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

DOE ZERO ENERGY READY HOME™

U.S. DOE ZERO ENERGY READY HOME 2016 WINNER *Housing Innovation Awards*

Kalamazoo Valley Habitat for Humanity

The Glendale Model
Kalamazoo, MI

BUILDER PROFILE

Kalamazoo Valley Habitat for Humanity
Kalamazoo, MI
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Rater: Home Energy Insight, LLC
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Glendale
- Location: Kalamazoo, MI
- Layout: 3 bdrm, 1 bath, 1 fl, 1,120 ft²
- Climate Zone: IECC 5A, mixed-humid
- Completion: May 2016
- Category: affordable

Modeled Performance Data:

- HERS Index: without PV 46
- Projected Annual Energy Costs: without PV $858
- Projected Annual Energy Cost Savings (vs home built to 2009 IECC): without PV $741
- Projected Annual Energy Savings: without PV 2,138 kWh, 417 CCF
- Added Construction Cost: without PV +4-6%

With its cheerful red siding, white trim, broad front porch, and simple one-story design, the high-performance home constructed by Kalamazoo Valley Habitat for Humanity in suburban Kalamazoo, Michigan, has a quaint, "prairie schoolhouse" look to it, but it's what's inside that matters most. Unique advanced framing details and a blanket of rigid foam in the walls, plus advanced heating, lighting, and ventilation equipment, make this affordable home one of the most high-performing new homes in the country and helped the Habitat affiliate earn a 2016 Housing Innovation Award from the U.S. Department of Energy's Zero Energy Ready Home program.

For Kalamazoo Valley Habitat's construction manager Tom Tishler, these high-performance features mean that the Habitat affiliate can offer "a much lower cost of ownership for our home owner families, as well as a very high-quality, high-performing home."

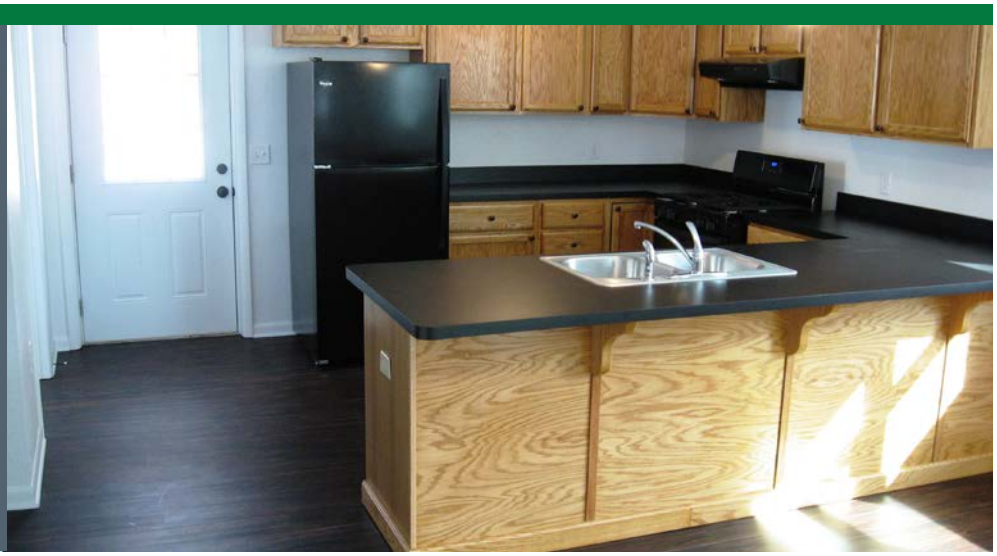
"We have found that we spend, on average, 4-6% more on additional improvements to go beyond a code-built (Habitat) home, but with much higher performance" said Tishler. With this relatively modest cost increase, the program has seen the Home Energy Rating System (HERS) scores of its homes drop from an average of 80 to below 50 (typical new code-built homes have average HERS scores of 80 to 100). The Habitat affiliate's 2016 award-winning home received a HERS score of 46 and is expected to cost the home owner no more than $75 per month in energy bills.

The home achieves this by meeting the construction requirements of the DOE Zero Energy Ready Home program. Every DOE ZER home is certified to ENERGY STAR Certified Homes Version 3.0 and the U.S. Environmental Protection Agency's Indoor airPLUS program. Each home meets the hot water distribution requirements of the EPA's WaterSense program and the insulation requirements of the 2012 International Energy Conservation Code. In addition,

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 (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.

Kalamazoo Valley Habitat for Humanity built this 1,120-ft² home in Kalamazoo, Michigan, to the performance criteria of the DOE Zero Energy Ready Home (ZERH) program. The home is equipped with an ENERGY STAR-rated refrigerator. It also meets the EPA Indoor airPLUS requirements by using wood products, primer, paint, cabinets, and flooring that limit the release of air contaminants.



What makes a home a DOE ZERO ENERGY READY HOME?

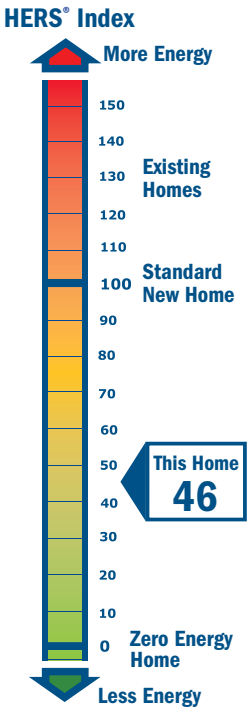
1 **BASELINE**
ENERGY STAR Certified Homes Version 3.0

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.

homes are required to have solar electric panels installed or have the conduit and electrical panel space in place for future installation of solar panels, if the geographical location provides adequate solar radiation.

"We feel strongly that a home need not use space-age materials and be expensive to build to be a high-performance home," said Tishler. "We believe that the best high-performance home is the one you can't recognize from the curb as such, and that this path will lead more people to build in this way." The energy-saving features of the Kalamazoo Valley Habitat home are subtly hidden within the 1,120-ft² single-story, three-bedroom, one-bath home. Local architects volunteered to work on the design and added curb-appeal facade details along with a deep front porch to protect the entryway from snow and 24-inch-deep overhangs to keep water away from the foundation and provide summer shading.

Inside the walls are the special features that help keep this home snug despite Kalamazoo's cold snowy winters and hot, humid summers. The walls are wood framed using 2x6 top and bottom plates, which allows for about 1.5 inches more insulation in the walls than typical walls constructed with 2x4 top and bottom plates. However, instead of using 2x6 studs, the Habitat affiliate used 2x4 studs that are spaced every 12 inches and staggered along the 2x6 plates so that every alternate stud aligns with either the inside edge or outside edge of the plates. This allows the blown cellulose insulation to wrap around the edges of the studs stopping the flow of heat through the studs from one side of the wall to the other. The Kalamazoo Habitat uses other advanced framing techniques to reduce the amount of lumber in the walls. They use two studs rather than three or four to frame corners and single, not double, top plates. There are no king and jack studs around windows; in fact, there are no studs side by side anywhere in the exterior walls. Many builders will use solid wood 2x10s or 2x12s to fill the header space above doors and windows. Kalamazoo Habitat uses no lumber in the headers on non-load bearing walls; instead, they leave that space open for insulation. On load-bearing walls, they use just one piece of dimensional lumber plus rigid foam insulation.

The Habitat affiliate used 2-inch (R-10) extruded polystyrene (XPS) for the sheathing with metal bracing rather than OSB at the corners so the rigid foam is continuous. They used a no-VOC sealant to seal all seams in the framing and glue the foam to the framing and taped any seams in the foam to provide a comprehensive air barrier. Then, netting was installed to the interior face of

After pouring the footing and foundation wall, the space within the foundation walls was filled to level with the top of the wall and an R-10 layer of rigid foam was laid down covering the ground space and the footing walls. After pouring the slab, the sill plates and wall framing were installed. Then, 2-inch rigid foam was installed along the exterior of the footing wall. This vertical foam extends 16 inches below grade to the base of the footing, then extends out 24 inches from the foundation wall. This shallower footing allows the affiliate to save excavation costs, while still protecting the foundation from frost.

the framing and the walls were filled with R-22 of dense-packed cellulose before installing the interior drywall. On the exterior, seams around all windows, doors, and penetrations were sealed with flashing tape, then the walls were covered with house wrap that was properly overlapped and taped at the seams. The walls were clad with vinyl siding.

The Habitat affiliate also used rigid foam to insulate the foundation slab and footing wall and to isolate the slab from the footing wall. To save excavation costs, the affiliate employed a frost-protected shallow slab foundation where an R-10 "wing" of rigid foam was installed extending 24 inches out from all foundation walls, approximately 16 inches below grade.

On the roof, over the OSB roof decking, the builder installed ice-and-water barrier on the bottom six inches of the roof edge and wrapped the barrier down around the sub-fascia. A drip edge was installed over this to protect the sub-fascia framing. Then the builder installed additional ice-and-water shield along the eaves and extending six feet up from the roof edge, as well as in the valleys and around any penetrations before installing laminated shingles. Kick-out flashing was installed at any roof-to-wall junctures. The vented attic was constructed with raised heel trusses to allow a full depth of insulation on the attic floor. Before installing the blown cellulose, the builders first installed Styrofoam baffles along the underside of the roof decking just above the eaves to carry ventilation air from the soffit vents up along the underside of the roof deck to the ridge vents. The lower edge of the baffles extends down and was sealed to the top plate with spray foam and caulk to keep the blown cellulose out of the soffit vents and to prevent wind washing of the insulation. Then the insulation contractors used two-part closed-cell spray foam to seal the framing plates, holes for electric wiring, etc., then they piled nearly 20 inches of blown cellulose onto the ceiling deck for a total insulation value of R-60.

The affiliate constructed a sealed and insulated closet in the attic to house the home's 96% efficient gas furnace. The rigid metal ducting was sealed with mastic and the ducts were located within the conditioned space of the home.

The home was equipped with a 97% efficient gas tankless water heater. Plumbing fixtures were clustered and ½-inch PEX was run from the central manifold directly to each fixture to reduce hot water use. Any water lines located under the slab were insulated to reduce heat loss to the ground.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program, 100% commitment

ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

GreenStar Certified, silver

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.

Staggered studs allow blown cellulose to wrap around the edges of the studs.

The affiliate selected highly insulated triple-pane windows with vinyl frames, plus low-emissivity coatings and an argon gas fill between the panes to minimize heat transfer.

Thanks to the multiple layers of air sealing, blower door testing showed the house had only 1.81 air changes per hour at 50 Pascals pressure, well below the air leakage limit of 3 ACH 50 allowed by code. To reduce the potential for mold and moisture in the humid climate, the affiliate used WUFI hygrothermic analysis software to design the exterior walls with the most ideal vapor permeability levels given their budget. High-quality ventilation includes moisture-sensing exhaust fans in the bathrooms and kitchen and a heat recovery ventilator (HRV). Measures including kick-out flashings, flashing on all siding and sheathing penetrations, the vapor-resistant wall assemblies, grading of the site, French drains, and deep overhangs are all employed to keep moisture out and to give walls the ability to dry, to reduce the chances of mold in the future. The overhangs also shade the home in summer.

"All of this effort helps to create a home that is very comfortable, with low humidity, no drafts in the winter, no large fluctuations in indoor temperatures from room to room, and excellent air quality," said Tishler.

Every home built by Kalamazoo Valley Habitat for Humanity is built to minimize energy use as much as possible in a cost-effective manner. Weekly construction team meetings address any potential issues and communication among team members is critical to this process. Site supervisors are trained in resource management, advanced framing, insulation, air-sealing measures, HVAC quality, and overall building science principles.

One key challenge for the Kalamazoo Valley Habitat team has been educating the general public and donors about how high-performance, energy-efficient measures can improve the affordability and longevity of the home. Too often these are thought of as luxury features. Although Tishler recognizes that high-efficiency equipment and skilled contractors can increase costs, he contends that once you have worked through the initial learning curve, these advanced systems and techniques become affordable to integrate into the construction process. Home owners are definitely seeing the benefits. As the home owner of the award-winning home noted, the combined mortgage and monthly energy bills for their new home will be lower than what they had paid for rent alone in their previous home.

"We're just really excited about how these energy-efficient homes provide power and the ability for families to thrive and succeed," said Don Jones, past executive director of Kalamazoo Valley Habitat for Humanity. "If Habitat can build this kind of housing and make it affordable, anybody can step forward and build this kind of housing."

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance.
- **Walls:** 2x4 studs 24″ o.c. staggered on 2x6 plates, advanced framing, 2″ XPS R-10 sheathing, metal wind bracing, R-22 dense-packed cellulose with netting, house wrap, vinyl siding.
- **Roof:** Ice-and-water shield 6′ up from eaves, in valleys, around penetrations, and down sub-fascia; drip edge; soffit and ridge vents; Styrofoam baffles and wind dams.
- **Attic:** Vented attic; lid sealed with flash spray of two-part foam; 20″ R-60 blown cellulose; 16″ raised heel trusses.
- **Foundation:** R-10 frost-protected shallow slab foundation.
- **Windows:** Triple-pane, vinyl-framed, low-e, argon-filled, U=0.20, SHGC=0.25.
- **Air Sealing:** 1.81 ACH 50.
- **Ventilation:** HRV, MERV 11 filter.
- **HVAC:** Forced-air natural gas furnace, 96% AFUE, metal ducts, sealed with mastic and located in insulated mechanical space in attic.
- **Hot Water:** Tankless hot water, 0.97 EF.
- **Lighting:** 100% LED, motion and moisture-sensing bath fan/light.
- **Appliances:** ENERGY STAR refrigerator.
- **Solar:** None.
- **Water Conservation:** Compact plumbing design, all WaterSense fixtures.
- **Energy Management System:** None.
- **Other:** No-VOC adhesives, low-VOC paints, carpet, pad, stains, finishes.

Photos courtesy of Kalamazoo Valley Habitat for Humanity

PNNL-SA-123501, December 2016