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

BUILDING TECHNOLOGIES OFFICE

U.S. DOE ZERO ENERGY READY HOME 2013 WINNER Housing Innovation Awards

DOE ZERO ENERGY READY HOME™ CASE STUDY

Garbett Homes

Herriman, UT

BUILDER PROFILE

Garbett Homes
Salt Lake City, Utah, 801-456-2430
Bryson Garbett, President
Bruce Hanson, Energy Director
Damian Mora, Energy Coordinator
damian@garbetthomes.com
www.garbetthomes.com

FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Garbett's Net Zero-Energy Home at Rosecrest
- Location: Herriman, Utah
- Layout: 3 bedrooms, 2.5 baths
- Conditioned Space: 4,111 ft² with basement
- Completion: July 2013
- Climate Zone: 5B
- Category: Production

Performance Data:

- HERS Index without solar PV: 40
- HERS Index with solar PV: -1
- Projected annual utility costs: with solar $70, without solar $1,275
- Projected annual utility cost savings (compared to a home built to the 2006 IECC): with solar $3,580, without solar $2,325
- Annual PV production revenue: $1,500
- Total energy savings: 28,243 kWh, 454 therms natural gas

Completed in July 2013, the 4,111-ft² zero-energy home in Herriman, Utah (just outside Salt Lake City), is claiming two impressive firsts: the first U.S. Department of Energy (DOE) Zero Energy Ready Home production home certified in Utah and the first net zero-energy production home built in Utah. The home also meets the requirements of ENERGY STAR Version 3 and the U.S. Environmental Protection Agency (EPA) Indoor airPLUS certification.

"Our motivation was to build a high-quality, affordable, net zero-energy home, and the DOE Zero Energy Ready Home program is the logical next step after ENERGY STAR on this path," said Damian Mora, an in-house energy coordinator for Garbett Homes.

The DOE Zero Energy Ready Home, which was designed by KTGY Group Architecture + Planning, is located in the master planned community of Rosecrest where a comparable home built to code has an average utility bill of $300 to $400 a month. This home has a Home Energy Rating System (HERS) score of -1, meaning its utility bills are zero.

"We took it one step at a time, building on the knowledge we gained from ENERGY STAR," said Mora. "The challenge we faced was building this home affordably at zero energy in Climate Zone 5. We range between 10°F and 20°F during the winter and can drop below 0°F. Our summer temperatures typically range from 85°F to 95°F and can reach over 100°F. We are at over 5,000 feet in elevation here."

With the net zero-energy and affordable goal before them, the Garbett Homes' team planned, modeled energy options, evaluated, and modeled again, repeating the evaluation and modeling processes multiple times, until they finally decided

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 for Homes Version 3 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.

All of the ducts are installed inside conditioned space in duct chases that run below the ceiling. At 9 HSPF and 16.75 SEER, the air source heat pump provides heating and cooling at well above the minimum federal appliance standard levels of 7.7 HSPF and SEER 13. A 96% efficient gas furnace provides back-up heat in extreme weather events.

DOE ZERO ENERGY READY HOME CERTIFIED:

1 **BASELINE**
certified ENERGY STAR for Homes Version 3.0

2 **ENVELOPE**
meets or exceeds 2012 IECC levels

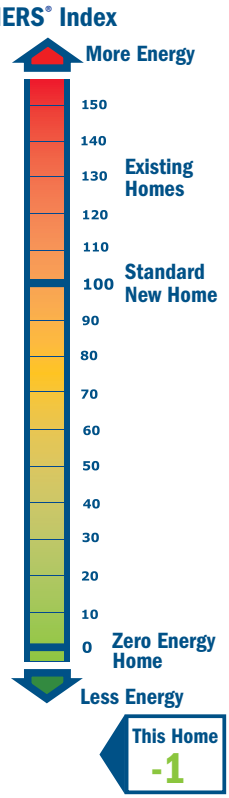
3 **DUCT SYSTEM**
located with the home's thermal boundary

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.



upon the right design and energy options for this prototype production home. The home is one of four with similar styles ranging in price from $350,000 to $650,000, depending on the design and energy options selected. "Where the homeowner will see the real savings is in the utility bill," said Mora.

Much of the planning and modeling involved a tightly sealed and highly insulated building envelope. Whole-house building air leakage is tested using a blower door test to determine the number of air changes per hour (ACH) at 50 Pascals pressure difference between the inside and outside of the home. The DOE Zero Energy Ready Home requirement is 2.0 ACH 50 or less in climate zones 5 through 7. "In our energy modeling, our input data required that the blower door test come in at 1.0 ACH 50 or lower," said Mora. "Our final testing exceeded this mark, testing at 0.8 ACH 50."

The walls are built with advanced framing techniques using 2x6 studs at 24-inches on-center. Critical joints are sealed using a sprayer-applied nonhardening sealant. This sealant was also applied to the top plates before installing drywall to form a gasket-like seal. The wall cavities are filled with R-23 blown-in fiberglass insulation. Exterior to the studs is OSB sheathing, housewrap, and a 1.5-inch layer of R-7.5 rigid insulation. The exterior cladding for the house is a combination of stucco, fiber cement, and cedar siding. This complete wall system achieves an insulation rating of R-30.5.

Garbett employs advanced framing techniques that call for drywall clips instead of extra framing members as support for the drywall. With advanced framing, Garbett reduces the number of 2x6 wood studs needed by approximately 100+ studs. In addition to saving money and reducing thermal bridging, the space taken up by the studs is now available for an additional 120 cubic feet of fiberglass blown-in insulation.

The unconditioned attic assembly achieves a total insulation rating of R-60 by using blown-in fiberglass insulation on the attic floor, which has been carefully air sealed with the sprayer-applied sealant. Spray foam is applied to all rim joists, raised heel trusses, attic double top plate caps, and any areas with potential air gaps. The roof is covered with cool-roof shingles on the sloped surfaces and thermoplastic polyolefin (TPO) on the flat surfaces; these cover a basic roof structure of pre-manufactured trusses, OSB, a weather barrier, and a roof membrane.

The DOE Zero Energy Ready Home is loaded with solar panels to take advantage of Utah's sunny weather. The 10.29-kW photovoltaic system more than meets the home's electric needs while the solar water heating panels are sized to meet the majority of the home's hot water needs.

The unfinished daylight basement is insulated on the exterior of the concrete walls with 2 inches of closed-cell rigid insulation (R-10). On the interior of the concrete walls, two R-11 batt blankets are draped together for a total basement wall insulation value of R-32.

Completing the envelope are carefully flashed, dual-pane, argon gas-filled windows (with insulating values of U=0.30 to 0.34 and solar heat gain coefficients of 0.32 to 0.34). The windows are coated with a low-emissivity coating that reduces radiant energy loss by up to 30% and protects from UV glare.

With the house air tight and insulated, Garbett chose an air-source heat pump. "We have not used a heat pump before because it has not made sense in our climate zone. Electricity is more expensive than natural gas here. However, since we are generating all of the electricity onsite, then it made sense to move to an air-source heat pump for the heating and cooling demand," said Mora.

The air-source heat pump has 9 HSPF heating and 16.75 SEER cooling ratings. Because of the potential for extreme weather conditions, the heat pump has a 96% efficient gas furnace as a backup, which turns on automatically when the temperatures drop below a specific setting. Both the heat pump condenser and the gas furnace have variable speed electrically commutated (ECM) motors for the fan and main blowers, which consume less energy than permanent split capacitor (PSC) motors.

An energy recovery ventilator (ERV) is ducted into the air handler in the basement. The ERV brings in fresh air through a filter and heat exchanger, which warms or cools the fresh incoming air while exhausting stale air from the home. The ducts are completely located within the home's thermal envelope, minimizing the opportunity for thermal losses through the ducts.

The home's hot water is provided by two 94% efficient tankless condensing gas-fired water heaters; however, the water for these water heaters is preheated by two roof-mounted 27-ft^2 solar panels (minimum 17 MMBtu capacity) that pre-heat the water and send it to a 65-gallon holding tank inside the home.

HOME CERTIFICATIONS:

DOE Zero Energy Ready Home

ENERGY STAR Version 3

EPA Indoor airPLUS

Every DOE Zero Energy Ready Home combines building science specified by ENERGY STAR for Homes and advanced technologies and practices from DOE's Building America research program.

Without any solar technologies, the home achieves a HERS score of 43. When solar water heating is added, the score drops to HERS 40. To reach its HERS score of -1, the home is equipped with 42 roof-mounted, solar photovoltaic panels located on the south- and east-facing sides of the home. These panels have a combined generating capacity of 10.29 kW.

"We have been building to ENERGY STAR for a while. We had a desire to build to zero energy. A benefit of the DOE Zero Energy Ready Home program is that it not only takes us to the next step, but it also requires more depth by requiring the EPA's Indoor airPLUS specifications," said Mora.

For water conservation, the home has low-flow faucets and dual-flush toilets, and the landscaping uses drip irrigation. In addition, all lighting is 100% CFLs and appliances are ENERGY STAR rated.

Finally, the home is equipped with smart home technologies provided by Vivint that include a system for monitoring solar production and use, a smart thermostat, automated door locks, appliance and lighting controls, video surveillance, and an enhanced security system, which can provide two-way communication with emergency dispatchers in an emergency.

The 2x6, 24-inch on-center advanced-framed walls are stuffed with R-23 of blown-in fiberglass while an additional R-7.5 of rigid insulation wraps the exterior, providing a total wall insulation value of R-30.5.

"Our president Bryson Garbett wants to leave a positive legacy. Garbett Homes believes in the principles of building better, more efficient, and more comfortable homes for the future," said Mora. Since its founding in 1983 Garbett has built more than 4,000 homes in the Unitest States and Mexico including single-family homes achieving HERS ratings in the 30s and multi-family projects that are achieving HERS ratings in the 20s and 30s with only 1.4-kW solar systems.

"If I had a message for builders thinking about building to DOE's Zero Energy Ready Home criteria, it would be to build incrementally better. Going from code to the DOE Zero Energy Ready Home would be a huge step. It would be best to take smaller steps along the way. Go to a higher code level, then make ENERGY STAR the next step, and then DOE's Zero Energy Ready Home program would be the next step," said Mora.

KEY FEATURES

- **Path:** performance
- **Above-Grade Walls:** 2x6, 24-in. o.c., advance-framed walls with R-23 blown-in fiberglass, R-7.5 exterior rigid insulation, housewrap, stucco or panel siding for R-30.5 total
- **Roof:** vented attic; R-60 blown-in fiberglass at attic floor, cool-roof shingles
- **Foundation:** daylight basement
- **Below-Grade Walls:** R-10 exterior closed-cell rigid insulation plus two R-11 draped batts on interior (R-22) for R-32 total
- **Windows:** dual-pane, argon gas-filled windows (U=0.30 to 0.34; SHGC=0.32 to 0.34)
- **Air Sealing:** 0.8 ACH 50
- **Ventilation:** ERV
- **HVAC:** air source heat pump (9 HSPF and 16.75 SEER), with 96% AFUE gas backup furnace, ducts in conditioned space
- **Water Heating:** solar, two 27-ft^2 panels; 65-gallon holding tank, two 94% efficient tankless condensing units
- **Lighting:** 100% CFLs
- **Solar:** 10.29 kW PV system; solar water heating
- **Appliances:** ENERGY STAR
- **Water Conservation:** low-flow faucets, dual-flush toilets, and drip irrigation
- **Other:** smart home technology