DOE CHALLENGE HOME CASE STUDY

e2 Homes

Winter Park, Florida

BUILDER PROFILE

e2 Homes
President: Rob Smith
Winter Park, FL

FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Wilson Residence
- Location: Winter Park, FL
- Layout: 4 bedrooms, 4 baths
- Conditioned Space: 4,305 ft^2
- Completion: May 2012

Performance Data:

- HERS Index without solar PV: 57
- HERS Index with solar PV: -7

Modeled Cost Data:

Standard home, same size/location:

- Projected annual utility costs: $3,378

Wilson Residence Challenge Home:

- Projected annual utility costs: $2,297
- Projected annual energy cost savings (without solar): $1,081
- PV production revenue: $2,420
- Projected total annual energy cost (with solar): $-123

U.S. DEPARTMENT OF ENERGY CHALLENGE HOME

The Nation's First Certified DOE Challenge Home Leaves a BIG Impression with a SMALL Footprint

The first certified DOE Challenge Home—the "Wilson Residence" in Winter Park, Florida—produces more energy than it uses with construction costs one-third less than originally proposed. Completed in May 2012, this 4,305-ft^2 custom home scores a HERS 57 without solar, which is well below the HERS 100 for a standard home built to code. With its photovoltaic system, the home produces better than zero net-energy performance, with a score of HERS -7. This translates into no electric utility bills and even $123 annually in the homeowner's pocket from the utility.

The homeowner, Mr. Wilson, hired e2 Homes to build his dream home. From the start, Rob Smith (the president of e2 Homes) worked with the homeowner, his HERS rater, and his mechanical contractor to come up with a package of measures that meets the energy-efficiency, comfort, and durability requirements of DOE's Challenge Home while taking into account the hot-humid climate and the homeowner's cost constraints. "The DOE Challenge Home is data driven and performance driven, based on all the standards…and it addresses concerns of different climates," said Smith. The home also meets the requirements of LEED for Homes, the Florida Green Building Coalition, Florida Water Star Gold, and other programs.

As specified in the Challenge Home requirements, the envelope was designed to meet all ENERGY STAR Version 3 requirements and 2012 International Energy Conservation Code (IECC) insulation levels. Final blower door tests confirmed a tight envelope at 1.77 ACH 50.

The exterior walls were constructed of autoclaved aerated concrete (AAC) blocks. "My client wanted AACs to avoid using drywall [in this hot-humid climate]," said Smith. Like concrete block, AAC is mold-resistant, non-combustible, and not penetrable by termites or pests, but the unique foam-like structure of the AAC also results in good insulating performance (R-8 for an 8-inch block), effective sound resistance, light weight (one-fifth the weight of concrete), easy workability since it can be readily sawed or drilled, and excellent structural capabilities (AAC blocks and panels come reinforced with rebar).

The window package the team ultimately selected is an ENERGY STAR certified, low-E window that blocks 95% of ultraviolet and infrared light, with a solar heat gain coefficient of .24.

A light-colored standing-seam metal roof was installed over engineered roof trusses that are spray foamed underneath to R-20. This creates a sealed, conditioned attic with summer temperatures down to 85°F instead of a typical 150°F.

All of the 962-ft² porch roof is comprised of solar panels with a 13.4-kW solar array system. The 69 panels don't sit on top of the roof; they are the roof. The completely watertight structure allows about 15% of natural light to filter through the panels, lighting the space below. The panels are dual surface meaning they can produce power from any sunlight reflected up onto their lower surface, for up to 30% greater than rated power production. All wiring is hidden within the canopy's aluminum support beams.

CHALLENGE HOME CERTIFIED:

1. **BASELINE**
   certified ENERGY STAR for 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 Solar Electric and Thermal checklists with PV already installed

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

The heating and cooling system ducts and air handler are located within this unvented attic to meet the Challenge Home requirements of locating HVAC ducts within conditioned space. The home is heated and cooled by three systems: conventional heat pumps for the first and second floors (SEER 18, HSPF 9.5 and SEER 16.5, HSPF 9 respectively), and a ductless mini-split heat pump for the master bedroom (SEER 16, HSPF 10).

The team chose a supply-only ventilation system that creates a slight positive pressure in the house to help control humidity. The "low-cost ventilation system" includes a fresh air duct to the outside of the home with an electric damper regulated by the thermostat to meet ASHRAE ventilation standards.

The home is water efficient in several ways. Two tankless, propane-fired water heaters are located as close to the points of use they serve as possible to minimize water and energy waste (one is near the master bedroom and the other is near the kitchen, laundry room, and other bedrooms). Also, the house is double piped for a 7,000-gallon cistern that collects and supplies rain water to all toilets as well as to the plants in the backyard.

With the home designed for maximum energy and water conservation, the 13.5-kW photovoltaic system is now the appropriate last step for zero net-energy performance. Rather than mounting the 69 solar panels on the roof, the solar installer fit them together to form a watertight structure that literally is the roof of the home's 962-ft² porch. The 195-Watt solar panels are bifacial, meaning they can generate some electricity from reflected light that hits the bottom surface of the panels. The panels also permit about 15% of the daylight to filter through them, lighting the porch area beneath. The hybrid inverter converts the panel-produced direct current power into a utility-compatible alternating current, using a unique technology that overcomes the limitations of traditional central string inverter systems but at a much lower cost than micro-inverter systems.

"At the end of the day, my message for builders considering [building to] Challenge Home is that this program is very rigorous, so it should help builders stand out from the crowd," said Smith. "If you plan early in the process, there doesn't have to be a cost differential to implement high-performance building."