U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

DOE ZERO ENERGY READY HOME™

U.S. DOE ZERO ENERGY READY HOME 2021 WINNER Housing Innovation Awards

Martha Rose Construction

Abbot's Alley Net Zero
Sedro Wooley, WA

BUILDER PROFILE

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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Abbot's Alley Net Zero
- Location: Sedro Wooley, Washington
- Layout: 2 bdrm, 2 bath, 3 fl, 1,804 ft²
- Climate: IECC 4C, marine
- Completed: January 2019
- Category: Custom Spec

Modeled Performance Data:

- HERS Index: without PV: 47; with PV: -13
- Annual Energy Costs: without PV: $750; with PV: -$100
- Annual Energy Cost Savings: (vs typical new homes) without PV: $950; with PV: $1,800
- Annual Energy Savings: without PV: 7,600 kWh; with PV: 18,000 kWh
- Savings in the First 30 Years: without PV: $39,100; with PV: $72,900

With the Abbot's Alley Townhomes, Martha Rose of Martha Rose Construction set an ambitious goal for herself—to build a community of solar-powered live-work units that met the requirements of the U.S. Department of Energy's Zero Energy Ready Home program and were priced on par with entry-level housing in the Skagit Valley, so they would sell in a small rural town unfamiliar with net zero homes but at a price point high enough to pay back Rose and her crew. Rose succeeded with six units that achieved Home Energy Rating System (HERS) scores of -13 (well below net zero) for the 1,804 ft² units that sold for $377,000 with the full solar array already installed as a standard feature. "As with my career in Seattle, I decided to roll the dice and differentiate my product from that of other builders. The risk paid off," said Rose. It's paying off for the six home owners too, who can expect to pay no more than connection fees for their electric bills.

These were Rose's first homes certified to the DOE ZERH program, although she is no stranger to high-performance home construction. She was the first builder to install solar on a spec home in Seattle in 2004 and has built many 5-Star Washington State Built Green homes with solar. Her homes average 750 to 900 points, far above the 600-point threshold required for a 5-Star Built Green rating. Martha began in construction in late 1972 in the Washington, D.C., area. Through a circuitous path in the industry, she found her way into the Built Green Community in Seattle in 2003 and by 2005 was certifying all of her spec homes to the 5-Star Built Green standard. She joined the ENERGY STAR Program shortly after that with a personal goal to make each home more energy efficient than the last. Rose became a partner in the DOE Zero Energy Ready Home program in 2018 and has now committed to constructing every home to the DOE ZERH criteria.

ZERO ENERGY READY HOME U.S. DEPARTMENT OF ENERGY

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.

The six live-work units in this community achieved HERS scores of -13 thanks to a combination of highly efficient construction; high-efficiency ductless mini-split heat pumps, appliances, and lighting; triple-pane windows; and 9.9 kW of solar panels on each of the monoplane roofs.

What makes a home a DOE ZERO ENERGY READY HOME?

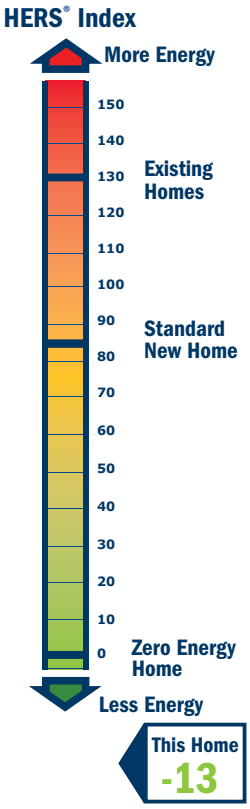
1 **BASELINE**
ENERGY STAR Certified Homes Version 3.0/3.1

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.

Every ZERH certified 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 and meet the hot water distribution requirements of the EPA's WaterSense program. DOE ZERH 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.

The three-story homes were built with 2x6 16-inch on-center stud walls that are insulated with dense-blown fiberglass insulation. Rose wraps the walls in 1 inch of XPS that is sandwiched between the stud and the ½-inch plywood sheathing, which is then wrapped with draining house-wrap and topped with fiber-cement, metal, and wood siding. This foam-under-plywood wall assembly, nicknamed the "Martha Wall," was structurally tested in the early 2010s in Oregon and found to be more resistant to lateral forces than framing with the sheathing nailed directly to it, according to Rose. "Besides the aesthetic and simple design, the wall assemblies have the added feature of being 2.5 times more resilient in the event of an earthquake. A longer nail is used through the sheathing for attaching both layers at once. The foam acts as an air and water barrier and also provides sound attenuation and greater resilience in an earthquake. It is one component of our R-28 wall assembly," said Rose.

The slab-on-grade foundations are fully insulated with two layers of XPS foam providing R-20 under-slab insulation. The stem walls are also wrapped in an R-10 layer of rigid foam. Rose noted as of this year the extruded polystyrene foam she uses is NGX, a next generation polystyrene which uses a different manufacturing technique that is 90% less harmful to the environment.

The monoplane shed roofs are all angled to the south at a 3/12 pitch for optimum solar exposure. The unvented vaulted roof assemblies are insulated with two layers of fiberglass batts for an R-value of 60. Fifty-year composition shingles and 9.9-kW solar arrays complete the roof assemblies. This is more than enough power to supply the needs of the compact, energy-efficient units. Each home has a 40-amp circuit with wiring in place to install an electric car charger to take advantage of the surplus power produced. The homes' design includes north and south overhangs that are 3 feet and rake overhangs that are 2 feet. "In our climate, big overhangs are an essential design feature for weather protection and for shielding against the summer sun," said Rose.

A mix of fiber cement, metal, and wood siding provides architectural interest to the facades of the identical units, covering the uniformly high-performance wall assemblies of advance framed 2x6, 16-inch on-center walls, which are wrapped with 1 inch of EPS, plywood, and draining house wrap. The slab-on-grade foundation sits on 4 inches of XPS closed-cell foam and the vented cathedral ceilings are filled with R-60 batt insulation.

All of the homes' windows are triple-pane with a U-factor of 0.18 providing reduced heat and sound transfer and a solar heat gain coefficient (SHGC) of 0.29 to allow in some beneficial heat gain. The vinyl-framed argon-filled windows have low-emissivity coatings on three sides to decrease heat transfer into the home in the summer and out in the winter. Most of the window styles are fixed or casement style to further reduce air leakage.

The homes are quite air tight which Rose credits in part to the sandwiched EPS foam that she felt provides good air sealing on the exterior walls. She noted that her crew also does detailed hand sealing of penetrations at the ceilings and that they installed a sill seal (foam fabric) gasket between the sill plate and the slab at the base of the exterior walls. The award-winning home achieved a blower door-tested air tightness of 1.0 air changes per hour at 50 Pascals, well below the code-required 3 ACH 50.

To bring in fresh air and remove stale air from the draft-free units, a heat recovery ventilator was installed and set to operate continuously, with fresh air drawn in through MERV 6 filters (contractor-grade filters have a MERV of 1). HRVs provide balanced fresh air ventilation to sleeping and living areas and exhaust stale air from the bathrooms and laundry.

Heating and cooling is provided by a single ductless mini-split heat pump with a heating efficiency of 11 HSPF and a cooling efficiency of 20 SEER that was installed on the ground floor of each unit. Infrared cove heaters were also installed in the upper rooms to provide supplemental electric radiant heat on the coldest days. Home owners can also open the stairwell door to encourage natural convection to bring warm air from the ductless heat pump to the second and third floors.

All-LED lighting with photo cells on the exterior lights provides additional energy savings as do the ENERGY STAR refrigerator, clothes washer, and condensing heat pump clothes dryer. A 40-gallon electric tank water heater with an efficiency factor of .95 was installed inside the units to serve all three floors. Low-flow fixtures were installed to save water and drought-resistant landscaping was installed. A PEX piping system with ½-inch piping speeds hot water to end uses.

To handle stormwater runoff at the site, an infiltration basin was installed under the small concrete-surfaced alley around which the six homes are arranged. Beneath the concrete surface lays a 36-inch-deep basin of railroad ballast. All site and roof water drainage is directed to this bed.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Quality Management Guidelines

DOE Zero Energy Ready Home Program - 100% Commitment

ENERGY STAR Certified Homes Version 3.1

EPA Indoor airPLUS

Built Green WA, 5-Star Net Zero

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 wall assembly has become standard for Martha Rose homes – advanced framed 2x6 walls filled with R-22 insulation, wrapped with an inch of EPS, and topped with a ½ inch of plywood sheathing plus draining house wrap.

The homes were designed with aging in place in mind. The first-level live-work space is stepless with a bathroom with a wheelchair-accessible shower. It is plumbed for a kitchen if needed for first-floor living.

Like all DOE Zero Energy Ready Homes, these units meet the requirements of the EPA Indoor airPLUS program and additional efforts were made to use non-toxic sustainable materials. All interior paints are no/low VOC. Adhesives, caulks, stains, and pigments are all low-toxic/low-VOC, meeting the Built Green program standards. Sheathing is exterior-grade NAUF plywood. No OSB was used in the homes. Interior finish materials and cabinet casework are solid wood or NAUF plywood; no medium density fiberboard (MDF) or particle board cabinetry was used. The stair treads are made of cork. Salvaged lumber from existing structures on the site was used in bracing and blocking and trim. Recycled-content insulation, drywall, and metal siding were used. For the first floor the concrete foundation slab is sealed and stained to serve as the finished flooring.

Rose noted that using the concrete slab as the finished flooring is one of many techniques she employs to reduce costs to keep the high-performance homes on par with local housing costs. “I let the energy-saving features be the “bling.” I offset the cost of that in a myriad of ways: simple design, hacks to save lumber like using rim joists as headers, using open shelving instead of upper cabinets, installing one-piece showers and tubs, choosing fixed instead of openable windows, etc.”

Rose had no trouble selling the six units. She noted that she participated in the National Solar Tour and gave presentations at Sustainable Connections in Bellingham and at the NW EcoBuilding Guild in Seattle. She also was present for several open houses. “But the best communication, I have found over the years, is the solar panels on the roof. Until consumers see the icing on the cake, it’s extremely difficult for them to grasp that these homes are truly that different from the mainstream,” said Rose.

“Abbot’s Alley provides a unique live-work, net zero, walkable lifestyle on the main street of this small town,” said Rose. She noted that the design of this collection of homes clustered around their own alley has allowed a strong sense of community to develop with regular outdoor movies, community gardening, and other activities.

Photos courtesy of Martha Rose Construction

KEY FEATURES

- **Walls:** 2x6, 16″ o.c., R-28 total: advanced framed, 1″ EPS, ½″ plywood sheathing, draining house wrap, fiber cement, metal, and wood siding.
- **Roof:** Truss shed roof: flat 24″ truss, composition shingles, monoplane angled for solar.
- **Attic:** Unvented attic: 22″ R-60 fiberglass batts and full-height energy trusses.
- **Foundation:** Slab-on-grade: R-20 XPS under slab, R-7.5 XPS on exterior of stem wall.
- **Windows:** Triple-pane, argon-filled, low-e3, vinyl frame, U=0.18, SHGC=0.29.
- **Air Sealing:** 1.0 ACH50, detailed hand sealing of penetrations at ceiling, sill seal gasket at slab-on-grade.
- **Ventilation:** HRV, MERV 6 filters, 1.58 CFM/Watt, 77 SRE.
- **HVAC:** Ductless mini-split heat pump with variable speed compressor, 11 HSPF, 20 SEER. Infrared cove heaters upstairs.
- **Hot Water:** Electric tank, 50-gal, .95 EF.
- **Lighting:** 100% LED, photo sensors on exterior lights.
- **Appliances:** ENERGY STAR refrigerator, clothes washer, heat pump clothes dryer.
- **Solar:** 9.9 kW, rooftop panels.
- **Water Conservation:** Low-flow plumbing, PEX piping; stormwater infiltration under alley.
- **Energy Management System:** N/A
- **Other:** EV charging, accessible floorplan, bath, showers. 1st floor live-work space. No/low-VOC paints, adhesives, caulks, stains; salvaged lumber; recycled content insulation, drywall, and metal siding.

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