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

DOE ZERO ENERGY READY HOME™ CASE STUDY

Murphy Brothers Contracting

Shore Road Project
Old Greenwich, CT

BUILDER PROFILE

Murphy Brothers Contracting, Inc.
Mamaroneck, NY
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Shore Road Project
- Location: Old Greenwich, CT
- Layout: 4 bedrooms, 4 baths, 2 floors
- Conditioned Space: 4,100 ft^2
- Climate Zone: IECC 5A, Cold
- Completion: June 2014
- Category: Custom

Modeled Performance Data:

- HERS Index: without PV 40, with PV 27
- Projected Annual Utility Costs: without PV $2,099, with PV $1,376
- Projected Annual Energy Cost Savings (compared to a home built to the 2009 IECC): without PV $490, with PV $1,233
- Builder's Added Cost over 2009 IECC: $21/ft^2 with PV add 10%
- Annual Energy Savings: without PV 2,452 kW, 108 therms; with PV 7,763 kW, 108 therms

For Murphy Brothers Contracting, constructing a U.S. Department of Energy Zero Energy Ready Home has been a great way to learn by doing and to share what they've learned.

Murphy Brothers' first DOE Zero Energy Ready Home, in Old Greenwich, Connecticut, was the site of several muddy boots tours for architects, was host to an American Institute of Architects (AIA) presentation on ENERGY STAR, was chosen by the U.S. Green Building Council of Connecticut for its spring home tour, and was the subject of numerous articles in the local and regional newspapers. The home, dubbed the Shore Road Project, was the recipeint of several awards in 2014 including "Best Green Energy Efficient Custom Home" from the Home Builders & Remodelers Association of Connecticut and "Best Green Home" from the Hudson Valley Builders & Remodelers Association.

"We tell architects and other builders, it's pretty easy to get attention for your work when you put this kind of innovation into a house. We're glad it is attracting attention because we'd love to see more people build high-efficiency homes like this," said Michael Murphy, head of new product development for Murphy Brothers, although not a relative of its founders, brothers Chris and Sean Murphy.

Learning as they go and sharing what they know have become second nature to the general contracting and construction firm, which routinely hosts continuing education seminars, workshops, and project tours to share with architects and other design professionals what they are learning about new construction products and techniques. The firm, which has been in business for 35 years, has 45 employees, not counting subcontractors, and does about $20 million a year in

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.

Murphy Brothers' first DOE Zero Energy Ready Home was built with insulated concrete forms. The interlocking rigid foam blocks stack to create a hollow wall that is reinforced with steel rebar then filled with poured concrete. The rigid foam stays in place to provide continuous insulation layers on the inside and outside of the walls. Because the foam blocks are glued together, ICF walls also provide a very airtight and water-resistant structure.

WHAT MAKES A HOME DOE ZERO ENERGY READY HOME-CERTIFIED?

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

2 **ENVELOPE**
meets or exceeds 2012 IECC levels

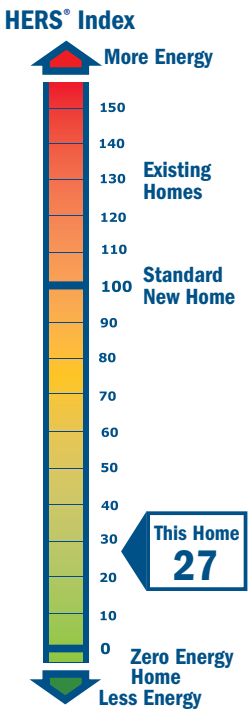
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



business, building 4 to 5 new homes and renovating about 15 to 20 homes each year. According to Michael Murphy, about 20% of the firm's projects come from homeowners and 80% come from architects.

Although Murphy Brothers has always sought to build above-code homes, its focus on certifying high-performance homes began in 2009 with construction of a home to the National Association of Home Builders' National Green Building Standards. "We learned a lot on that project about how to make a house energy efficient," said Michael Murphy. "Then we did the first LEED for Homes house in Westchester County, New York. It was a beautiful retrofit home and it got a lot of publicity. Over 600 people toured the home."

Murphy Brothers learned about the DOE Zero Energy Ready Home program from Steven Winter Associates, an energy consulting firm that conducted several of their AIA presentations. Steven Winter Associates also leads a research team for DOE's Building America program and recommended that Murphy Brothers try constructing a home to meet the strict performance standards of the DOE Zero Energy Ready Home program.

Murphy Brothers completed its first DOE Zero Energy Ready Certified Home in 2014. The 4,100-ft^2 four-bedroom, four-bath, two-story home with full basement and insulated attic space is situated on a tight lot and is considered small by Old Greenwich standards but, with its "coastal colonial" styling, it fits in well among the town's historic colonials. The photovoltaic (PV) roof shingles are the only visible hint at the super-efficient construction that lies beneath the quaint exterior.

The home meets all of the high-performance requirements of the DOE Zero Energy Ready Home certification program. It meets the building envelope and HVAC requirements listed in the checklists of ENERGY STAR Certified Homes Version 3.0. It meets the indoor air quality specifications of the U.S. Environmental Protection Agency's Indoor airPLUS program and the water-saving requirements of EPA's WaterSense program. It also meets the insulation requirements of the 2012 International Energy Conservation Code (IECC), which is a DOE program requirement. It more than meets the program's Renewable Energy Ready Checklists by having a 4.5-kW solar PV system already integrated into the roof.

The ICF walls are resistant to moisture, bugs, fire, wind, and earthquakes. They provide an airtight structure with excellent soundproofing. Murphy Brothers used closed-cell spray foam to insulate under the basement slab and on the underside of the roof decking to provide a sealed, insulated attic for the home's HVAC system. Shredded recycled blue jean insulation provides sound attenuation in the home's interior walls and between floors. High-performance windows, ENERGY STAR-rated appliances and ceiling fans, and LED and CFL lighting add to the efficiency of the home.

On the Home Energy Rating System (HERS) Index, the home scores a 27 with PV roof shingles. A typical home built to state code (the 2009 IECC), would score about 80 on the HERS Index, and existing homes typically score 120 or higher. This low score of 27 reflects just how far the Shore Road Project outperforms typical new construction.

Insulated concrete forms (ICFs) were used for all of the walls of the home from the foundation footing to the roof line, a first for Murphy Brothers Contracting although the builder had used ICFs for basement walls in the past. After excavating the site to 8 feet below grade, extensive under-slab drainage and a sump system were installed to help deal with potential flooding and/or rising ground water tables. Murphy Brothers then laid down 5 inches of crushed rock. This rock served as a capillary break and an escape path for any radon or soil gases seeping up through the soil. The builder sprayed 4 to 5 inches of closed-cell foam directly on to the rock then laid down a 10-mil polyethylene vapor barrier before pouring the concrete basement floor slab.

The walls were constructed of 48x16-inch ICF blocks consisting of two 2.5-inch-thick layers of rigid foam held apart by plastic spacers. The foam blocks are stacked like bricks and reinforced with steel rebar then concrete is poured into the hollow wall and allowed to harden. ICF walls provide a fire-resistant, bug-resistant, moisture-resistant, storm-resistant, earthquake-resistant, and sound-proof shell for the home. The13-inch-thick basement walls were filled with an 8-inch-thick layer of concrete and had an R value of R-33. The first- and second story walls were composed of 11-inch-thick ICFs that were filled with a 6-inch-thick layer of concrete.

The above-grade walls have an R value of R-21. However, in terms of insulation value, there is an important difference between ICF walls and stud-framed walls. Stud-framed walls vary in insulation value - with a higher R-value between the studs where the insulation is thickest and a lower R-value at the studs themselves, which both interrupt the insulation and provide a path for thermal bridging or heat transfer between the inside and outside of the home. ICF walls provide a consistent R-value across the wall, thanks to the continuous insulation layers along both the inside and outside of the walls. With stud-framed walls, rigid foam sheathing could be added to provide a continuous insulation layer, but this is an additional step, whereas with ICF construction the foam layers are an inherent part of the wall.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program

ENERGY STAR Certified Homes, Version 3.0

EPA Indoor airPLUS

"Building green is simply building smart."

— Michael Murphy, head of new product development for Murphy Brothers Contracting

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.

Murphy Brothers installed a 4.5-kW photovoltaic system using PV shingles that integrate into the roof for a lower profile than raised panels.

Dozens of architects walked through the home during and after the ICF installation. "They were amazed that you can install the sheetrock directly to the insulated concrete forms and you can add fiber cement siding directly to the outside. You don't need furring strips," said Murphy. Because all of the seams in the ICF blocks are glued, the foam surface is also water tight, so no house wrap was needed.

To determine the home's airtightness, a door blower test was conducted. The test showed the home's total air leakage was only 0.96 air changes per hour at 50 Pascals of pressure (ACH 50). This is about four times tighter than the 4 ACH 50 required by ENERGY STAR Version 3.0 for cold climate zones 5, 6, and 7.

The unvented attic is insulated along the underside of the roof deck with spray foam, giving it an insulation value of R-70 and providing an insulated, air-sealed location for the home's HVAC equipment, which includes a dual-fuel heat pump and R-8 insulated ducts. The heat pump provides cooling for the entire house with a Seasonal Energy Efficiency Ratio (SEER) of 16.5. The heat pump provides heating at a heating seasonal performance factor (HSPF) of 9. When outdoor temperatures dip below 35°F, the 96 AFUE gas furnace switches on. All of the heating and cooling ducts have been sealed and insulated to an R-value of R-8, and the ducts are located in the fully insulated attic.

The home's hot water is provided by a 97% efficient condensing water heater. A recirculation loop minimizes water loss while waiting for hot water at faucets and showers. The loop is either push button- or motion sensor-activated and uses wireless electronics.

Murphy attributes the high level of performance achieved to having Stephen Winter Associates' involvement in the project from the start. "Stephen Winter Associates was instrumental. We gave them the initial design of the house, they made recommendations and suggested changes, and we implemented them. They were there during the entire process of building. This project's successful results were the work of our wonderful team headed by Rex Gedney, our architect (from Crozier Gedney Architects) and Lois Arena, our energy consultant (from Steven Winter Associates)," said Murphy. Murphy said he highly recommended getting an energy consultant's input upfront because "if you get too far in the process, then it is more likely that radical changes will have to be made in order to achieve a super energy-efficient home. If the house is designed with energy-efficiency strategies already in mind, a more cost- and time-effective home can be built."

Photos courtesy of Murphy Brothers Contracting, Inc.

KEY FEATURES

- **DOE Zero Energy Home Path:** Performance
- **Walls:** 13-inch-thick R-33 ICF basement walls, 11-inch-thick R-21 first and second floor ICF walls
- **Roof/Attic:** Asphalt shingles; R-70 closed-cell spray foam on underside of roof deck
- **Foundation:** 13-inch-thick R-33 ICF basement walls. Under 5-inch concrete slab floor: 5 inches rock, 10-mil vapor barrier, 4 to 5 inches closed-cell spray foam
- **Windows:** Double-pane, wood-framed, low-e, double-hung windows; SHGC=0.18, U=0.3
- **Air Sealing:** 0.96 ACH 50
- **Ventilation:** ERV run continuously to meet ASHRAE 62.2
- **HVAC:** A dual-fuel heat pump, 16.5 SEER, 9 HSPF, with 96 AFUE gas furnace for backup heat. HVAC system and ductwork located in sealed, insulated attic
- **Hot Water:** Instantaneous 97% efficient condensing water heater
- **Lighting:** 45% LED, 45% CFL; ENERGY STAR ceiling fans
- **Appliances:** ENERGY STAR rated refrigerator, dishwasher and clothes washer
- **Solar** 4.5-kW solar shingle PV incorporated into roofing
- **Water Conservation:** Hot water recirculation loop, motion-sensor or push button, wireless electronics
- **Other:** Three energy management thermostats were installed. Reclaimed lumber was used for the kitchen island counter, office desk tops, and a sliding door into den. Recycled blue jean insulation was used in the interior walls and floors for sound attenuation. Low-VOC paints were used throughout the home. ICF construction was used for disaster resistance. Under-slab drainage and sump system were installed