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

DOE ZERO ENERGY READY HOME™

U.S. DOE ZERO ENERGY READY HOME 2022 WINNER *Housing Innovation Awards*

ZeroNetNow

Cooper Street Residence
New Paltz, NY

BUILDER PROFILE

ZeroNetNow
Esopus, NY; www.ZeroNetNow.com
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Cooper Street Residence
- Location: New Paltz, New York
- Layout: 4 bdrm, 3.5 bath, 2 fl + bsmt, 3,718 ft²
- Climate: IECC 6A, Cold
- Completed: February 2022
- Category: Custom for Buyer >2,500 ft²

Modeled Performance Data:

- HERS INDEX: without PV: 26; with PV: -13
- Annual Energy Costs: without PV: $2,000; with PV: -$250
- Annual Energy Cost Savings: without PV: $4,500; with PV: $6,250
- Annual Energy Savings: without PV: 25,250 kWh; with PV: 40,100 kWh
- Savings in the First 30 Years: without PV: $182,950; with PV: $254,100

Builder Anthony Aebi has been building homes from insulated concrete forms for over a decade because of their energy efficiency and disaster resistance. Until this year, affordability was not considered one of their strong suits but, with pandemic-related shortages driving up the cost of lumber, ICF construction has become relatively more cost-effective. Owners of this new 3,718-ft² home in New Paltz, New York, will get a home with highly thermally resistant ICF walls at a cost of $7,500 less than a similar sized conventional stick-framed enclosure built to the minimum energy code, according to the builder.

Aebi's company ZeroNetNow, formerly known as Greenhill Contracting of Esopus, New York, builds all of its homes out of durable, highly efficient insulated concrete forms (ICF). The company also builds all of its homes 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 it.

ZeroNetNow constructed its first zero energy home in 2007 and has built 39 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. ZeroNetNow 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

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.

Large triple-pane windows and sliding doors bring daylight and views into the home without sacrificing thermal performance or energy efficiency. Low- and no-offgassing cabinetry, paints, and finishes are used throughout the home, including on the locally sourced oak flooring, to help reduce indoor contaminants. An energy recovery ventilator is set for continuous low-speed operation and can be activated by indoor air quality sensors or manual or remote controls for higher levels of ventilation when needed.

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

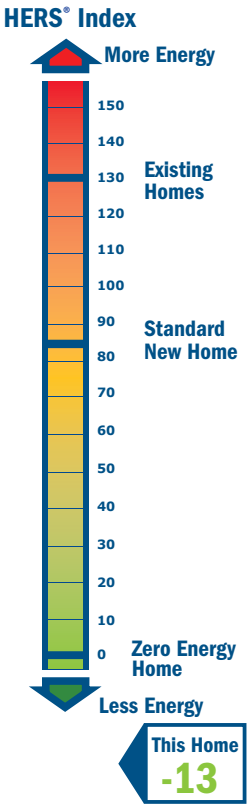
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



produce as much energy as the home uses over the course of a year. ZeroNetNow's homes often score below 40 before including the photovoltaic panels. ZeroNetNow's home this year achieved a HERS score of 26 without PV and minus 13 when the 13.74 kW of solar panels are added.

The homes start with the highly insulating properties of the 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. ICF construction eliminates framing and sheathing at exterior walls. The ICF blocks have integrated plastic splines which allow for direct fastening of the exterior cladding without the need for furring strips or nailers. Aebi uses the ICF blocks for the entire wall up to the eaves and to the roof line on the gable ends. Along the eaves, he installs pieces of 1.5-inch insulated coated OSB sheathing between the rafters at the roof-to-wall interface to serve as a backer board for the attic spray foam insulation while providing a complete R-6 thermal break to the roof truss framing.

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. Composite wood clapboard 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 10 inches (R-44) of open-cell spray foam followed by 2.5 inches (R-18) of closed-cell foam insulation which completely covers the open-cell spray foam, providing a total attic insulation value of R-62. The closed-cell spray foam also serves as a Class II vapor retarder. Above the roof deck, a

Insulated concrete forms are used to construct the entire wall from footing to roof line. The concrete-filled foam blocks are reinforced with steel rebar to provide resistance to high winds and earth movement. The foam blocks are caulked at the seams and openings are sealed with a fluid-applied flashing to provide a water- and weather-resistant exterior drainage plane. The blocks are also mold and bug resistant.

self-adhered bitumen membrane is installed at the roof edges and valleys to provide additional moisture protection.

The home was designed with large windows on all sides to maximize views and daylighting of the interior. To allow for an abundance of natural light without sacrificing too much in thermal performance, the builder opted for high-performance triple-pane windows. The windows are argon and krypton-filled, vinyl-framed, fixed, casement, and sliding style windows with an insulation value of U-0.17 and a solar heat gain coefficient (SHGC) of 0.21. Even the sliding doors are triple paned. They have an insulation value of U-0.20 and an SHGC of 0.25.

The home is so airtight that a blower door test of whole-house air leakage showed the home had leakage of only 0.23 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 CO2 sensors that will trigger higher levels of ventilation when CO2 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 6 filter as it enters the ERV heat exchanger then it is ducted into the return trunk of the air-handling unit, where it is filtered again via a set of electro-static and MERV 11 media air filters. The redundant air filters, zero-VOC paints, and non-combustion HVAC all contribute to indoor air quality.

The home is equipped with a highly efficient ground-source heat pump with one 3-ton central air-handler unit, ground-loop configuration with a rated efficiency of 5.1 coefficient of performance. The air handling unit is fitted with an electrical heating coil for emergency back-up only. The duct system is made from rigid metal and is all located in conditioned space. The properly sized HVAC equipment includes an air handler with a variable-speed compressors and high efficiency ratings. Variable speed compressors modulate the fan speed and produce the output needed based more precisely on the demands of the thermostat, which allows the equipment to run longer and more efficiently and to increase the lifespan on the system as it doesn't need to turn off and on as much.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Quality Management Guidelines

DOE Zero Energy Ready Home Program - 100% Commitment

ENERGY STAR Certified Homes Version 3.1

EPA Indoor airPLUS

NYSERDA Low-Rise Residential New Construction Program (LRNCP)

"My experience with net zero energy homes started with a drive through Green Acres in 2009. I was immediately curious as the concept seemed "too good to be true". Even if it did turn out to be real, I believed it would never be my reality as it was beyond my price range. Long story short, I've been in a DOE Zero Energy Ready home for three years and have sold back a surplus of energy each year I have been here." – Homeowner

ENERGY STAR

Building AMERICA U.S. Department of Energy

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 ground-source heat pump provides both space and water heating.

Hot water for the all-electric home is provided by the water-to-water ground-source heat pump with an 80-gallon storage water tank to provide 100% of the domestic hot water for the home. The storage tank is fitted with an electrical element for emergency back-up only, should the heat pump fail (e.g., due to an electrical surge). The heat pump is located in a mechanical room within the conditioned basement. The heat pump has a coefficient of performance of 3.10 and then is de-rated for the thermal standby loss of 0.63% in the storage tank resulting in a system energy factor rating of 2.66, per the EF calculator of the supplemental energy modeling toolkit.

Low-flow EPA WaterSense-labeled plumbing fixtures reduce water and water heating demand. This home is a part of a development that was designed to handle the storm water from multiple lots. Therefore, 100% of storm water runoff is managed onsite through design.

Additional energy savings come from the 100% LED lighting and ENERGY STAR-rated appliances. The builder specified a ventless heat pump clothes dryer, in part for efficiency but primarily because the home is so air-tight that a standard vented clothes dryer would have depressurized the home too much.

Another feature of this home is the innovative solar shingles that were installed on the roof. This solar roof system was the second installation of its kind in New York State. Engineers from the product manufacturer were required to come to the site to train the crew on how to properly install the solar shingles. Despite the initial cost to invest in this solar array, the engineers claim that the roof lasts up to 200 years and that the durability of the solar PV shingles is three times stronger than asphalt shingles which need to be replaced every 15 to 20 years.

“The best kilowatt of energy is the kilowatt not used. It's critical that builders focus on constructing more robust thermal enclosures and optimally efficient mechanical systems,” said Aebi. With ZeroNetNow’s highly efficient ICF building envelope and high-performance HVAC, he is practicing what he preaches but Aebi goes beyond construction with continued monitoring. “Our job doesn't end when the homeowners receive their keys.” The builder installs energy and climate monitoring systems on each home to track energy use and production, operation of the mechanicals, and indoor air quality measures. “We can monitor, identify, and troubleshoot equipment in a quick and efficient manner and assess whether or not homes are performing as expected. Based on those assessments, corrective action can be taken to prevent challenges that a homeowner may face. The data collected is proof of what works and what doesn't,” said Aebi.

Photos courtesy of ZeroNetNow

KEY FEATURES

- **Walls:** ICF walls, R-22 total: 11.25″ ICF blocks, engineered wood siding.
- **Roof:** Gable truss roof, coated OSB sheathing, 1″x3″ furring strips, self-adhered membrane, solar PV shingles.
- **Attic:** Unvented attic, vaulted ceilings: 10″ R-44 medium-density spray foam topped by 2.5″ R-18 high-density spray foam.
- **Foundation:** Insulated basement: ICF blocks R-22, 11.25″ wide.
- **Windows:** Triple-pane, argon and kypton filled, low-e, vinyl; U=0.17-0.20, SHGC=0.21-0.25.
- **Air Sealing:** ACH50 = 1.48 CFM50. Spray foam under slab and on attic walls and ceiling; ICF walls with liquid-applied flashings at all rough openings and penetrations.
- **Ventilation:** ERV with MERV 11 and 6 filters, demand-controlled ventilation, CO sensors.
- **HVAC:** Heat pump, ground-loop config, 5.1 COP, variable-speed compressor, 34 EER.
- **Hot Water:** Ground-source heat pump water heater, 80-gal, 2.66 EF.
- **Lighting:** 100% LED, motion sensors, large windows.
- **Appliances:** ENERGY STAR refrigerator, dishwasher, clothes washer and dryer.
- **Solar:** 13,74-kW roof shingles.
- **Water Conservation:** EPA WaterSense fixtures; central manifold, PEX piping.
- **Energy Management System:** CO_2 sensors in master bedroom, return duct, and kitchen trigger boost setting on the ERV. Wi-Fi monitoring of energy production and end uses.
- **Other:** Low-VOC products. ICF thermal mass holds temp through power outages. EV ready.

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