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

DOE ZERO ENERGY READY HOME™

U.S. DOE ZERO ENERGY READY HOME 2019 WINNER *Housing Innovation Awards*

Greenhill Contracting

Newburgh Custom
Newburgh, NY

BUILDER PROFILE

Greenhill Contracting
Esopus, New York; ZeroNetNow.com
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Newburgh Custom
- Location: Newburgh, NY
- Layout: 3 bdrm, 3 bath, 2 fls + bsmt, 2,512 ft²
- Climate: IECC 5A, cold
- Completed: July 2019
- Category: custom for buyer

Modeled Performance Data:

- HERS Index: without PV 39; with PV -5
- Projected Annual Energy Costs: without PV $1,800; with PV $100
- Projected Annual Energy Cost Savings: (vs typical new homes) without PV $2,200; with PV $3,950
- Projected Annual Energy Savings: without PV 14,700 kWh; with PV 26,200 kWh
- Added Construction Cost: without PV $10,000; with PV $37,000
- Savings in the First 30 Years: $167,200

Owners of this new 2,512-ft² home in Newburgh, New York, can rest easy knowing that their home is resistant to hurricanes, earthquakes, wildfires, tornados, blizzards, mold, and bugs; and their monthly electric bill will rarely go above $10 a month. All of this came at a cost of less than $10,000 more than a home built to just meet code.

Greenhill Contracting of Esopus, New York, built the home out of durable, highly efficient insulated concrete forms ICFs. They also built it to the exacting specifications of the U.S. Department of Energy's Zero Energy Ready Home program. The program starts with certification to the program checklists for ENERGY STAR Certified Homes Version 3.0, 3.1, or 3.2 and the U.S. Environmental Protection Agency's Indoor airPLUS program. Homes must also meet the hot water distribution requirements of the EPA's WaterSense program, the insulation requirements of the International Energy Conservation Code, and other mandatory requirements of the DOE program. In addition, homes are required to have solar electric panels installed or have the conduit and electrical panel space in place for them.

Greenhill Contracting constructed its first zero energy home in 2007 and has built 36 zero energy custom homes to date. The company has been a partner in the DOE Zero Energy Ready Home program since the program started in 2013 and has committed to certifying all of its homes to the DOE Zero-Energy Home label. Greenhill Contracting routinely achieves among the lowest Home Energy Rating System (HERS) scores in the country. On the HERS index, a typical new home built to code would achieve roughly 80 to 100, while a net zero energy home would score under 10, which is made possible by building a very efficient home and then adding solar panels that will produce as much energy as the home uses over the course of a year. Greenhill Contracting's homes often score below 40 before including the photovoltaic panels. Greenhill Contracting's home this year achieved a HERS score of 39 without PV and minus 5 when the 10.2 kW of solar panels are added.

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. Every DOE Zero Energy Ready Home starts with ENERGY STAR Certified Homes Version 3.0/3.1/3.2 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.

Greenhill Contracting built this 2,512-ft² house in Newburgh, New York, to the high performance criteria of the DOE Zero Energy Ready Home (ZERH) program. The roof-mounted photovoltaic system offsets electricity usage to cut energy bills to nearly zero. Many months of the year the homeowners see a credit on their utility bill.

What makes a home a DOE ZERO ENERGY READY HOME?

1 **BASELINE**
ENERGY STAR Certified Homes Version 3.0/3.1

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

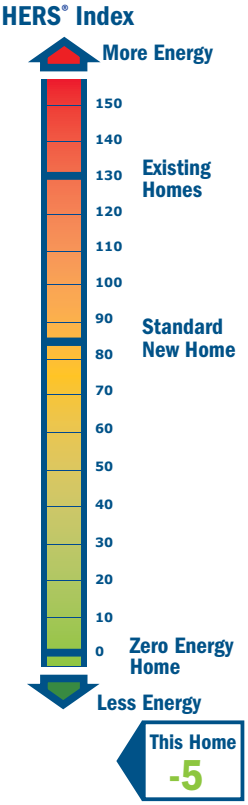
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



The homes start with the highly insulating properties of insulated concrete forms (ICFs), which are hollow foam blocks that stack like Legos to form a hollow wall that is reinforced with steel rebar then filled with concrete. The concrete hardens and the foam stays in place forming a solid wall with continuous layers of insulation on each side. This home was constructed of 11.25-inch-wide ICF blocks consisting of a 6-inch concrete core with about 2.6 inches of rigid EPS on each side for a total wall insulation value of R-22. The solid walls are airtight and the continuous foam layers on either side limit thermal bridging or heat transfer through the walls.

The ICF blocks were used for both the below-grade basement walls and the above-grade walls, providing a continuous thermal barrier from the footing to the roof line. They also provide R-22 of slab-edge insulation around the basement floor slab. Before pouring the floor slab, the builder sprayed 4.5 inches (R-29) of closed-cell spray foam directly onto the gravel base where the foam serves as both a vapor barrier and under-slab insulation.

The ICF blocks are sealed at the seams to provide a continuous air barrier. They also serve as the drainage plane on the exterior side of the walls so no house wrap is needed. To protect the framing where windows or doors will be installed, an elastomeric waterproofing compound is applied with a caulk gun and putty knife to provide a seamless, jointless flashing layer around the openings. Vinyl siding is used for the exterior cladding. Below-grade portions of the ICF walls are protected with cementitious boards.

"The design and construction utilizes highly durable, moisture-tolerant materials and best practices for water-management so the structures may serve as safe, comfortable homes for many generations to come. These reinforced concrete structures are designed to survive severe winds (above 200 miles per hour) and earthquake activity, creating a safe haven for the occupants. These building materials and strategies also create a pest-proof environment," said Anthony Aebi, owner of Greenhill Contracting.

Like a Styrofoam cooler, this Greenhill Contracting home is wrapped in foam insulation, with 4.5 inches of closed-cell spray foam under the slab and 11.25-inch-thick R-22 ICF block walls. The underside of the roof deck is covered with 10.5 inches of open-cell spray foam plus 2.5 inches of closed-cell spray foam to provide an R-65 insulated attic.

Aebi constructs a sealed, unvented attic that is insulated on the underside of the roof deck with two types of spray foam. He sprays 10.5 inches (R-46) of open-cell spray foam followed by 2.5 inches (R-19) of closed-cell foam insulation which completely covers the open-cell spray foam, providing a total attic insulation value of R-65. The closed-cell spray foam also serves as a Class II vapor retarder. The insulated attic serves as a conditioned space for the ducted minisplit HVAC system. Above the roof deck, a self-adhered bitumen membrane is installed at the roof edges and valleys and the roof is covered with enhanced-performance shingles that have a 130-mph wind-speed rating and a lifetime warranty.

To allow for an abundance of natural light without sacrificing too much in thermal performance, the builder opted for high-efficiency triple-pane windows. The windows are argon-filled vinyl-framed casement style windows with an insulation value of U-0.18 (R-5.55) and a solar heat gain coefficient (SHGC) of 0.23. Even the sliding doors are triple paned. They have an insulation value of U-0.20 (R-5) and an SHGC of 0.28.

The home is so airtight that a blower door test of whole-house air leakage showed the home had leakage of only 0.18 air changes per hour at 50 Pascals pressure difference (ACH 50). That level of airtightness (which is typical of Aebi's homes) is far below the 3 ACH 50 required by the 2015 International Energy Conservation Code and even well below the 0.60 ACH 50 required in the Passive House U.S. standard.

To provide fresh air for the home, an energy recovery ventilator (ERV) runs 24/7 at low speed to exhaust air from the bathrooms, kitchen, laundry, and attic. The ERV is equipped with CO_2 sensors that will trigger higher levels of ventilation when CO_2 levels exceed 1,000 ppm. The main controller for the HVAC system allows occupants to increase (or decrease) ventilation as desired. Boost-speed controllers are also located in each bathroom and the kitchen for higher speed exhaust when desired. Fresh air brought into the home through the supply duct is filtered by a MERV 7 filter as it enters the ERV heat exchanger then it is ducted into the return trunk of the mini-split heat pump prior to the air-handling unit, where it is filtered again via a set of electro-static and MERV 8 media air filters. The redundant air filters, zero-VOC paints, and non-combustion HVAC all contribute to indoor air quality.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program – 100% Commitment

ENERGY STAR Certified Homes Version 3.1

EPA Indoor airPLUS

DOE Zero Energy Ready Home Quality Management Guidelines

"Perhaps the most pleasant surprise for me is the high indoor air quality. With no sources of combustion inside the home and complete electrification—among other elements—air quality far exceeds that of code-built homes I've lived in. With an interior layout designed to "age in place," it is comforting to know I can look forward to years of healthy indoor air." – *Homeowner*

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.

Triple-pane sliding-glass doors and windows allow ample natural light into the home while minimizing heat transfer.

The home is equipped with a highly efficient ducted mini-split air-source heat pump with hyperheat inverter technology to operate at very low temperatures. It also has a modulating condenser and variable-speed ECM blower. The heat pump and short metal ducts are located in the insulated attic. The heat pump has a heating season performance factor (HSPF) of 9.8, a cooling efficiency of 16 SEER, and an energy efficiency ratio (EER) of 10.3.

Hot water is provided by an air-source heat pump water heater with a 50-gallon tank and an energy factor of 3.53. The water heater is located within the conditioned space of the home and uses a central manifold distribution system with appropriately sized PEX piping (⅜ inches in diameter) that minimizes the volume of water stored in the piping.

Additional energy savings come from the 100% LED lighting and ENERGY STAR-rated appliances, including an air-source heat pump clothes dryer. Low-flow EPA WaterSense-labeled plumbing fixtures reduce water usage and water heating demand. Drought-tolerant turf and native plants were planted to eliminate the need for landscape irrigation systems, and 100% of storm water runoff is managed onsite through landscape design.

This energy-efficient ICF house is also a disaster-resistant house. With the footing-to-roofline steel reinforcement, the ICF exterior walls are resistant to earthquakes, tornados, and hurricanes. Hurricane clips and closed-cell spray foam in the attic reduce the potential for roof uplift during high winds, and the asphalt shingles are designed to survive 130-mpg winds. The ICFs are fire-, moisture-, and bug-resistant. The home's highly insulated enclosure reduces the impacts of power outages. Because of the continuous thermal enclosure, pipes are less likely to freeze and interior temperatures can be maintained for days without power.

"In fact, one of our homes was monitored during a 4-day period of power outage during severe cold winter weather (outdoor temperatures were between –8°F and +16°F). The indoor temperature did not drop below 56°F," said Aebi. "This house can serve as resources to provide safe shelter to extended family and friends in the community during severe weather conditions."

KEY FEATURES

- **Walls:** ICF, R-22 total: ½″ drywall; 11.25″ ICF blocks, vinyl siding.
- **Roof:** Gable roof; ¾″ OSB sheathing, self-adhered membrane at valleys and roof edges; underlayment; 130 mph rated asphalt shingles, lifetime warranty.
- **Attic:** Unvented attic; R-65 total, 10.5″ R-46 open-cell spray foam plus 2.5″ R-19 closed-cell spray foam on underside of roof deck; 16″ raised heel trusses.
- **Foundation:** R-22 ICF basement walls clad with cementitious boards waterproofed with tar; 4.5" R-29 closed-cell spray foam under slab.
- **Windows:** Triple-pane, argon-filled, low-e, vinyl casement frames, U=0.18, SHGC=0.23; triple-pane sliding doors, U=0.20, SHGC=0.28.
- **Air Sealing:** 0.18 ACH 50.
- **Ventilation:** ERV with continuous 20 cfm draw from baths and 40 cfm from kitchen plus boost settings; CO_2 sensor also controls boost setting; MERV 7 & 8 filters.
- **HVAC:** Ducted mini-split heat pump, 9.8 HSPF, 16 SEER, 2 air handlers, ducts inside.
- **Hot Water:** Heat pump water heater, EF 3.53, 50-gal.; central manifold plumbing with PEX.
- **Lighting:** 100% LED, motion sensors.
- **Appliances:** ENERGY STAR refrigerator, clothes washer, dishwasher, heat pump clothes dryer.
- **Solar:** 10.2-kW PV.
- **Water Conservation:** WaterSense-labeled fixtures, drought-resistant landscaping.
- **Energy Management System:** Programmable thermostat
- **Other:** Wide doors and hallways, zero-VOC paint, low-VOC KCMA cabinets; hurricane clips, disaster-resistant features.

"After just a short while living in a high-performance home, I can't imagine living anywhere else." *Homeowner*

Photos courtesy of Greenhill Contracting

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