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

DOE ZERO ENERGY READY HOME™

Housing Innovation Awards

Southern Energy Homes

First DOE Zero Energy Ready Manufactured Home Russellville, AL

BUILDER PROFILE

Southern Energy Homes, Inc.
(a division of Clayton Homes)
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: First DOE Zero Energy Ready Manufactured Home
- Location: Russellville, AL
- Layout: 3 bedrooms, 2 baths, 1 floor
- Conditioned Space: 1,232 ft^2
- Climate Zone: IECC 3A, mixed-humid
- Completion: May 2014
- Category: Affordable

Performance Data:

- HERS Index: without PV 57
- Projected Annual Utility Costs: without PV $799
- Projected Annual Energy Cost Savings (compared to a home built to the HUD Code): without PV $372
- Builder's Added Cost Over HUD Code (MHCSS): $1,817
- Annual Energy Savings: without PV 4,658 kWh

The country's first U.S Department of Energy-certified Zero Energy Ready manufactured home is up and running in Russellville, Alabama. The manufactured home is being put through its paces along side of a standard to-code manufactured home and an ENERGY STAR manufactured home. The manufactured home, built by Clayton Home's Southern Energy Homes subsidiary, has an impressive suite of energy-saving, water-saving, high-tech features that any home would be proud of. "The DOE Zero Energy Ready home is a potential game changer for the factory building industry," said Jordan Dentz, a building scientist for The Levy Partnership, a research partner in the DOE Building America program who is collaborating with Clayton Homes and the National Renewable Energy Laboratory to do 15 months of side-by-side performance testing on the three homes.

Testing began May 2014 and preliminary cooling-season results are already showing the DOE Zero Energy Ready Home as a strong leader in this energy savings race, using half the space conditioning energy of a manufactured home built to the U.S. Department of Housing and Urban Development's Manufactured Home Construction and Safety Standards (commonly known as the HUD code), which is the building standard for all U.S. manufactured housing. The other manufactured home, which was built to the ENERGY STAR criteria for manufactured homes has about a 15% savings over the HUD Code home.

The DOE Zero Energy Ready Home meets all of the requirements that site-built homes must meet to qualify for this high-performance home labeling program. The home is built to meet all of the air sealing and construction quality requirements of ENERGY STAR Certified Homes Version 3.0. It also meets the indoor air quality and water saving measures of the U.S. Environmental Protection Agency's Indoor airPLUS and WaterSense programs. The DOE

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.

After thoroughly air sealing the ceiling, Southern Energy Homes dense packed blown fiberglass insulation into the attic space of the DOE Zero Energy Ready Home, covering the home with an R-54.6 blanket of insulation.

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

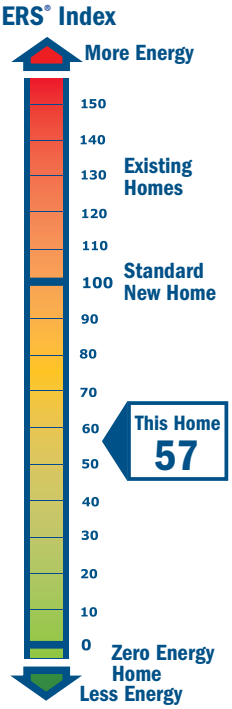
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



Zero Energy Ready Home program also requires homes to meet the insulation requirements of the 2012 International Energy Conservation Code (IECC) and to have solar power and water heating installed or conduit and electric panel space installed for future solar equipment installation.

The DOE Zero Energy Ready-certified home actually exceeded the insulation requirements for its IECC 3A mixed-humid climate location. While the 2012 IECC would require R-38 in the ceiling, R-13 +R-5 rigid in the walls, and R-19 in the floors, the DOE Zero Energy Ready-certified home has R-54.6 in the ceilings, R-13 + R-5 in the walls, and R-28 in the floors. This was far above the R-32.5 ceiling, R-13 wall, and R-22 floor insulation levels that were installed in the ENERGY STAR home and the R-21.7 ceiling, R-11 wall, and R-11 floor insulation installed in the HUD Code home. HUD Code actually requires R-12 ceiling, R-9 wall, and R-9 floor insulation to comply in the IECC hot-humid climate zone 1.

The three homes are set up side by side on the grounds of Southern's Russellville facility and look identical from the outside. All three homes are built with the same floor plan and all three have vinyl siding, black shutters, and asphalt shingles. The DOE Zero Energy Ready-certified home uses wood-framed walls with 2x4 studs spaced 16 inches on center like the other two homes, and in fact all three homes incorporate some advanced framing techniques, which is common for manufactured homes. Southern and Clayton Homes have incorporated value engineering over the years to reduce lumber usage in this cost-conscious industry. There are no extra studs at the doors and windows. On non-load-bearing end walls, the wall space above the windows has open cavities rather than solid wood headers to allow more room for insulation. There are two studs, not three, at the corners, allowing more room for insulation. Wall panels have single top plates rather than double top plates. No blocking is used where interior walls intersect exterior walls, allowing more room for insulation in the exterior walls.

However, on the inside, the DOE Zero Energy Ready-certified home incorporates several construction quality details that together provide a significant edge in performance over the other two homes. For starters, the framers were instructed to take extra care to caulk around every plumbing, wiring, ducting, and vent stack hole in the floors and ceilings. While this step may seem inconsequential, stopping air flow can significantly cut heat loss. After caulking the holes, a whopping R-54.6 of fiberglass insulation was blown into the 42-inch attic space

An inch-thick layer of rigid foam wraps around the home. The continuous layer provides insulating, air sealing, and drainage plane in one step, eliminating the need for house wrap and taking the place of OSB or plywood sheathing for considerable time and cost savings. The foam layers stop heat transfer through the studs, boosting the wall's overall thermal performance.

above the ceiling. The insulation was dense packed into the eaves above the exterior wall top plates. Baffles were installed to prevent the insulation from blocking the soffit vents.

One of the biggest differences in the construction of the home was the addition of rigid foam exterior sheathing. In addition to installing R-13 of unfaced fiberglass batt insulation in the wall cavities, the exterior of the walls was covered with a 1-inch layer of XPS rigid foam insulation sheathing, which was fastened to the studs with adhesive. The rigid foam provides an important function—it serves as a thermal break, stopping the transfer of heat through the studs between the inside and outside of the wall. The rigid foam has a water-resistant skin on one side. When carefully taped, it takes the place of house wrap as a drainage plane for any rain water that might get behind the siding or around the windows. Thus, the insulated taped sheathing provides a continuous air barrier, thermal barrier, and drainage plane. Combining all three functions in one application provides the manufacturer with a considerable time and cost savings while greatly improving the performance of the walls.

High-performance equipment in the DOE Zero Energy Ready-certified home added to the home's energy efficiency. The double-glazed windows that were installed have low-emissivity coatings that reduce heat transfer and insulating argon gas that fills the space between the glass panes. These high-performance windows had an insulation U factor of 0.27 and a solar heat gain coefficient (SHGC) of 0.33. In comparison, the windows installed in the other two homes had a U factor of 0.31 and SHGC of 0.33 for the ENERGY STAR home and U factor of 0.47 and SHGC of 0.73 for the HUD Code home.

The HUD Code home has an electric furnace for heating and a standard 2-ton air conditioner with a Seasonal Energy Efficiency Factor (SEER) of 13, the minimum required by federal appliance standards. The ENERGY STAR home has a split-system electric heat pump for heating and cooling. The air handler is located in a closet in the hallway and the ducts run under the floor to floor registers in each room. While the main trunk ducts are protected by the blanket of fiberglass insulation below the floor joists, the R-4-insulated crossover duct in the HUD Code home and the R-8-insulated crossover duct in the ENERGY STAR home are somewhat exposed to outside temperature conditions.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program

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.

This single small mini-split heat pump (shown here in the prototype home with monitoring equipment attached) provides all of the heating and cooling the home needs with exceptional efficiency. No ducts mean fewer holes through the home's floor. Small thermostat-controlled fans inserted in the bedroom walls draw cool or warm air into those rooms when needed.

In contrast, the DOE Zero Energy Ready-certified home uses a new HVAC design that keeps the HVAC equipment completely within the home's conditioned space. The home is equipped with a super high-efficiency, mini-split heat pump with a SEER of 22 and a heating season performance factor (HSPF) of 12. The ductless heat pump functions something like a room air conditioner in that it cools the area in which it is located. However, it is narrower and quieter than a traditional air conditioner, mounts on an interior wall, and provides heating as well as cooling. To move the conditioned air to the bedrooms, each bedroom has a small fan mounted in the wall to pull the air through the wall. Door undercuts and transfer grilles in the bottoms of some doors provide a path for air to return from the bedrooms to the return side of the wall-mounted heat pump.

All of the home's appliances are ENERGY STAR rated. The lighting is all energy-efficient compact fluorescent. The home meets the EPA's Indoor airPLUS requirements, which ensure indoor air quality with good moisture management practices, adequate ventilation, and the stipulation that all paints, finishes, cabinets, and carpets contain no- or low-volatile organic compounds (VOCs).

The home and the study have gained the attention of the manufactured housing industry with factory building organizations across the nation running articles in their publications describing the home and its advances. Articles have also run in industry press like *Builder Magazine* (July 28, 2014).

David Brewer, the general manager for Southern Energy Homes, said the company is looking forward to seeing the results of the study. "We're excited about the project. We've seen bits and pieces of the energy savings. It will be great to see what the cost impacts are from a construction stand point. I think when we have the full 15 months of data to show the payback on this level of performance, it will be highly marketable," said Brewer.

Dentz noted "We expect the first cost of the home to be within the means of most buyers. When rising energy costs and total homeownership costs are considered, this level of home performance should be competitive with or even lower than the conventional home in terms of costs. Since this is a prototype, it is too early to have either billing data or sufficient experience to make performance claims but expectations are high that this home will alter how the industry does business in the future."

Photos courtesy of Southern Energy Homes Division of Clayton Homes.

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance
- **Walls:** 2x4 16 in. o.c., R-13 unfaced fiberglass batt, 1 inch (R-5) XPS rigid foam sheathing with taped seams, no house wrap
- **Roof:** R-54.6 blown fiberglass dense packed at eaves
- **Foundation:** Open or crawl space, R-28 blanket fiberglass under floor joists
- **Windows:** Double-pane, low-E, argon filled U=0.27, SHGC=0.33
- **Air Sealing:** 3.85 ACH 50
- **Ventilation:** Exhaust, continuous
- **HVAC:** One mini-split wall-mounted ductless heat pump (SEER=22; HSPF=12); thermostat-controlled in-wall fans to transfer heat to bedrooms.
- **Hot Water:** Electric storage tank, 30 gallons, 0.93 EF
- **Lighting:** 100% CFL
- **Appliances:** All ENERGY STAR rated appliances

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