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

Habitat for Humanity, Grand Traverse Region

The Depot Neighborhood Traverse City, MI

BUILDER PROFILE

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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: The Depot Neighborhood
- Location: Traverse City, MI
- Layout: 3 bdrm, 2 bath, 2 fl, 1,352 ft²
- Climate Zone: IECC 6A, cold
- Completion: November 2014
- Category: Affordable

Modeled Performance Data:

- HERS Index: without PV 36, with PV -1
- Projected Annual Energy Costs: without PV $1,002, with PV $106
- Projected Annual Energy Cost Savings (vs home built to 2009 IECC): without PV $119, with PV $896
- Projected Annual Energy Savings: without PV 34.7 MMBtu, with PV 4.2 MMBtu
- Added Construction Cost: without PV $0, with PV $18,000

The Habitat for Humanity, Grand Traverse Region has an inspiring vision for its new Depot Neighborhood begun in Traverse City, Michigan, in May 2014 - to build each of the community's 10 single-family homes to be truly affordable homes that harvest and produce all the energy they need over the course of a year, with the goal of eliminating home owner energy bills forever. To meet this goal, the Habitat affiliate decided to certify all 10 of the homes to the strict energy performance requirements of the U.S. Department of Energy's DOE Zero Energy Ready Home (ZERH) program.

The program requires every home to be certified to ENERGY STAR Certified Homes Version 3.0 and the U.S. Environmental Protection Agency's Indoor airPLUS program. Each home must meet the hot water distribution requirements of the EPA's WaterSense program and the insulation requirements of the 2012 International Energy Conservation Code. The program also requires homes to have solar electric panels installed or at a minimum to have the conduit and electrical panel space in place for future PV installation.

The Grand Traverse affiliate chose to install solar panels on the roofs at construction so that the homes could start performing as net zero homes from the start. A net zero home is one that produces as much energy as it uses over the course of the year. It is not uncommon for home owners in the Depot Neighborhood to have negative energy bills in the spring and summer, when the photovoltaic panels are producing more electricity than the home uses. This excess production shows up as credits on the utility bill, which can be applied to winter season bills when energy demands are higher in this heating-dominated climate.

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.

Habitat for Humanity, Grand Traverse Region built this 1,352 ft² home in Traverse City, Michigan, to the DOE Zero Energy Ready Home (ZERH) program requirements. For additional energy savings, this home has an ENERGY STAR-rated certified refrigerator and ceiling fans. All of the home's lighting is LED based for further energy savings.

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

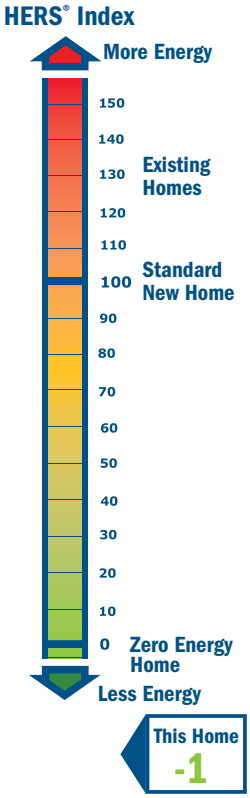
3 **DUCT SYSTEM**
located within the home's thermal boundary

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 DOE Housing Innovation award-winning home at the Depot Neighborhood is a 1,352-ft² two-story home with 27 solar photovoltaic panels mounted on the roof. Each panel is rated at 275 watts so the array provides a total installed capacity of 7.4 kilowatts. The solar panels cost about $17,000, but a 30% tax credit reduced this amount to about $12,000, yielding a project payback of about 13 years.

Like all of the houses in the Depot Neighborhood, the 3-bedroom, 2-bath Midwestern farmhouse-style home faces a central garden area with the roof aligned for southern exposure to accommodate the solar panels.

Solar panels alone are not what allows the home to achieve its zero energy status. Before the PV panels were installed, the home was designed and constructed with a high-performance building envelope and efficient equipment that meet the DOE ZERH program requirements to significantly reduce energy use compared to a standard home constructed to just meet the state energy code.

The award-winning home at the Depot Neighborhood was constructed with 2x6 24-inch on-center wood-framed walls. The wall cavities were filled with 5.5-inches of dense-packed, blown-in fiberglass insulation, which provides an R-23 cavity insulation value. The walls were wrapped with ½-inch sheathing plus a continuous layer of insulation consisting of two 2-inch-thick layers of rigid foam equaling R-20, for a total wall R-value of 43, well above Michigan's current code-required R-20 insulation level. Fiber cement lap siding was installed over 1x4 furring strips installed vertically over the foam board to create a ¾-inch air gap between the foam board and siding that helps prevent moisture build-up.

The builders kept solar panels in mind when designing the home. The home's south-facing roof was kept free of obstructions with all vents, chimneys, etc., located on the north-facing roof. The roof's 7/12 pitch is slightly steeper than would be ideal for solar gain but the angle is necessary to help shed snow more quickly. Two-foot overhangs at both the eaves and gable ends help protect the walls from rain and snow. The attic was air sealed with closed-cell spray foam at eave-wall connections and at all ceiling penetrations. The roof has raised-heel trusses to allow space for 20 inches of blown-in cellulose insulation, which provides an attic insulation value of R-80. (Michigan requires R-49.)

After excavating 60 inches, the builder poured concrete footings and constructed 54-inch-high insulated concrete form (ICF) footing walls, then backfilled the space within the walls with dirt to within 12 inches of the top of the ICF walls. The packed dirt was covered with three 2-inch layers of rigid EPS foam board, providing R-30 of insulation under the 4-inch concrete slab while the ICFs provide R-20 of slab-edge insulation.

To construct the home's slab foundation, the builder excavated nearly 60 inches to get below the Michigan frost line, poured concrete footings, then constructed 54-inch-high footing walls consisting of insulated concrete forms (ICF)s. ICFs are hollow foam board blocks that are stacked like bricks then filled with concrete and reinforced with steel rebar to form very sturdy walls. The foundation area between the ICF walls was then filled with dirt to within 12 inches of the top of the ICF wall. The packed dirt was covered with three 2-inch layers of rigid EPS foam board, providing R-30 of insulation under the 4-inch concrete slab while the ICFs provide R-20 of slab-edge insulation. The current code requires R-10 of foundation wall insulation and no insulation is required under the slab. The ICFs were topped with a butyl tape capillary break before constructing the above-grade wood-framed walls. The EPS was covered with a 6-mil vapor barrier of plastic sheeting.

The home's windows are all triple-pane with low-emissivity coatings to reduce heat transfer and an argon gas fill between the panes to increase the insulation value. The windows have an insulation U-factor of 0.19—well below the current code requirement of U=0.35 (lower is better).

The home was tested for air tightness and had a whole-house air leakage rate of 0.88 air changes per hour at 50 Pascals pressure difference (ACH 50), which far exceeds the code requirement of 4 ACH 50 (lower is tighter).

HVAC is provided by a ductless mini-split heat pump, consisting of a single outdoor unit (compressor and condenser) with two indoor units (each having an evaporator and fan-coil). The inverter technology on the ductless mini-split heat pump allows the outdoor unit to vary its speed and output to match the comfort needs of the home's occupants. The heat pump has a cooling efficiency or Seasonal Energy Efficiency Ratio (SEER) of 18, a heating efficiency or Heating Season Performance Factor (HSPF) of 9.3, and a Coefficient of Performance (COP) of 3.44 (which exceeds the current Federal minimum efficiencies). A heat pump water heater with an energy factor (EF) of 2.75 provides domestic hot water to the home. An energy recovery ventilator (ERV) provides ventilation for the air-tight home.

All lighting is provided by LED lights and all appliances are ENERGY STAR rated. The home's design optimizes natural daylight to eliminate the need to use electric lights during the day.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program, 100% commitment

ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

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 2x6 framed walls were filled with blown fiberglass and wrapped with R-20 of rigid foam. Furring strips provide an air gap under the fiber cement siding.

The home is expected to cost its owners about $106 per year in energy bills, or roughly $9 per month on average. The home achieved a Home Energy Rating System (HERS) score of 36 without factoring in the roof-mounted solar panels. With the panels, the home achieved a HERS score of -1. Over the course of a year, this net zero home can produce as much energy as it uses. For this home, this equates to about $900 in annual energy bill savings for the home owners.

"Net zero is where it's at. This is the direction everyone should be going. Low energy and water use mean this home will be inexpensive to live in for years to come," said Habitat board member Ryan McCoon who served as project manager during the planning stages of the Depot Neighborhood project.

The home also includes several water-saving features including low-flow shower heads, toilets and plumbing fixtures, and an irrigation system that is LEED Certified for maximum water efficiency.

Habitat for Humanity, Grand Traverse Region engages in a variety of events to educate the community about the need for affordable housing and now the benefits of net-zero energy homes. Habitat home owners also learn about energy-efficient construction through the sweat equity hours they put into building their homes. The Habitat affiliate also teaches home owners how to keep the house running efficiently. They are shown how to change the filters in the mini-split air handlers and the energy recovery ventilation system. They learn about habits that can increase or decrease their utility bills. Home owners are given a comprehensive home operation binder that includes a sustainable energy manual, schedules for regular maintenance activities, and information on how to do a self-guided home inspection. The binder also contains manuals for all of the home's appliances and mechanical equipment as well as warranty information.

For Habitat home owners, the economic impacts of energy-efficient housing have been life changing. Said one home owner in the Depot Neighborhood, "previously if you took our gas bill and electric bill, it was over $300 a month. Now, our electric bill (in the all-electric home) is under $10 a month. I can actually afford to not only save for repairs and upkeep on the house and make the payments on the house, but I can also save for our kids' future."

Photos courtesy of Habitat for Humanity, Grand Traverse Region

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance.
- **Walls:** R-43: 2x6, 24″ o.c. with 5.5″ R-23 blown fiberglass in cavity, ½″ OSB, two 2″ layers XPS R-20 rigid foam on exterior, fiber cement lap siding over 1x4 battens.
- **Roof:** Raised heel trusses, 2′ overhangs at eaves and gables, asphalt shingles.
- **Attic:** Vented attic with 20″ (R-80) blown cellulose insulation, plus closed-cell spray foam at eaves and penetrations.
- **Foundation:** R-22.5 ICF foundation walls, three 2″ layers EPS under slab for R-30.
- **Windows:** Triple-pane low-e, argon-fill, U=0.19.
- **Air Sealing:** 0.88 ACH 50.
- **Ventilation:** ERV.
- **HVAC:** Ductless mini-split heat pump, 2 indoor wall units, 18 SEER, 9.3 HSPF.
- **Hot Water:** Heat pump water heater, 2.75 EF.
- **Lighting:** 100% LED.
- **Appliances:** All ENERGY STAR.
- **Solar:** 7.43-kW PV.
- **Water Conservation Features:** All fixtures low flow.
- **Energy Management System:** Energy monitoring of PV HVAC, appliances, and plug load.
- **Other:** No-/low-VOC paints.

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