

**DOE CHALLENGE HOME
CASE STUDY****Preferred
Builders, Inc.**

Old Greenwich, CT

**BUILDER PROFILE****Preferred Builders, Inc.**

Owner: Peter J Fusaro
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FEATURED HOME/DEVELOPMENT:**Project Data:**

- Name: The Performance House
- Location: Old Greenwich, CT
- Layout: 4 bedrooms, 3.5 baths, 2 floors plus basement.
- Conditioned Space: 2,700 ft², not including basement.
- Completion: Oct 2012
- Climate Zone: 5A

Performance Data:

- HERS Index without solar PV: 42
- HERS Index with solar PV: 20
- Projected annual utility costs: without solar \$2,419, with solar \$910
- Projected annual energy cost savings (compared to a home built to the 2006 IECC): without solar \$2,170
- PV production revenue: \$1,509
- Builder costs over to-code construction (w/o incentives): without solar \$47,340, with solar \$76,608
- Annual energy savings: 73 MMBtu

The “Performance House” by Preferred Builders, Inc., may not be as big or fancy as the many mansions that grace the historic coastal town of Old Greenwich, Connecticut, but it is sure to be among the best performing.

Completed in fall of 2012, the home has earned a host of green building awards and certifications including designation as the second home in the country to earn the U.S. Department of Energy Challenge Home certification. The home also achieved an ENERGY STAR for Homes Version 3 certification, EPA Indoor airPLUS and EPA WaterSense certifications, LEED Platinum, the National Green Building Standard Emerald level, the Connecticut Home Builders Industry Awards for Best Green Energy Efficient Spec Home and Best Green Energy Efficient Home Overall, and runner up for the 2012 Connecticut Zero Energy Challenge.

Builder Peter J. Fusaro chose a traditional Neo-Colonial design with steep gables, dormer windows, and a columned front porch for the 2-story, 4-bedroom, 3.5-bath home, which has 2,700 ft² of conditioned space, not counting the full finished basement. The exterior components also enhance the home’s efficiency and durability. Traditional cedar siding is accented by trim and decking made of PVC for maximum wear and weather resistance. The casement style windows are more airtight than double-hung windows. All of the windows are low-emissivity, argon-filled with highly durable pultruded fiberglass frames. Windows on the north, east, and west have a U factor of 0.28 and a solar-heat gain coefficient of 0.27, while south-facing windows have a U value of 0.30 and an SHGC of 0.46. Deep 2-foot overhangs shade the windows from high summer sun but let in low winter sun. The roof uses “cool roof” shingles with a solar reflectance index of 29 that meets ENERGY STAR and LEED for Homes criteria.

Underneath its quaint exterior, the home is all 21st century performance, starting with footings made of concrete that has an additive to make it waterproof. The foundation sits on an 8-inch bed of trap rock (3/4 inch stone with no dirt). At the



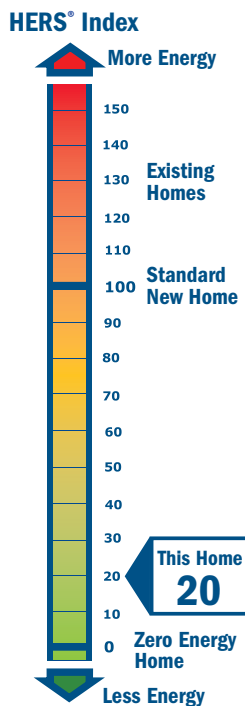
DOE Challenge Home builders are in the top 1% of builders in the country meeting the extraordinary levels of excellence and quality specified by the U.S. Department of Energy. Every DOE Challenge Home starts with ENERGY STAR for Homes Version 3 for an energy-efficient home built on a solid foundation of building science research. Then, even more advanced technologies are designed in for a home that goes above and beyond current code to give you the superior quality construction, HVAC, appliances, indoor air quality, safety, durability, comfort, and solar-ready components along with ultra-low or no utility bills. This provides homeowners with a quality home that will last for generations to come.

The unvented attic is insulated along the roof line to provide a conditioned space for one of the home's two air handlers, which use ECM fans to provide air that is heated via a hot-water coil from the high-efficiency boiler or cooled with a SEER 16 air conditioner. The attic insulation totals R-52.6 with layers of closed-cell spray foam, mineral fiber batt, and foil-faced fiberglass batt.



CHALLENGE HOME CERTIFIED:

- 1 BASELINE**
Certified ENERGY STAR home
- 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 Solar Electric and Thermal Checklists



top of the foundation walls, a copper flashing termite barrier was installed under the pressure-treated sill plate and wrapped up around the bottom of the rigid foam. The foundation walls were treated on the exterior with a rubberized spray-on waterproof coating. A drain board product with an R-3 insulation value was installed on the exterior side of the foundation walls.

A 4-inch perforated footing pipe was installed along the outside edge of the footing, then covered with 4 inches of gravel, filter fabric, and 4 more inches of gravel. Gravelly sandy soil was backfilled and packed down along the foundation wall.

A passive radon removal system was installed under the basement slab consisting of 4-inch perforated pipe laid horizontally in the trap rock and connected to a stack pipe that vents through the roof. An electrical outlet was installed in the attic next to the stack in case a fan needs to be installed in the stack for active radon removal.

Before pouring the concrete basement slab, 2 inches of closed-cell spray foam was sprayed directly onto the trap rock. The foam was also sprayed 6 inches up along the inside of the foundation walls to provide R-13.6 insulation for the bottom and edges of the slab. Spray foam was also applied to the inside of the concrete basement walls to a depth of 3 inches. This spray foam provides a continuous air, moisture, and R-20.7 thermal barrier between the foundation wall and the 2x4 16-in. on-center basement wall framing. The interior walls were faced with 5/8-in. moisture- and mold-resistant gypsum board.

The above-grade 2x6, 16-in. on-center framed walls were dense packed with blown fiberglass at 1.8 lb per cubic feet for an R-24 insulation value that extends up the gable ends to the roof. The exterior walls were sheathed with a treated wood product that is installed like OSB or plywood but has an integrated coating on the exterior side that is both water and weather resistant as well as permeable to allow vapor transmission. The coating does away with the need to install house wrap when all of the seams are taped with the manufacturer's proprietary tape.

Over the coated sheathing, the builder installed high-density EPS rigid foam. The 1.5-inch-thick sheets provide R-7.5 of insulation value and have tongue and groove joints that are taped for a water-tight, wind-proof seal. When combined with the cellulose cavity foam, this gives the exterior walls a total insulation value of R-31.5. The wall between the garage and the house was insulated with four inches (R-27.6) of closed-cell high-density spray foam.



After the basement walls were set but before pouring the concrete basement slab, 2 inches of closed-cell spray foam was sprayed directly onto the 8-inch bed of trap rock, then radiant heat floor piping was laid. The basement walls were then framed with 2x4 16-in. on-center studs set 3 inches in from the concrete walls and spray foam was applied to the concrete basement walls to provide a continuous, air, moisture, and thermal barrier between the foundation wall and the framing.

On the exterior walls, over the rigid foam, the builder installed a synthetic mesh rain screen product. The 0.25-inch-thick mesh layer can be used in place of furring strips to provide a continuous air space for drainage and drying as well as a thermal break behind exterior cladding.

To improve water resistance in the bathrooms, a water-proof, breathable fabric product was installed on the backer board with thinset before the tile was installed. A bubblewrap-like water-proofing membrane was installed over the subfloor with thinset before the floor tile was installed.

A combination of insulation types was used in the attic areas. The main roof was insulated along the roof line with 4 inches of closed-cell spray foam for an R value of 27.6. This was covered with a 3-inch-thick (R-12) fire-rated mineral fiber batt that was friction fit between 2x12 roof rafters. The batt was covered with a 3.5-inch (R-13) fiberglass batt that was correctly stapled onto the surface, not the insides, of the rafters. The fiberglass batt has a foil-scrim-kraft facing, which serves as both a vapor retarder and a fire retarder, allowing the batt to be left exposed and still satisfy code for fire rating because the attic could be used for storage space. Together these provided R-52.6 of insulation in the main roof assembly. The garage ceiling was thoroughly air sealed and insulated with 3 inches of closed-cell spray foam plus R-30 fiberglass batt for an insulation value of R-50.7. The garage dormer roof assembly and knee walls were insulated to R-53 with 5.5 inches of closed-cell spray foam (R-38) plus R-15 fiberglass batt.

Like the walls, the roof was sheathed with a waterproof-coated sheet good and the joints were taped. This was covered with a water-resistant, breathable roof deck protection. An adhesive-backed roofing membrane was applied at the overhangs, eaves, and valleys.

A natural gas-fired 95% high-efficiency condensing boiler and hydro-coil combination system was installed in the basement to heat water for hot water coils for two air handlers located in the basement and attic to heat the first and second floor. Two additional loops off the boiler supply radiant floor heat in the basement floor and domestic hot water via a 78-gallon storage tank. The boiler has energy-efficient variable-speed circulating pumps. The two air handlers have variable-speed fans and are equipped with 16.5-SEER air conditioning units for cooling.

For ventilation, the home has an energy recovery ventilator (ERV) that is separately ducted to supply fresh air to key areas throughout the house. Multiple return grilles located in the central areas of the first and second floor circulate air back through the ERV and outside while exchanging heat with incoming fresh air.

HOME CERTIFICATIONS:

DOE Challenge Home

National Green Building Standard - Emerald

LEED for Homes - Platinum

ENERGY STAR Version 3

EPA Indoor airPLUS

EPA WaterSense



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 ERV fan runs all the time at a baseline of 102 cfm to meet ASHRAE 62.2 ventilation requirements. It is also wired to a carbon dioxide sensor in the living room and can ramp up to speeds of 200 cfm if CO levels in the house rise (e.g., during large gatherings). Jump ducts located in each bedroom provide return air pathways to centrally located return grilles. Each bathroom is also equipped with ENERGY STAR-rated exhaust fans that are controlled by motion and humidity sensors. Indoor air quality is also enhanced with no-VOC and low-VOC paints and sealants, formaldehyde-free adhesives, and a timer-controlled garage exhaust fan.

The home has 77 recessed ceiling fixtures, all of which are fitted with airtight housings and dedicated LED modular light sources that provide 3500 lumens at 13.8 watts each. All of the home's appliances are ENERGY STAR rated.

The home achieves a HERS 20 rating with a roof-mounted 7.44-kW photovoltaic system (or HERS 42 when not counting the solar). According to Fusaro, the Nov-Jan gas bill was only \$292, and the electric bill showed a \$558 credit.

The builder met DOE Challenge Home Indoor airPlus and WaterSense criteria, as well as the disaster-resistance recommendations. Water-conserving features include demand-activated hot water, insulated PEX hot water piping, and EPA WaterSense-approved shower heads, faucets, toilets, and irrigation. A storm water management system channels rainwater to retention chambers buried in the front yard.

The infill lot earned green program credits for proximity to city services, onsite recycling, and use of recycled materials. All of the cardboard, wood, gypsum, scrap metal, and PVC trim and deck scraps were recycled. Cabinets are Forest Stewardship Council-certified, countertops are recycled quartz, the sheetrock is 100% recycled content, and the concrete contains recycled glass.

The home was completed in October 2012 and has been toured extensively by members of the building community, local press, and interested home buyers.

Fusaro, a custom and spec home builder who builds about one home a year, serves as president of the Home Builders & Remodeling Association of Fairfield County and has served on local green building committees as well as the 2012 National Green Building Standards committee. He is also a certified HERS rater and Building Performance Institute (BPI) building analyst and envelope professional.

Fusaro worked with DOE's Building America program through Steven Winter Associates, a team lead for DOE's CARB research team, which conducted energy analysis for the project. Fusaro appreciates the fact that ENERGY STAR Version 3 is a building block certification for both DOE Challenge Home and LEED for Homes. "It saved a lot of paperwork and it allowed me to go the performance path for LEED platinum." These certifications paved the way for several other green awards and designations, which have helped to set this home builder apart from the competition, both big and small, in coastal Connecticut.

KEY FEATURES

- **Path:** performance
- **Above-Grade Walls:** R-24 blown cellulose plus R-7.5 high-density EPS rigid foam, membrane-coated OSB sheathing, mesh rain screen.
- **Roof:** main roof insulated along roofline with 4 inches (R-27.6) closed-cell spray foam, 3 inches (R-12) fire-rated mineral wool batt, and 3.5 inches (R-13) foil-faced fiberglass batt for a total of R-52.6. Garage ceiling is R-50.7 closed-cell spray foam plus R-15 batt. Cool roof shingles are SRI 29.
- **Foundation:** under slab: R-13.6 closed-cell foam sprayed directly onto 8-inch bed of ¾-inch stone
- **Below-Grade Walls:** 3 inches closed-cell spray foam interior (R-20.7) R-3 drain board exterior.
- **Windows:** ENERGY STAR low-E, double-pane, fiberglass framed. On the south side: U=0.30, SHGC=0.46. On north, east, and west side: U=0.28, SHGC=0.27.
- **Air Sealing:** < 1 ACH 50
- **Ventilation:** ERV unit with independent duct system and CO₂ override control, humidity-controlled bath exhaust fans
- **HVAC:** 95% gas-fired boiler with hot water coils to air handlers with variable-speed fans in basement and in attic, plus radiant floor loop in basement. Two SEER-16 air conditioners.
- **Water Heating:** line from boiler to 78-gallon storage tank
- **Ducts:** R-8 fiberboard, in conditioned basement and sealed insulated attic.
- **Lighting:** 77 LED modular recessed lights, with airtight housings, 3500 K, 13.8 watts, 3500 lumens per light.
- **Solar:** roof-mounted fixed 7.44 kW PV panels, OSHA-approved permanent footing anchors
- **Water Conservation:** push-button hot water circulation pumps. EPA WaterSense showerheads, faucets, toilets; rain water collection; WaterSense irrigation monitor; drought-tolerant landscaping.
- **Other:** home energy management system; timer-controlled garage exhaust fan, on-site recycling of construction debris; recycled content countertops, drywall concrete; Forest Stewardship Council-certified cabinetry, electric car charging station.