant enough to work as a weather-resistant barrier on the exterior of the house. The 5.5-inch and 9.5-inch wall cavities were filled with high-density cellulose insulation for a total insulation value of R-57.7. Hammer and Hand applied a vapor-permeable coating that serves as an air barrier and moisture management layer and functions as a seamless flashing around window and door openings.

The window flashing detail is the element that actually pushed Hagerman into building science. In the late 1990s Hammer and Hand started experiencing building envelope failures—rotten sheathing and rotten framing around windows within 2 years of construction. He couldn't get a good answer as to why this was happening from the architects he was working with and he was installing windows exactly as specified by the manufacturer. Peel and stick membranes had just become popular and he was putting them everywhere around the window. Unfortunately, in the continuously damp Pacific Northwest, they put an unintentional vapor barrier on the outside of the building that was trapping moisture and causing sheathing to start to rot.



Hammer and Hand installed engineered trusses on the outside of the primary wall's sheathing to create a second wall cavity. Both wall cavities are filled with cellulose insulation for a total wall insulation value of nearly R-60. Battens provide ventilation behind the cedar and fiber cement siding.



Hagerman switched to a liquid-applied membrane product that comes out of tube and is applied with a trowel. According to Hagerman, the product takes the place of pan and corner flashing, remains sticky so it self-seals when nails go through it, is seamless, and is vapor-open at 20 perms so it solved the moisture problems he had been experiencing. His quest to solve this problem led to a deeper understanding of many other building science aspects of construction.

After the fluid-applied flashing was applied to the walls, Hagerman then installed horizontal and vertical battens to provide a drained rain screen and ventilation gap behind the vertical cedar siding. "With the super air-tight envelopes we are building, we need a way to dry out the wall, so now we use a ventilated wall cladding. Air can flow behind the cladding to keep the outside surface of the wall dry," said Hagerman.

To ensure airtightness at the ceiling plane, the home has a double ceiling. A continuous plywood layer is installed below the trusses with all joints and penetrations sealed with a tenacious air-sealing tape that creates a continuous air barrier at the ceiling plane. Then, a second drywall ceiling is installed 1.5 inches below to provide a service cavity for wiring. Above the top ceiling, 24 inches of blown cellulose insulation is installed in the vented attic for an R-86 insulation value. The roof is covered with plywood sheathing and 30-lb felt underlayment and topped with 40-year composition shingles.

All of these air sealing details helped the home achieve a super-airtight blower door test reading of 0.36 air changes per hour at 50 Pascals (ACH 50), well within the Passive House requirement of 0.60 ACH 50. To ensure good air quality, continuous ventilation is provided by a heat recovery ventilator with a 90% efficiency rating and MERV 13 filters. The HRV is separately ducted to provide fresh air to the living areas of the house and pull stale air from the bathrooms. The HRV is set to run 24/7 and has a night-flush function that bypasses the heat exchanger to provide free cooling in the summer.

Hagerman said "one thing I like about the DOE program is that it's not just about energy, it's also about indoor air quality and health. People move into these homes and the kids' asthma inhaler goes in the kitchen drawer and never comes out. Thermally, they are so comfortable, no drafts, no thermal disparity, plenty of light, and a new slug of air every 3 hours from the outside."

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program, 100% commitment

ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

Passive House Institute U.S. +

Earth Advantage Home Certification: platinum level



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.



Sliding cedar shades block unwanted solar heat gain on hot summer afternoons.

One minisplit heat pump provides all of the heating and cooling the highly efficient home needs. While some homes are set up so that the HRV uses the central heating system's ducts to distribute air, in this home the heat pump uses the HRV's sheet metal ducts to distribute warm and cool air throughout the home. The inverter-driven system has a heating efficiency of 10 HSPF and a cooling efficiency of SEER 15.5.

The home is equipped with a heat pump water heater having a coefficient of performance (COP) of 2.2. The hot water distribution system is equipped with an on-demand hot water circulation pump to minimize the time spent waiting for hot water. The home's energy-efficient lighting includes 95% LEDs and 5% CFL fixtures. ENERGY STAR appliances in the home include a refrigerator, dishwasher, and

clothes washer, and two ENERGY STAR ceiling fans. An electronic monitoring system provides full, circuit-by-circuit energy monitoring, and is internet-accessible via smart phones, tablets, computers, etc.

Rain that hits the roof is captured by the home's rainwater harvesting system. Irrigation is minimized through the use of hardy, drought-resistant plants throughout the home's landscaping.

Unwanted solar heat gain was minimized by designing the home with a generous roof overhang and installing a system of movable slatted cedar exterior shades that can be slid in front of windows when shading is needed.

The triple-paned Passive House-compliant windows also have two layers of low-emissivity coatings to help reduce heat transfer as well as argon fill and insulated wood frames for increased insulation value. The windows have an insulation U-factor of 0.13 and a solar heat gain coefficient (SHGC) of 0.5. Triple-paned European solar tubes provide additional daylighting.

Hagerman noted "By employing the Passive House approach to Zero Energy Ready Home design and construction, the Pumpkin Ridge Passive House enjoys both a robust and highly thermally resistant building envelope as well as passive heating and cooling features that make it resilient in the face of future power outages or disasters. The home will remain comfortable and safe to inhabit for long periods of grid outages. The home was built solar-ready and now features a 10-kW solar PV array that enables it to perform at net zero energy."

Photos courtesy of Hammer and Hand

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance.
- **Walls:** 2x6; 24" on center; plywood sheathing; 8" engineered truss mounted to exterior; 2nd sheathing of wax-wood; dense-packed cellulose in cavities (R-60); fluid applied permeable flashing; vented rain screen; cedar siding.
- **Roof:** 40-year composition shingles.
- **Attic:** Vented; 24" blown cellulose (R-86); plywood ceiling with sealed seams; dropped drywall ceiling creates air-sealed cavity for wiring.
- **Foundation:** Daylight basement; 6" EPS under slab (R-29); 6" EPS on exterior foundation walls (R-29); 4" high density EPS under footings (R-16).
- **Windows:** Triple-pane; argon-filled; low-e; U=0.13; SHGC=0.5.
- **Air Sealing:** 0.36 ACH 50.
- **Ventilation:** HRV; night vent function; MERV 13 filter.
- **HVAC:** Minisplit heat pump; ducted with HRV; 15.5 SEER; 10 HSPF.
- **Hot Water:** Heat pump water heater.
- **Lighting:** 95% LED; 5% CFL.
- **Appliances:** ENERGY STAR-rated refrigerator, dishwasher, and ceiling fans.
- **Solar:** 10 kW PV.
- **Water Conservation:** Push-button recirculation pump.
- **Other:** Energy management system; low-VOCs.