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*

Addison Homes

Invision Zero Home
Greenville, SC

BUILDER PROFILE

Addison Homes, Greer, SC
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Rater: Wood Insulating
Dodd Wood, dodd@woodinsulating.com

FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Invision Zero Home
- Location: Greenville, SC
- Layout: 4 bdrm, 3 bath, 2 fl, 2,625 ft^2
- Climate Zone: IECC 3A, mixed-humid
- Completion: November 2015
- Category: custom spec

Modeled Performance Data:

- HERS Index: without PV 47, with PV 0
- Projected Annual Energy Costs: without PV $1,417, with PV $134
- Projected Annual Energy Cost Savings (vs home built to 2009 IECC): without PV $1,040, with PV $2,323
- Projected Annual Energy Savings: without PV 9,797 kWh, 85 therms, with PV 22,627 kWh, 85 therms
- Added Construction Cost: without PV $500 with PV $42,000

Addison Homes of Greer, South Carolina, built the "Invision Zero South Carolina" home to prove to its market that a conventionally styled zero energy home that produces as much electricity as it consumes is not only possible, it's practical. In the process the company ended up winning a 2016 Housing Innovation Award from the U.S. Department of Energy's (DOE's) Zero Energy Ready Home program.

Addison Homes achieved a net zero by incorporating a variety of high-performance products and processes to maximize efficiency—to some 70% beyond code—then adding a solar photovoltaic system capable of generating enough renewable energy to meet the home's remaining electrical needs.

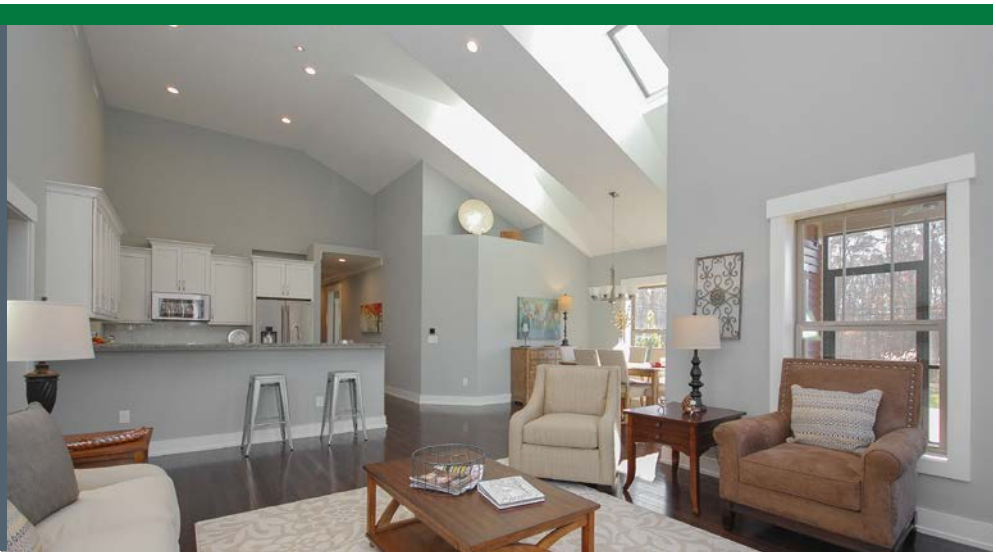
The result is a number of "firsts" according to Todd Usher, president of Addison Homes. "It's the first mainstream net zero energy home in Greenville, and it's located in the first community started in the United States where every house will meet the rigorous energy savings, comfort, health, and durability requirements of the U.S. Department of Energy's Zero Energy Ready Home program." The home is one of 16 homes in the Trailside Community in Greenville, South Carolina, to be built by Addison Homes. "It's also the first home in the Southeast to achieve Active House certification—an international label for homes that have been designed and evaluated with a focus on comfort {including natural daylighting}, air quality, smart use of energy, and low impact on the environment," said Usher.

To qualify as a DOE Zero Energy Ready Home, the Invision home is certified to ENERGY STAR Certified Homes Version 3.0 and the U.S. Environmental Protection Agency's Indoor airPLUS program. It also meets the insulation requirements of the 2012 International Energy Conservation Code and the hot water distribution requirements of the EPA's WaterSense program.

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.

Addison Homes built this 2,625-ft² home in Greenville, South Carolina, to the performance criteria of the DOE Zero Energy Ready Home (ZERH) program. The home's lighting needs are met with advanced lighting technology—more than 95% of the fixtures are LED. During the day, the main areas of the home are flooded with natural daylight through skylights, sun tunnels, and roof windows.



What makes a home a DOE ZERO ENERGY READY HOME?

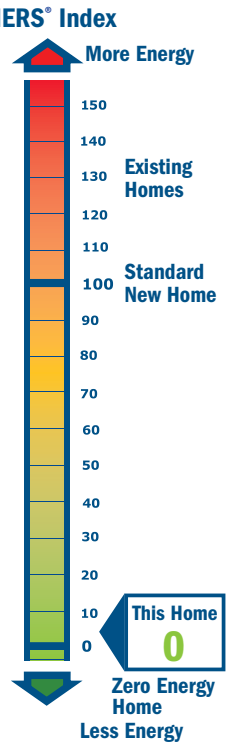
1 **BASELINE**
ENERGY STAR Certified Homes Version 3.0

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.

"Addison Homes is committed to making zero energy a mainstream choice. We're modeling a vision of sustainable construction that's attractive, affordable, and attainable for home owners right here in the Upstate," said Usher. In addition to maximized efficiency, achieved via DOE's Zero Energy Ready Home building standard, this project incorporates solar shingles as a renewable energy system designed to offset all of the home's annual energy usage.

The solar shingles integrate with standard asphalt roof shingles to function as a roofing material while producing solar electricity. The system is tied to the electric grid, so any surplus electricity over the amount needed to operate the home is returned to the power grid for a credit on the home owner's bill. Without the photovoltaic shingles, the energy-efficiency features alone would help the home achieve a Home Energy Rating System (HERS) score of 47 (far lower than the HERS 80 to 100 of typical new homes). With the solar PV added, the home achieves a HERS score of 0, and energy bills drop to about $11 per month (for service charges).

The two-story 2,625-ft² home has quaint craftsman-style details, but underneath the exterior, "it's all about high performance," said Usher. Advanced framing techniques were incorporated to conserve lumber and maximize insulation. The wood-framed walls were constructed of 2x6s set 24 inches on-center with insulated headers and two-stud (rather than three- or four-stud) corners. A variety of insulation and sealants wrapped the home in a blanket of efficiency. The wall cavities were filled with R-19 unfaced fiberglass batt insulation and sheathed with OSB, then covered with 1-inch-thick (R-5) sheets of rigid foam insulation that provided a continuous thermal break to stop heat from transferring through the walls at the studs. All of the seams in the rigid foam were taped so the rigid foam also serves as an air barrier and drainage plane behind the vinyl siding. Flashing tape sealed the seams around windows and doors to keep out moisture and air.

Addison insulated the attic to beyond-code levels to create conditioned space for the ultra-efficient HVAC system. The unvented attic was insulated with 8 inches of open-cell polyurethane foam sprayed on the underside of the roof decking for an insulation value of R-28. The roof decking was covered with synthetic felt. Extra care was taken to prevent leaks with drip edge flashing, vent gaskets on all vents, butyl tape at all penetrations, and ice-and-water shield in valleys and low roofs under the asphalt and PV shingles. Kick-out flashing helps to protect side walls from water entry.

Solar electric shingles on the south-facing roof make this home a true zero energy home, generating enough electricity to meet the home's electricity needs over the course of a year. Whenever the solar power system provides more energy than the home needs, the home owners receive a credit on their electric bill for the excess power produced.

The foundation utilized an unvented, conditioned crawl space. The crawl space was insulated with 2 inches (R-13) of foil-faced polyiso foam board installed along the interior surface of the walls and a 40-mil liner installed over the floor and fastened to the walls and piers. The below-grade exterior surfaces were waterproofed with a spray-applied asphalt water proofing that was also applied to the tops of the concrete foundation walls and concrete piers to provide a capillary break between the concrete stem walls and the wooden sill plates.

The home was tested per DOE Zero Energy Ready Home requirements and showed air leakage of only 1.24 air changes per hour at 50 Pascals. That's more than twice as tight as required by the newest energy code. (The 2015 International Energy Conservation Code requires 3 ACH 50 or less.)

For ventilation, a fresh air intake was ducted to the return side of the HVAC air handler. An air cycler controller operates the air handler fan and the fresh air damper. Air is circulated through a MERV 16 filter and a photocatalytic oxidation (PCO) air purifier. The bathrooms are equipped with timer-controlled exhaust fans.

The home is equipped with a highly efficient central heat pump with a cooling efficiency of 21.5 SEER and a heating efficiency of 10.2 HSPF. Return registers were installed in each room of the home and balancing dampers allow for precise adjustment of air flows to maintain comfort throughout the home. All ductwork was installed in the conditioned attic and sealed per ENERGY STAR and Zero Energy Ready Home requirements for improved performance.

Nearly all of the home's lighting is provided by LEDs while precisely placed windows, skylights, sun tunnels, and roof windows provide natural lighting for the home during daylight hours, even on overcast days. The operable windows and skylights also provide the opportunity for natural ventilation and stack effect cooling during periods of mild temperatures. All glazing in the home incorporates double-pane glass with low-emissivity coatings to reduce solar heat gain.

An ENERGY STAR-labeled tankless condensing gas water heater with a 0.95 energy factor provides efficient water heating with low NOx emissions. The home is piped with an insulated hot water recirculation loop that distributes hot water close to each hot water fixture in the home. The water heater includes a smart logic controller that "learns" the occupants' hot water usage patterns and circulates hot water through the insulated loop during times when the residents

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program, 100% Commitment

ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

EPA WaterSense

Active House USA

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.

All ductwork is well sealed, insulated to an insulation value of R-8, and located inside conditioned space in the spray foam-insulated attic.

are most likely to use it. This eliminates the wait time for hot water at the fixtures while reducing the amount of cold water wasted. The home also has low-flow faucets and 1.28-gallon-per-flush toilets. Outside, the WaterSense irrigation system uses a weather station installed on the home's exterior to control watering periods and amounts based on the local weather conditions as well as plant type and topography. The sprinkler heads are designed to provide slower, more uniform, and accurate delivery of water.

High-efficiency appliances like the ENERGY STAR-rated clothes washer, refrigerator, dishwasher, ceiling fans, and exhaust fans add to energy savings. Energy management systems include the Internet-connected smart HVAC thermostat and PV monitoring.

To promote healthier indoor air, in addition to the MERV 16 filter, PCO (photocatalytic oxidation) air purifier, and fresh air intake on the HVAC, Addison also implemented all of the requirements of the EPA Indoor airPLUS program including using low-VOC paints and finishes; no-added-formaldehyde insulation; GREENGUARD-certified hardwood flooring, carpet, and carpet pad; non-toxic termite treatment, and good moisture management details.

Elements of universal design were incorporated throughout the home, including wide doorways, a zero step garage entry, and a curbless shower in the master bath.

Addison also implemented good stewardship practices including installing cabinetry labeled through the Kitchen Cabinet Manufacturer's Association's (KCMA) Environmental Stewardship Program (ESP). Laminated engineered beams, I-joist floors, engineered roof trusses, and finger-jointed trim were used to reduce the use of large-dimensional lumber.

While home owners can feel good about the healthy air quality aspects of this Addison home, Usher likes to point out how DOE Zero Energy Ready Homes are also healthy for the bottom line. In a case study for the Invision Home, Usher showed that over the first five years of ownership, utility bill savings plus state and federal tax credits would offset the increased mortgage due to a slightly higher upfront cost, so that the owners of the Zero Energy Ready Home would actually pay $23/month *less* than the owner of a code-built home (the 2012 International Energy Conservation Code).

"Addison Homes' goal for this project was a home that scores Zero on total energy use and rates a Perfect Ten with today's home owners," said Usher. With results like this, Addison is likely to succeed.

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance.
- **Walls:** 2x6 24″ o.c. advanced framed with insulated headers and 2-stud corners, R-19 unfaced fiberglass batt, OSB, 1″ R-5 taped, R-18 total. Vinyl siding.
- **Roof:** Asphalt and PV shingles, ice-and-water shield in valleys and low roofs; kick-out flashing, synthetic felt, drip edge flashing, vent gaskets on all vents, butyl tape at all penetrations.
- **Attic:** 8″ open-cell polyurethane spray foam (R-28) on underside of roof.
- **Foundation:** Unvented, conditioned crawl space, 2″ (R-13) foil-faced polyiso foam board on interior, 40-mil liner on floor, up walls and piers; exterior waterproofing.
- **Windows:** Double-pane low-e, U=0.30, SHGC=0.26. Sun tubes and venting skylights.
- **Air Sealing:** 1.24 ACH 50.
- **Ventilation:** Fresh air intake to HVAC return with air cycler control. MERV 16 filter and photocatalytic oxidation air purifier. Timer-controlled exhaust fans.
- **HVAC:** Central heat pump 21.5 SEER, 10 HSPF. Return registers, balancing dampers.
- **Hot Water:** Tankless gas water heater, 0.95 EF, with smart controller.
- **Lighting:** 95% LED, 5% CFL, skylights, sun tubes, and roof windows.
- **Appliances:** ENERGY STAR clothes washer, refrigerator, dishwasher, ceiling fans, exhaust.
- **Solar:** 8.75-kW solar shingle array, grid tied.
- **Water Conservation:** Low-flow fixtures and toilets. WaterSense irrigation.
- **Energy Management System:** Smart HVAC, solar PV monitoring system.
- **Other:** Low-/no-VOC paints, adhesives; GREENGUARD-certified hardwood flooring, carpet, pad; non-toxic pest control, KCMA ESP-labeled cabinets, no added formaldehyde insulation. Laminated beams, I-joist floors. Finger-jointed trim and cabinets. Universal design.

Photos courtesy of Addison Homes

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