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

DOE ZERO ENERGY READY HOME™

U.S. DOE ZERO ENERGY READY HOME 2016 WINNER *Housing Innovation Awards*

Greenhill Contracting

Green Acres Taylor St. Home
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
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Green Acres Taylor St. Home
- Location: New Paltz, NY
- Layout: 4 bdrm, 3.5 bath, 3 fl + bsmt, 4,190 ft^2
- Climate Zone: IECC 6A, cold
- Completion: May 2015
- Category: Production

Modeled Performance Data:

- HERS Index: without PV 25, with PV -5
- Projected Annual Energy Costs: without PV $1,655, with PV $36
- Projected Annual Energy Cost Savings (vs home built to 2009 IECC): without PV $3,223, with PV $4,841
- Projected Annual Energy Savings: without PV 24,790 kWh, with PV 37,241 kWh
- Added Construction Cost: without PV $45,000, with PV $73,000

The home owners knew they were going to get an energy-efficient home when they first met Anthony Aebi of Greenhill Contracting in Esopus, New York, and saw his super-insulated homes with solar panels on the roof. But they were still surprised at just how well his homes performed when they visited their house under construction on a cold December day. “When I went inside to greet the contractors, I was surprised at how warm the interior of the house was. I assumed the heating system had just been installed. So I was even more pleasantly surprised when I heard that the heating system was not yet installed, and that the entire house (all three levels) was being heated by a single small electric space heater in the basement. I knew then that all of the work Anthony put into insulation, orientation, and materials really made a difference,” said the home owner.

Aebi’s five homes in the Green Acres development in the Village of New Paltz, New York, achieved Home Energy Rating System (HERS) scores of about 25 before adding solar photovoltaic panels, and net zero energy scores of -1 to -7 after adding PV. For comparison, a typical new home would score about 80 to 100. All of Aebi’s homes are certified to the U.S. Department of Energy (DOE) Zero Energy Ready Home (ZERH) program so they meet the requirements of ENERGY STAR Certified Homes Version 3.0 and the U.S. Environmental Protection Agency’s Indoor airPLUS program, 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.

All homes by Aebi’s Greenhill Contracting are constructed with insulated concrete forms (ICF), which not only provide efficiency advantages, but are also rated to withstand hurricane-force winds and earthquakes. Aebi switched to ICF construction in 2007 and built his first home certified to the DOE labeling

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 built this 4,190-ft² house in New Paltz, New York, to the performance criteria of the DOE Zero Energy Ready Home (ZERH) program. The energy-efficiency features and the 9.9-kW solar electric system are expected to save the home owners more than $4,800 per year in energy costs compared to a similar sized house just built to code and without the PV.

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

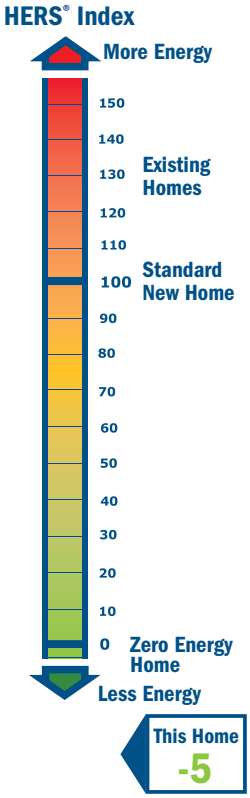
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



program in 2008. It was one of the first zero energy homes in the Northeast and was a DOE Challenge Home Award winner. Aebi was recognized by DOE with Housing Innovation Awards in 2014 and 2015. He has built 20 homes certified to the DOE ZERH program and prior to that he built 9 homes certified to an earlier DOE high-performance home program called Builders Challenge. This year, in addition to this home, Aebi also won a Housing Innovation Award for a custom home constructed in Gardiner, New York.

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 for an R-22 insulation level. The foam sides also provide two continuous thermal layers with no thermal bridging for very low heat transfer through the walls. Aebi starts the ICF walls below grade where they serve as the foundation stem walls providing R-22 of slab-edge insulation for the basement floor slab. The slab is poured over 4.3 inches (R-27) of closed-cell spray foam, which is sprayed directly onto the gravel base and acts as the insulation and vapor barrier. The ICF blocks serve as the basement and above-grade walls all the way up to the roof line of the two-story homes.

The ICF blocks are sealed at the seams to provide a continuous air barrier. They also serve as the drainage plane so no house wrap is needed. An elastomeric waterproofing compound is applied with a caulk gun and putty knife to provide a seamless, jointless flashing layer around all of the doors and windows. Vinyl siding is used for the exterior cladding.

Aebi constructs a sealed, unvented attic that is insulated on the underside of the roof deck with two types of spray foam. He sprays 11 inches of open-cell spray foam (R-4.45/in.) followed by 2 inches of closed-cell spray foam insulation (R-7.4/in.) to completely fill the roof rafter cavities and encase the rafters, providing R-64 worth of insulation and creating a thermal break to keep heat from transferring to the outside. 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.

High-performance triple-paned windows complete the thermal envelope of this snug, draft-free home. In fact the home is so airtight that a blower door test of whole-house air leakage showed the home had leakage of only 0.19 air

A hybrid application of 11 inches of open-cell spray foam and 2 inches of closed-cell spray foam create a conditioned attic with an insulation value of R-64. The spray-foamed attic meets the R-22 walls, which consist of insulated concrete form blocks. Together they provide a continuous thermal blanket around the structure.

changes per hour at 50 Pascals pressure difference. That 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. That level of air tightness is typical of Aebi's homes. His five Green Acres homes ranged from 0.28 to 0.17 ACH 50.

To provide fresh air for the homes, Aebi installed an energy recovery ventilator (ERV). The ERV runs 24/7 at low speed to exhaust air from the bathrooms, kitchen, laundry, and attic. The bathroom exhaust registers are also equipped with occupant-controlled boost settings and the kitchen range has a dedicated, occupant-controlled 100-cfm range hood fan. Fresh air is brought into the home from an air duct that brings the outside air through the ERV, which has a MERV 7 filter on it. The ERV also contains the exhaust duct, which pulls stale air out of the house. Both ducts pass through a heat exchanger which transfers heat and humidity from the warmer air to the cooler air, warming incoming air in the winter and cooling incoming air in the summer. The incoming fresh air is then ducted to the return side of the air handler, where it is again filtered via a set of electro-static and media air filters rated at MERV 11 to help ensure clean air for the air-tight home. The redundant air filters, zero-VOC paints, and non-combustion HVAC should contribute to indoor air quality, Aebi noted.

The home is heated and cooled with a highly efficient ground source heat pump rated to have a coefficient of performance (COP) of 5.7 and an energy efficiency ratio (EER) of 44. The air handler is located inside the home in a utility room and all of the sealed metal ducts are located within the conditioned space of the home. The heat pump draws heat from the ground using a closed-loop system installed in a 400-ft-deep standing well column. Untreated pure water is circulated in the ground loop. The standing column is also filled with ground water, which increases the overall performance and efficiency of the system by more than 15%. The ground source heat pump has a desuperheater that heats domestic hot water, which is stored in a dedicated 50-gallon buffer storage tank. The home also has an air-source heat pump storage water heater with an energy factor of 3.1.

Additional energy savings come from using 100% LEDs for lighting and installing ENERGY STAR-rated appliances. Low-flow plumbing fixtures reduce water and water heating demand. Drought-tolerant turf and native plants were planted to eliminate the need for landscape irrigation systems.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program, 100% commitment

ENERGY STAR Certified Homes Version 3.1

EPA Indoor airPLUS

LEED for Homes, silver

"There is a noticeable difference in air quality inside our home, especially during allergy season. For a family of allergy sufferers, this is invaluable."

— Home owner

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.

A liquid-applied flashing helps to keep water from seeping in around the triple-pane windows.

Aebi installed a 9.9-kW solar electric systems on the home, which helped the home achieve a Home Energy Rating System (HERS) score of -5 and cut annual utility costs from an expected $1,655 without the PV to $36 per year with the PV system installed.

"This house is not only solar ready, it was built with the solar PV system as an integrated, standard turn-key feature so that the house can function as a zero energy home when the home owners move in," says Aebi. "Moreover, since the net zero energy rating was based on the HERS index, the projected energy usage was based on "typical" occupant lifestyles and energy-use patterns. Therefore, achieving Net Zero Energy living in this home typically does not require any lifestyle modifications."

"We have yet to pay more than a connection fee to our energy company, essentially leaving us with no utility bill as we have generated more energy than we used this year," said the home owner, who went on to comment how the house has exceeded their expectations. "Solar power, geothermal, superior quality, environmentally friendly construction materials, and high-efficiency mechanics combine to generate all of our power and sustain a very comfortable living environment. All the while we sacrifice nothing. Our family of four operates this home just as we have all previous homes and saves money in the process."

Aebi noted that the ICF house is not only an energy-efficient house; it's 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. The ICFs are fire-, moisture-, and bug-resistant. The home's highly insulated enclosure reduces the impacts of power outages. Pipes are less likely to freeze and interior temperatures can be maintained for days. Aebi tested this by monitoring indoor temperatures in one of his houses during a four-day period of severely cold winter weather when outdoor temperatures ranged from -8 to +16°F. Even though no heating systems were on in the house, the indoor temperature never dropped below 56°F.

Aebi, who has a degree in physics, enjoys the challenge of making a more energy-efficient home. He works with his project team including the architect, trade reps, and HERS rater seeking continuous improvement on each home. He also wants to share what he's learned, speaking often at builder conferences and publishing in construction journals. He has opened his houses up for tours by the nearby West Point Military Academy's engineering departments and talks to builders in NYSERDA's programs.

Photos courtesy of Greenhill Contracting

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance.
- **Walls:** R-22 ICF, vinyl siding, liquid-applied door and window flashing.
- **Roof:** Asphalt shingles, peel-and-stick at edges and valleys.
- **Attic:** R-64 vaulted ceilings, insulated, unvented roof with 11″ open-cell + 2″ closed-cell spray foam.
- **Foundation:** ICF below-grade foundation walls for R-22 at slab edge, R-27 closed-cell spray foam under slab.
- **Windows:** Triple-pane, U=0.17, SHGC=0.23, argon-fill, vinyl-framed.
- **Air Sealing:** 0.17 ACH 50.
- **Ventilation:** ERV, MERV 7 and 11 filters, returns from bathrooms, kitchen, and laundry.
- **HVAC:** Ground-source heat pump, 5.7 COP, 19.5 EER, all ducts inside.
- **Hot Water:** Ground-source heat pump desuperheater and 50-gal. air-source heat pump tank water heater 3.1 EF.
- **Lighting:** 100% LED.
- **ENERGY STAR Appliances:** Refrigerator, clothes washer, dishwasher, heat pump clothes dryer.
- **Solar:** 9.9 kW PV.
- **Water Conservation:** Low-flow fixtures, drought-tolerant plants.
- **Energy Management System:** None.
- **Other:** No-VOC paint, 75% of construction debris recycled, disaster-resistant ICF construction with spray foam and hurricane clips.

PNNL-SA-123522, December 2016