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

DOE ZERO ENERGY READY HOME™

Housing Innovation Awards

John Hubert Associates

EXIT-0 House
North Cape May, NJ

BUILDER PROFILE

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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: EXIT-0 House
- Location: North Cape May, NJ
- Layout: 3 bedrooms, 2.5 baths, 2 floors
- Conditioned Space: 1,871 ft^2
- Climate Zone: IECC 4A, mixed-humid
- Completion: June 2014
- Category: Custom

Modeled Performance Data:

- HERS Index: without PV 46, with PV 9
- Projected annual utility costs: without PV $1,456, with PV $493
- Projected annual energy cost savings (compared to a home built to the 2009 IECC): without PV $2,193, with PV $1,230
- Builder's added cost over 2009 IECC: without PV $10,000
- Annual energy savings: without PV 8,260 kWh, 23 therms, with PV 19,624 kWh, 23 therms

John Hubert Associates (JHA) has built the first home in the state of New Jersey certified to the U.S. Department of Energy's Zero Energy Ready Home program. The home was nicknamed the "EXIT-0 House," in part because of its North Cape May location, which is Exit 0 on the New Jersey turnpike, but also because the home is a true net zero energy home, producing as much electricity in a year as it uses.

The home is the first DOE Zero Energy Ready Home for architect John Hubert and his five-person design-build firm, which has been constructing and renovating homes in eastern Pennsylvania and southern New Jersey since 2000. Hubert first got serious about energy-efficient construction while renovating his neighbor's home in 2011. He and his team met with a Leadership in Energy and Environmental Design (LEED) consultant who showed them that, by adding just a few items to the things they already planned to do, they could get within two points of a LEED platinum rating. The client agreed and the home received a LEED platinum certification in 2012.

DSB Energy Services was brought in to assist with energy design and performance certification for the EXIT-0 House and recommended that JHA consider the DOE Zero Energy Ready Home program as a design goal. Hubert and his team decided to go for it, hoping to build the first and, if not the first, then the highest performing New Jersey home in the program.

The team worked to meet the DOE Zero Energy Ready Home program requirements, which include meeting ENERGY STAR Version 3.0, Indoor airPLUS, WaterSense, 2012 IECC insulation levels, and other requirements. The home achieved a HERS score of 46 when photovoltaics are not included, and a HERS score of 9 when the 6.5-kW PV system is considered. In comparison, a code-built home would score about a HERS 100, and the average HERS rating for existing homes is 120 or higher.

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.

A coated OSB sheathing was used on the walls and the roof. With the seams caulked and taped, the sheathing provides a weather-resistant air barrier and drainage plane, eliminating the need for house wrap. The wall sheathing has an interior-facing layer of R-3.6 rigid foam adhered to it. The roof sheathing is covered with a synthetic roof deck protection covering. Ice and water shield is installed along the perimeter and the roofing is asphalt shingles.

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

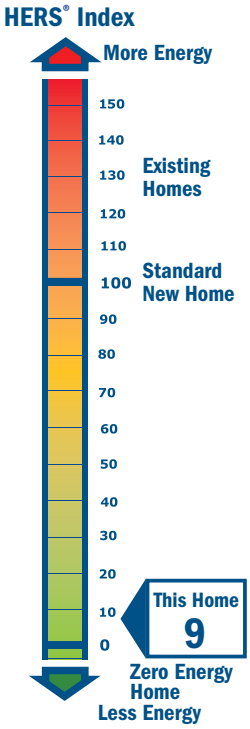
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



Hubert did not certify the Cape May home to LEED but, just for comparison, the rater, David Berg, ran a LEED for Homes Checklist. "According to the report, we were 86% better in terms of energy use than the minimum requirement for a home built to LEED," said Hubert.

Hubert likes the DOE Zero Energy Ready Home program for its simplicity, zero registration fee, and emphasis on energy efficiency. He plans to encourage future clients to consider the DOE Zero Energy Ready Home certification while stressing the inherent environmental and economic values associated with high-performance building design and construction practices.

For JHA, the DOE Zero Energy Ready Home was a learning experience and a prototype for the firm's future plans, which include a line of market-ready Zero Energy Ready home designs including a modified version of the EXIT-0 House.

The EXIT-0 House is a modern, custom-designed home with a small, limited footprint to minimize the house's requirements for energy, water, heating, and cooling. The small but high-ceilinged rooms create a spacious feeling maximized by large windows for natural day lighting. The asymetrical roof provides a large south-facing surface for solar panels.

The house is built on the foundation of a former house on the site owned by the client, eliminating the need for excavation. The existing crawl space walls were insulated on the inside with R-18 of rigid foam. A 6-mil polyethylene vapor barrier was laid over the crawl space floor and draped up the walls to provide a capillary break between the concrete stem walls and the rim joist. An additional 2 feet of R-18 foam board was laid horizontally on top of the vapor barrier along the perimeter of the crawl space floor.

The home's above-grade walls are constructed of 2x6 wood studs framed 24-inches on-center with un-faced R-21 fiberglass batt insulation installed in the wall cavities. On the exterior of the walls, JHA installed an OSB product that has an R-3.6 layer of rigid foam insulation adhered to the interior surface and an exterior coating that reduces air infiltration while protecting against moisture. As an additional measure against air infiltration, all edges of the wall and roof sheathing were first caulked then the joints were sealed with a proprietary tape on the exterior side. The coated OSB serves as an air and vapor barrier as well as a drainage plane; therefore, no house wrap is required. Cedar trim and plank siding were then installed on the exterior surface.

The existing crawl space foundation walls were covered with R-18 rigid foam that is caulked at all seams to form a moisture and thermal barrier. A plastic vapor barrier covers the floor of the crawl space and extends up and over the tops of the foundation walls providing a capillary break between the stem walls and the sill plate. An additional 2-foot layer of rigid foam was installed horizontally along perimeter of the foundation wall. This application is an acceptable alternative to digging below grade to extend the insulation down along the foundation wall to the footing.

The roof assembly consists of 12-inch engineered wood I-joists, spaced 24-inches on-center. The roof is also sheathed with coated OSB. The underside of the roof decking was sprayed with 3 inches of closed-cell foam, which air seals and insulates while also providing added shear strength to the assembly. The remainder of the vaulted ceiling cavity was then filled with R-30 fiberglass batt insulation for an effective roof R-value of R-42.

High-performance windows complete the energy-efficient shell. The home uses double-pane aluminum-clad wood windows with low-emissivity coatings to reduce heat transmission and insulating argon gas fill between the panes. The windows have a U-value of 0.30 or better and a solar heat gain coefficient (SHGC) of 0.28 or better.

The building shell was tested for air infiltration before the insulation was installed and measured 2.0 air changes per hour at 50 Pascals pressure difference (ACH 50), exceeding the Zero Energy Ready Home requirement of 2.5 ACH 50. DSB Energy Services certified the home for ENERGY STAR 3.0 and the DOE Zero Energy Ready Home program. The final testing showed an air leakage rate of only 1.4 ACH 50, surpassing the infiltration requirements of both programs.

To ensure the home's indoor air quality, a heat recovery ventilator (HRV) was installed. The HRV has two ducts to the outside—one to bring in fresh air and one to exhaust stale air. The two air streams pass in a heat exchanger, which transfers heat from the warmer air path to the cooler path. The incoming air is connected to the air handler of the home's central air source heat pump, so the air is further heated or cooled before being distributed throughout the home. Each bathroom has separate exhaust fans that vent to the outside.

The home's heating and cooling is provided by an air source heat pump that has a two-stage compressor, a cooling efficiency of 17.5 SEER, and a heating efficiency of 9.25 HSPF (considerably higher than the SEER 13 and HSPF 7.7 required by minimum federal appliance standards). The air handler and ducts were located inside the home's thermal envelope to eliminate any duct leakage to the outside.

To lower the energy usage for everyday living, the majority of the home's lighting fixtures are LED; some are CFL. Incandescent lamps comprise only 7% of the lighting. The home's clothes washer, dishwasher, and refrigerator are all ENERGY STAR rated, as are the three ceiling fans.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program

ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

EPA WaterSense

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.

Large north-facing windows provide daylight and views without adding much solar heat gain.

The home successfully met the DOE Zero Energy Ready Home's stringent hot water delivery requirement to minimize hot water waste. All hot water supply lines utilize a home run line design. Additional water conservation features include water-saving plumbing fixtures that meet the EPA WaterSense criteria.

A solar hot water system with a 120 ft^2 roof-mounted panel array supplies hot water to the 120-gallon water tank. The roof is also home to the 468 ft^2 panel array for the 6.5-kW photovoltaic system, which has high-efficiency inverters.

The builders complied with EPA's Indoor airPLUS checklist, including the requirements that all adhesives, sealants, finishes, and paints used in the house be low- or no-VOC, except in rare instances where regulations specified a material that was not available as a low/no-VOC product. On-site-applied finishes were kept to a minimum; for example, the exterior cladding is a weathered cedar that does not require an applied finish.

The home is equipped with a remote monitoring system that allows the homeowners to monitor a variety of building performance measurements including interior temperature, humidity, the solar PV and water heating systems, external temperature and humidity, and solar incidence. The system can also modify the operation of the HRV and the heat pump.

Hubert and his colleagues have committed to sharing the lessons learned in this project with their peers in the design and construction fields, as well as with the community. They have submitted abstracts to present on the project at the annual American Institute of Architects' Design on Delaware conference in Philadelphia, participated in a conference discussion regarding the project with AIA's Design Build Panel, and are planning to submit articles about the project for publication in local and national publications.

The time they've taken to share the benefits of high-performance construction with their homeowners and potential clients is paying off. "We find that our clients are not only pleased with their houses but continue to 'teach' others about the benefits of energy-efficient and low-impact construction—and more and more clients are coming to our office specifically wanting high-efficiency construction," said Hubert.

Photos courtesy of John Hubert Associates.

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance
- **Walls:** Above-grade walls 2x6 framed 24-in. o.c., OSB sheathing with R-3.6 rigid foam interior and water-resistant coating taped at seams for drainage plane and air barrier
- **Roof:** Cathedral ceiling with 12-inch I-joists; insulated under roof deck with 3 inches of closed-cell spray foam plus R-30 fiberglass batt; roof deck is coated OSB sheathing with water-resistant coating taped at seams for drainage plane and air barrier
- **Foundation:** Pre-existing crawl space foundation walls insulated on interior with R-18 rigid foam, then vapor barrier over dirt floor extending up and over foundation wall under rim joist; additional 2 feet of R-18 foam board laid horizontally on vapor barrier around interior perimeter foundation walls
- **Windows:** Double-pane, aluminum-clad wood frames; low-e coating, argon-fill. U=0.30, SHGC=0.28
- **Air Sealing:** 1.4 ACH 50
- **Ventilation:** HRV, bath exhaust and kitchen fans vent to exterior
- **HVAC:** Air source heat pump (two-stage) 17.5 SEER, 9.25 HSPF, R-8 insulated ducts and air handlers inside thermal envelope
- **Hot Water:** Solar water heating with 120-gallon tank, EF=0.80
- **Lighting:** 7% incandescent, 93% LED and CFL (majority LED)
- **Appliances:** ENERGY STAR clothes washer, dishwasher, refrigerator; 3 ENERGY STAR ceiling fans
- **Solar:** Solar water heater with 120 ft^2 collector, 6.5-kW PV with high-efficiency inverters and 468 ft^2 panel array
- **Water Conservation:** EPA WaterSense plumbing fixtures; all hot water supply lines use home-run central manifold design
- **Other:** Remote monitoring for interior and exterior temp and humidity; remote operation of HRV and heat pump; meets no/low-VOC requirements

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