Healthy Efficient Homes

Spirit Lake, Iowa

BUILDER PROFILE

Healthy Efficient Homes LLC
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Ridgeview Farms
- Location: Spirit Lake, Iowa
- Layout: 4 bedrooms, 3 baths, 1-story with basement
- Conditioned Space: 3,048 ft^2
- Climate Zone: IECC 6A, Cold
- Completion: April 2014
- Category: Custom

Modeled Performance Data:

- HERS Index: without PV 41, with PV 28
- Projected Annual Utility Costs: without PV $2,384, with PV $1,663
- Projected Annual Energy Cost Savings (compared to a home built to the 2009 IECC): without PV $4,489, with PV $5,280
- Builder's Added Cost over 2009 IECC: $42,000
- Annual Energy Savings: 16.4 MBtus

Custom home builder Jim Johnson built his first U.S. Department of Energy (DOE) Zero Energy Ready certified home in 2014. The four-bedroom, 3-bath, 3,048-ft^2 one-story home has ICF basement walls, and a 4-kW photovoltaic power system on the roof that helped the home achieve a Home Energy Rating System (HERS) score of 28, a far better score than the roughly HERS 80 of homes built to code. "If we were to build a house today, it's what we would build for ourselves," said Johnson, who has built the last ten homes he and his wife Patricia have lived in.

The home, which was built for Ridgeview Farms in Spirit Lake, Iowa, meets all of the high-performance requirements of the DOE Zero Energy Ready Home certification program. It meets the building envelope and HVAC requirements listed in the checklists of the ENERGY STAR Certified Homes Version 3.0. It meets the indoor air quality specifications of the U.S. Environmental Protection Agency's Indoor airPLUS program and the water-saving requirements of EPA's WaterSense program. It also meets the insulation requirements of the 2012 International Energy Conservation Code, which is a DOE program requirement and also a state requirement since Iowa joined the handful of states who have adopted the 2012 IECC as their state code.

In addition, the DOE Zero Energy Ready Home program requires that all homes complete a checklist of "renewable ready" solar power measures that ensure the home is wired and plumbed for the installation of solar photovoltaic and water heating panels. The Iowa home more than meets this solar-ready requirement with the 4-kW PV system plus 32 ft^2 of solar thermal water heating panels installed on the roof.

Johnson, who has been in the construction business since he began roofing with his dad at the age of 14, said he definitely plans to build more DOE-certified

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.

This custom home in Spirit Lake, Iowa, built by Healthy Efficient Homes LLC achieved a HERS score of 28 with ICF basement walls, advanced framed R-31 above-grade walls, an R-61 vented attic, mini-split heat pumps, solar-heated radiant floors, and a 4-kW roof-mounted PV system.

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

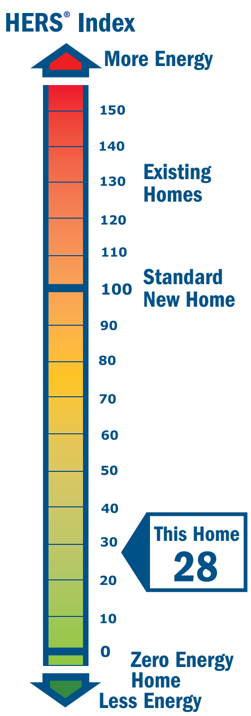
3 **DUCT SYSTEM** located within the home's thermal boundary

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.



homes because he appreciates the high quality required by the DOE program. After pursuing other careers, Johnson returned to home building in 1990 and has since built 200 homes. In 2009, when the economy took a downturn, Johnson and his son became RESNET HERS raters and began rating ENERGY STAR homes. Johnson also built his first ENERGY STAR home in 2009. It was ENERGY STAR that led Johnson to learn about the DOE program. A builder friend encouraged him to go for an even higher performance level that included solar and helped put up the funds to build the DOE Zero Energy Ready Home at Ridgeview Farms, which was built on speculation.

Johnson began construction of the house by excavating the sloped site, then pouring a 16-inch-wide by 8-inch-deep concrete foundation footing. The concrete footings were made using a footing-forming product that consists of hollow perforated boards similar in size to dimensional lumber. The perforated boards stay in place to provide drainage along the footing, removing both water and soil gases. Within the footing perimeter, an 8-inch-deep bed of 1-inch rock was laid to provide an escape path for radon. Over the rock, Johnson laid a 6-mil. sheet of polyethylene vapor barrier, then a 2-inch-thick layer (R-10) of XPS rigid foam. Over the foam, he installed the radiant heating system loops in the basement floor. A 4-inch concrete slab was poured over this.

Johnson installed radiant heating for the main floor of the home as well, by stapling the radiant floor loops to the underside of the main floor's plywood subfloor, which was supported by open-web floor joists.

He stapled radiant foil bubble wrap insulation to the underside of the floor joists with the foil side facing up to reflect the heat back up into the main floor. Johnson had considered using spray foam on the basement ceiling, but chose this approach instead to allow the heat to spread evenly throughout the floor and to avoid hot spots.

The basement walls were made of insulated concrete forms (ICFs) consisting of an 8-in. layer of concrete sandwiched between two 2-in. layers of EPS rigid foam for a total foundation wall insulation value of R-23. This ICF wall was 9 feet high along the north wall of the home, which was set into the slope, and tapered to 4 feet high along the south wall.

For the above-grade walls of the home, Johnson used 2x6 studs set 24 inches on center. Johnson used a "flash and batt" approach to insulate the walls, first

The builder used a "flash and batt" approach to wall insulation consisting of spray foaming the cavities with 1.5 inches of closed-cell spray foam, then filling the remainder of the walls with blown fiberglass. A coated 1-inch-thick rigid foam EPS sheathing was used on the exterior of the walls. The seams were taped with polybutyl tape to form a weather-proof air barrier under the resin-and-wood composite siding.

spraying each wall cavity with a 1.5-inch layer of closed-cell foam to insulate and air seal, then filling the remainder of the cavity space with blown-in fiberglass insulation to give the walls an insulation value of R-31. On the home's exterior, Johnson attached a 1-inch layer of skinned EPS to the above-grade walls. The foam layer extended down to the ICF foundation walls, covering the rim joist. All of the seams were taped with polybutyl tape to create a totally sealed envelope. Johnson installed a layer of taped house wrap over the rigid foam, then clad the house with a resin-and-wood composite siding.

The home's vented attic was built with 12-inch-high heel trusses to provide adequate space over the top plates along the exterior walls for a thicker layer of insulation at the roof eaves. The R-60 blown-in fiberglass provided on average 16 inches of insulation over the ceiling. To ensure that the ceiling deck was fully air sealed, before the blown fiberglass was installed, closed-cell spray foam was used to foam seal the seams between the top plates and the dry wall for all of the top plates along the interior and exterior walls. Premade foam caps were installed over the home's recessed can lights. These caps were spray foamed to the ceiling to form an airtight seal. Johnson also installed a solar fan and soffit vents to vent the attic.

The home's HVAC system consists of a mini-split heat pump with one outside unit and three indoor air handlers that are hidden: one above a closet on the main floor, one behind a vaulted ceiling in the living room, and one in the ceiling in the basement. Short ducts carry conditioned air to adjoining rooms on the main floor. The heat pump has a SEER rating of 17 and an HSPF rating of 9.8. Johnson also designed a ventilation system consisting of an exhaust fan in the basement directed to draw fresh air in from outside through a HEPA filter at a steady rate of 25 cfm. This fresh air supply fan is balanced with a main-floor bathroom exhaust fan, also set for continuous operation. Humidistat and motion sensors trigger boost speeds on the bathroom exhaust fan. Johnson felt this ventilation system provided good ventilation at a lower cost than an energy recovery ventilator.

To further cut air conditioning costs, Johnson plans to install a passive vent system to take advantage of the 65°F air found in the basement. "Before anyone moves into the house, I'm going to install a through-wall vent fan in the basement to circulate the cooler basement air to the main floor of the home. The basement air stays at about 65°F throughout the summer with low humidity," said Johnson.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program

ENERGY STAR Certified Homes, Version 3.0

EPA Indoor airPLUS

EPA WaterSense

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.

Closed-cell spray foam was used judiciously to seal and insulate above the top plates on all interior and exterior walls. Closed-cell spray foam was also used to air seal and insulate all of the rim and band joists.

The home has two 4x8-foot solar hot water panels that were plumbed to send hot water to a 50-gallon hot water storage tank and a 50-gallon electric hot water heater equipped with electric burners for back-up heat. The solar-thermal units can provide the heated fluid for the radiant floor loops as well. "It's a drain-back system so instead of letting the hot water sit there and do nothing, we can let the excess hot water heat the house through the radiant floors for a few hours every day," said Johnson.

Johnson said the EPA WaterSense certification was a priority for him. "Water is just too valuable; we can't keep throwing it away." Johnson installed low-flow faucets and dual-flush toilets in the home's three bathrooms.

The home features ENERGY STAR-rated appliances including an ENERGY STAR refrigerator, dishwasher, washing machine, and two ceiling fans. For further energy efficiency, the home's lighting is primarily provided by LED fixtures.

Johnson said the experience of building his first DOE Zero Energy Ready Certified Home was a good one and he plans to build more. "I would encourage anybody to do it," said Johnson. "The DOE requirements definitely add value to the home." For Johnson, this first certified home was a learning experience, for himself and for others. "Throughout the process we were redesigning, seeking to make things better." Johnson noted he was on the job site daily, meeting with subcontractors to provide guidance and frequently using diagnostic equipment like a blower door and infrared camera to check installation quality. To help educate the public, wall and counter displays were posted throughout the home describing its high-performance features. The home was featured in a parade of homes and in several local news stories and Johnson also conducted several training sessions for realtors.

Photos courtesy of Healthy Efficient Homes LLC.

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance
- **Walls:** Advanced framed 2x6 studs set 24 in. on center, flash-and-batt wall cavity insulation with 1.5 inches closed-cell spray foam plus blown fiberglass. Exterior sheathed with 1-inch skinned EPS, seams sealed with polybutyl tape, resin-and-wood composite siding; for a total wall R-value of R-31. Top and bottom plates caulked with silicon; rim and band joists insulated with closed-cell spray foam.
- **Roof/Attic:** Vented attic with 12-inch raised heel trusses, spray foam over all top plates (on interior and exterior walls) to seal drywall-to-top plate seams; 16 inches of R-60 blown fiberglass over ceiling deck; baffles at soffit vents; solar fan in attic.
- **Foundation:** ICF basement walls (8 inches concrete and two 2-inch layers of EPS for R-23. Poured concrete footings using perforated plastic "lumber" forms for drainage along inside and outside of footing; 8-inch bed of 1-inch rock covered by 6-mil poly vapor barrier and 2 inches R-10 EPS rigid foam then 4-inch foundation slab (R-23 total for foundation walls).
- **Windows:** Argon gas fill, low-E, U=25 to 28; SHGC=31, double-pane windows with 50 mph wind rating.
- **Air Sealing:** 1.19 ACH 50
- **Ventilation:** Continuous electric fan to pull air into house through HEPA filter at 37 to 76 cfm, balanced with continuous bathroom exhaust fans.
- **HVAC:** SEER 17, HSPF 9.8 mini-split heat pump with one outside unit and three indoor air handlers; radiant floor heat with modulating 92% efficient gas boiler
- **Hot water:** Two solar thermal collectors provide 90% of average usage.
- **Lighting:** 90% LED
- **Appliances:** ENERGY STAR refrigerator, dishwasher, clothes washer, 2 ceiling fans
- **Solar:** 4 kW PV; 32 ft^2 solar hot water panels; PV wired for internet connection
- **Water Conservation:** Low-flow water faucets; dual-flush toilets; no irrigation
- **Other:** Low-VOC paints and carpets