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

DOE ZERO ENERGY READY HOME™

U.S. DOE ZERO ENERGY READY HOME 2015 WINNER Housing Innovation Awards

Greenhill Contracting

Green Acres
#20, #26, #28
New Paltz, NY

BUILDER PROFILE

Greenhill Contracting, Esopus, NY
Anthony Aebi
greenhillcontracting@yahoo.com
845-594-5076, www.zeronetnow.com
Rater: Integral Building & Design, Inc.
Pasquale Strocchia,
pasquale@integralbuilding.com

FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Green Acres #20, #26, #28
- Location: New Paltz, NY
- Layout: #20: 4 bdr, 3.5 bth, 4 fl + bsmt; #26: 5 bdr, 3.5 bth, 4 fl + bsmt; #28: 3 bdr, 3.5 bth, 4 fl + bsmt
- Conditioned Space: #20: 4,454 ft^2; #26: 4,208 ft^2; #28: 4,208 ft^2
- Climate Zone: 6A, Cold
- Completion: #20: 10/2014; #26, #28: 05/2015
- Category: Custom

Modeled Performance Data:

- HERS Index: #20: w/o PV 26, w/PV -3.5; #26: w/o PV 28, w/PV -3 ; #28 w/o PV 26, w/PV -1
- Projected Annual Utility Costs: #20: w/o PV $2,024, w/PV $136; #26 w/o PV $2,061, w/PV $137; #28 w/o PV $1,918, w/PV $270
- Projected Annual Energy Cost Savings (compared to a home built to the 2009 IECC): #20: w/o PV $2,112, w/PV $4,000; #26 w/o PV $2,009, w/PV $3,933 ; #28: w/o PV $2,176, w/PV $3,824
- Builder's Added Cost Over 2009 IECC: #20, #26, #28: w/o PV $45,000, w/PV $73,000
- Annual Energy Savings: #20: w/o PV 72.9 MMBtus, w/PV 122.5 MMBtus; #26: w/o PV 70.2 MMBtu, w/PV 120.7 MMBtu; #28: w/o PV 73.9 MMBtus, w/PV 117.2 MMBtus

New Yorkers may be a little nervous about the weather after Superstorm Sandy but owners of homes by Anthony Aebi of Greenhill Contracting based in Esopus, 60 miles north of New York City, can rest easy. Anthony Aebi has certified 25 homes to the U.S. Department of Energy's Zero Energy Ready Home program criteria. and all of them are constructed with insulated concrete forms (ICF). According to Aebi, the homes should be able to withstand 200-mile per hour winds, an F5 tornado, a category 6 hurricane, or a magnitude 9 earthquake.

Aebi switched to ICF construction in 2007 and built his first home certified to the DOE labeling program in 2008; it was one of the first zero energy homes in the Northeast. Aebi was recognized by DOE with a 2014 Housing Innovation Award for one of nine zero energy homes he built at a community called the Preserve in Esopus. This year, three of his homes at a community of 25 homes called Green Acres in New Paltz, New York, earned Housing Innovation Awards.

All of the homes are certified to the DOE Zero Energy Ready Home program so they meet the requirements of ENERGY STAR Certified Homes Version 3.0 and the U.S. Environmental Protection Agency's Indoor airPLUS, as well as the hot water distribution requirements of the EPA's WaterSense program and the insulation requirements of the 2012 International Energy Conservation Code. In addition, homes are required to have a solar electric system installed or have the conduit and electrical panel space in place for it.

Aebi does install solar electric systems on the roofs of his homes but his goal is to get the lowest Home Energy Rating System (HERS) score he can before adding the photovoltaic (PV) panels. The homes at number 20, 26, and 28 Cooper Street achieved HERS scores of 26, 28, and 26, respectively, before adding the PV, or -3.5, -3, and -1 after adding PV. For comparison, a typical new home built to the 2006 International Energy Conservation Code would score a 100.

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.

Greenhill Contracting constructed three homes in 2015 that won Housing Innovation Awards from the U.S. Department of Energy Zero Energy Ready Home Program. All three achieved HERS scores below 30 without solar electric systems. Adding the solar electric systems brought each home to net zero.

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

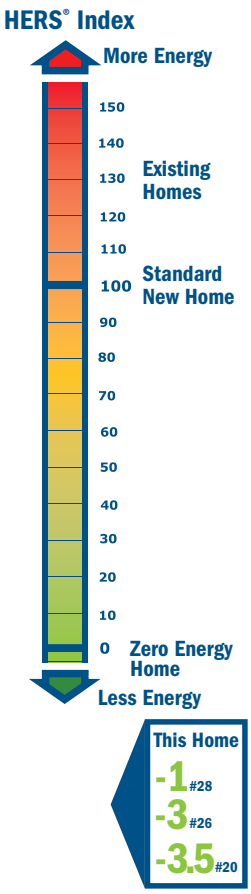
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



The homes start with the super-insulating properties of 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 sides remain in place to form a solid wall with continuous rigid insulation on the inside and exterior. The ICF wall provides a continuous air barrier. The blocks can be sealed at the seams to provide a drainage plane layer. The foam layers also provide two continuous thermal layers with no thermal bridging for very low heat transfer through the walls. Aebi uses 11.25-inch-thick R-22 blocks to form the foundation and above-grade walls from the footer to the roof line. The ICFs provide slab edge insulation as well. Before pouring the slab, Aebi sprays up to 5 inches of closed-cell spray foam directly onto the gravel base, to provide an R-30 insulating layer and vapor barrier. "The spray foam has a higher compressive strength than rigid foam, so it doesn't crack when the concrete contractors are walking on it, and you don't have to worry about getting the base perfectly level," said Aebi, who added that for him it works out to the same cost as having the rigid foam delivered. He feels it does a much better job of sealing out soil gas in high-radon upstate New York because the foam can be sprayed directly around any pipes that come through the slab such as the passive radon vent pipe and plumbing pipes. "Now all of the spray foam contractors here are offering it; after working on my houses, they decided it's great," said Aebi.

Because the foam serves as the drainage plane, no house wrap is needed. For flashing around windows, Aebi uses a thick liquid-applied weather-resistant barrier that comes in a tube and is spread with a putty knife around the top and sides of the windows.

The un-vented roof assembly is insulated on the underside of the roof deck with 10 inches of open-cell spray foam (R-4.5/in) and 2.7 inches of closed-cell spray foam (R-6.7/in) applied to completely fill the roof rafter cavities and encase the rafters to create a thermal break to the exterior conditions. The attic has a total insulation value of R-63. The roof is covered with asphalt shingles that have a lifetime warranty and a 130-MPH wind-speed rating.

Greenhill Contracting employs a simple boxy shape that is a more efficient layout to heat and cool. ICF walls and a spray-foamed attic provide superior thermal protection and a very airtight shell.

The ICFs and spray foam create a super-tight structure. "I get upset if I don't beat passive house three times over," said Aebi, whose three homes were blower door tested and all showed air tightness of 0.21 air changes per hour at 50 Pascals of pressure (ACH 50), well below the 0.60 ACH 50 Passive House requirement. The air leakage is so low that Aebi's rater has to use a duct blower fan rather than a blower door fan, and that is set at the smallest ring size to get an accurate reading.

To provide fresh air for the homes, Aebi installed an energy recovery ventilator (ERV). The ERV runs 24/7 to exhaust from bathrooms, kitchen, and laundry and to bring in fresh air that is ducted to the return side of the air handling unit. The air comes through a MERV 11 filter. Aebi said he used to install heat recovery ventilators but the homes were drying out a little too much in the winter, getting down to indoor humidity levels of 20%. ERVs transfer humidity as well as heat so they help retain some humidity in winter and remove more humidity in the summer. The ERV is a self-balancing air system with pressure sensors to modulate the motors on the exhaust and intake of the ERV, adjusting them to keep the home slightly pressurized even if the dryer or exhaust fans are operating. Aebi said he would not recommend pressurizing a stick-built home due to concerns about pushing moisture into the walls.

The home is heated with a ground source heat pump. Rather than using a glycol solution, Aebi uses plain water and, rather than packing the wells with grout, he lets the wells fill with water. Aebi, who has a college degree in physics, believes the water gives more efficient heat transfer than grout. The heat pump has a coefficient of performance (COP) of 5.7 and an EER of 44. The heat pump has modulating condensers and variable refrigerant flow. Heat is distributed via a central air handler with an electronically commutated motor.

A desuperheater on the ground source heat pump provides domestic hot water. The water heater has a dedicated buffer storage tank and a 55-gallon electric burner storage water heater for back up. The system has an efficiency of 1.20. Hot water is distributed directly to faucets via a central manifold with homerun distribution. There are dedicated hot and cold water lines to each faucet with a shutoff valve to each line. Water-efficient plumbing fixtures were installed. Drought-tolerant turf and native plants were used to eliminate the need for landscape irrigation systems.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program, 100% commitment

ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

LEED for Homes, silver level

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.

Insulated concrete form (ICF) blocks stack up to form hollow walls that are reinforced with steel and filled with concrete for a very sturdy wall that is resistant to wind, tornados, hurricanes, earthquakes, fire, and pests.

Additional energy savings came from installing triple-pane vinyl-framed windows that have an argon gas fill between the panes for added insulating value.

All of the home's lighting is energy-efficient LEDs or compact fluorescents. Energy-efficient appliances were installed including an ENERGY STAR-rated refrigerator, clothes washer, and dishwasher.

Aebi installed solar electric systems on all three homes, ranging from 10.08 to 11.76 kW PV. The garages are prewired for electric car charging stations. These systems should contribute to energy cost savings of $3,800 to $4,000 per year.

Aebi notes that energy savings aren't the only benefit. He said the homes can serve as a refuge during severe weather events. He cited an example of the homeowner of one of his zero energy homes who stayed in the home an entire week with no power and sub zero temperatures. The inside temperature never dropped below 60, even though the homeowner was opening doors several times a day to let the dogs out.

Aebi has been invited to speak at numerous regional conferences and has also hosted open houses for building professionals, code officials, students, and home buyers. Aebi's homes have been the subject of numerous media articles.

His homes have won numerous awards including the RESNET Cross Border Builder Challenge Award: Lowest HERS Score prior to PV in January 2015, the 2014 ICF Builders Award, a 2014 DOE Housing Innovation Award, and the 2013 NYSERDA Lowest HERS Index Builder award.

While the awards point to homes that are exceptional, Aebi contends that this level of performance can be built in the same price range as a code-built house. "Absolutely, this could be done in every home built everywhere today. And because of the energy savings, home owners are not spending $3000 to $6000 in energy bills every year. These improvements will pay for themselves," said Aebi.

Photos courtesy of Greenhill Contracting

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance.
- **Walls:** ICFs (R-22).
- **Roof:** Asphalt shingles; 130 MPH wind rating.
- **Attic:** #20: Sealed conditioned attic; 10″ open-cell spray foam, 2.7″ closed-cell spray foam (R-63). #26: Sealed conditioned attic; 11" open-cell spray foam (R-4); 2.75" closed-cell spray foam (R-7); total (R-69). #28: Sealed and conditioned; 10" open-cell spray foam; 2.7" closed-cell spray foam (R-68).
- **Foundation:** #20: ICF walls in basement (R-22); 42" below grade; 4.75" closed-cell spray foam under slab (R-30). #26": ICF walls (R-22); 42" below grade, 4.75" closed-cell spray foam under slab (R-29). #28: ICF basement walls (R-22); 42" below grade walls; 4.3" closed-cell spray foam under slab (R-27).
- **Windows:** Triple-pane; argon-filled; vinyl framed; U=0.20; SHGC=0.23; low-e.
- **Air Sealing:** 0.21 ACH 50.
- **Ventilation:** ERV; MERV 11 filters.
- **HVAC:** Geothermal heat pump; COP 5.7; EER 44.0; modulating condenser; variable speed ECM blower fan.
- **Hot Water:** Desuperheater; electric tank.
- **Lighting:** 100% energy efficient CFLs and LEDs.
- **Appliances:** ENERGY STAR-rated refrigerator, clothes washer, dishwasher.
- **Solar:** #20: 11.5 kW. #26: 11.76 kW. #28: 10.08 kW.
- **Water Conservation:** Low-flow fixtures; drought-tolerant and native plants for zero irrigation.
- **Other:** Natural disaster resistant; low-VOC.

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