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

DOE ZERO ENERGY READY HOME™

U.S. DOE ZERO ENERGY READY HOME 2023 WINNER Housing Innovation Awards

Affordable Housing Concepts

Zero Place
New Paltz, NY

BUILDER PROFILE

Affordable Housing Concepts
Gardiner, NY
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Project name: Zero Place
- Location: New Paltz, NY
- Layout: 1 bdrm, 1 bath, 1 fl, 900 ft²
- Climate: IECC 6A, cold
- Completed: March 2022
- Category: Multifamily

Modeled Performance Data:

- HERS Index: without PV 31; with PV -14
- Annual Energy Costs: without PV $750; with PV $-250
- Annual Energy Cost Savings: (vs typical new homes) without PV $1,200; with PV $2,250
- Annual Energy Savings: without PV 8,050 kWh; with PV 14,900 kWh
- Savings in the First 30 Years: without PV $50,500; with PV $93,400

This four-story mixed-use apartment building in New Paltz, New York, sports a roof-top deck with seating and views, plus 688 photovoltaic (PV) panels located on the roof and south-wall awnings capable of producing 270,000 kWh of power per year. What's underneath the building is even more impressive.

Fifteen ground-source heat pump wells reach deep into the earth below the building to draw heat from the temperate ground. The ground-source heat pumps provide space and water heating for tenants in the building's 46 apartments and 6 commercial spaces. This is the second ground-source heated multifamily building for builder and developer Keith Libolt of Affordable Housing Concepts and the first building that he has certified through the U.S. Department of Energy's Zero Energy Ready Home Program.

Ground-source heating was just one of several innovations convincing the judges for DOE's 2023 Housing Innovation Awards competition that Affordable Housing Concepts' Zero Place project was worthy of two grand awards—in the "Blazing the Trail" and "Total Package/Best All Around" categories.

The building, like every home certified through the DOE Zero Energy Ready program, met the criteria of ENERGY STAR Certified Homes Version 3.1 or 3.2 and the U.S. Environmental Protection Agency's Indoor airPLUS program. Builders must also meet other efficiency requirements, like the hot water distribution requirements of the EPA's WaterSense program; the insulation requirements of the 2015 International Energy Conservation Code; HVAC and water heating efficiencies; third-party verified air sealing targets; installation of ENERGY STAR appliances, windows, and lighting; and ducts in conditioned space. In addition, homes are required to have PV panels installed or have the conduit and electrical panel space in place for future installation.

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.

Affordable Housing Concepts built this four-story, 47-unit apartment building in New Paltz, New York, to the performance criteria of the DOE Zero Energy Ready Home program. Along with deck chairs, the rooftop also has space for half of the building's 248 kW worth of PV panels (the rest are installed as awnings over the south-facing windows). The PV provides occupants with free power over the course of the year, while also producing enough electricity to supply several electric vehicle chargers. No batteries have been installed yet, but Libolt is researching building-scale energy storage systems.

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

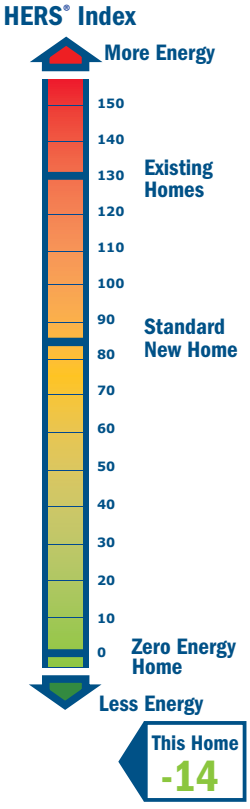
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



To meet the envelope requirements of the DOE certification, Libolt chose a building material not often seen in multifamily construction, insulated concrete form (ICF) blocks. Rigid foam (2-⅝-inch thick) and plastic spacers create hollow blocks which are stacked together to form walls. Steel rebar is laid horizontally and vertically through the spacers, then the 6-inch-wide space is filled with concrete that hardens in place for an R-22 wall that is 11.25 inches wide and is resistant to hurricanes, fires, pests, and mold. The ICF blocks form the crawlspace and basement foundation walls where they are covered with a waterproofing membrane. Above ground, the ICF blocks are covered with house wrap and brick veneer on the first three floors and engineered wood siding on the fourth floor. The ICF walls are inherently airtight but additional caulking or foaming was done at all rough openings around windows and doors, around plumbing and electrical holes, and at the edges of the drywall on party walls and wallboard behind showers and tubs. These measures yielded an airtightness of 1.9 air changes per hour at 50 Pascals pressure differential, better than the 2.5 ACH 50 required by ENERGY STAR.

The building's flat roof consists of open-web steel joists at 48 inches on center with corrugated metal and poured concrete decking and adhered rubber roofing membrane. The underside of the metal deck is covered with 4 inches (R-28) of closed-cell spray foam, that is covered by 12 inches (R-42) of open-cell spray foam.

The triple-pane windows, another unusual feature for multifamily housing, provide exceptional performance with a U-value of 0.17 and a solar heat gain coefficient of 0.27.

While the building envelope is impressive, the mechanicals are the real story. Heating and hot water are both provided by the ground-source heat pumps. Builders often have difficulty siting ground-source heat pumps because the piping used to extract heat from the ground is often installed as large loops of tubing buried 5 feet or deeper across several hundred feet of ground to the side of the building, thus requiring a site with a large amount of open space. In this case, the builder dug the fifteen wells straight down, 400 feet into the ground before starting the building. Each well contains a separate pipe loop that connects directly to a manifold in the equipment room, so if a well were to fail, it could be closed off with a valve without impacting the rest of the system. By digging the wells within the footprint of the building, no additional yard space was needed and excavation costs were reduced because excavation was already planned there for the building's footings and crawlspace.

The 11.25-inch-thick walls are constructed from insulated concrete forms (ICFs), which consist of pieces of rigid foam held together with plastic spacers to form hollow blocks that are filled with poured concrete. ICF construction eliminates framing and sheathing at exterior walls and provides continuous insulation along the interior and exterior of the wall. The ICF blocks have integrated plastic splines that allow for the direct fastening of the exterior cladding without the need for furring strips or nailers.

For space heating, each of the 46 apartments has its own unitary ground-source water-to-air heat pump; 9 more heat pumps provide heating and cooling for the corridors and common areas. The heat pumps have an average rated efficiency of 3.4 COP, which means they are 3.4 times more efficient at heating air than a standard electric furnace. The building's water loop employs variable speed pumping, which uses only as much power as is needed. The system makes automated variable speed adjustments relative to the amount of heating and cooling needed and the number of heat pumps operating. Pump power has been measured at 3.6 kW/year (or approximately 3% of the annual total ground-source heat pump system energy use).

The ground wells also provide heat for domestic hot water for the building via two water-to-water ground-source heat pumps that heat water in four 162-gallon storage tanks. The domestic hot water is distributed from these tanks via risers on each floor to each line of apartments. Each dwelling unit has its own manifold that distributes the hot water to each fixture. A recirculation pump and loop is installed to minimize wasted water while waiting for hot water to reach the faucet.

The domestic hot water system gets another boost in efficiency from excess heat that is pulled from the apartments when their air handlers are operating in cooling mode. This occurs more than one would expect for a building located in IECC Climate Zone 6A; energy load calculations determined the building is cooling dominant.

Heating and hot water are included in the monthly rent but tenants are encouraged to conserve and can track their usage on a mobile app; there is a surcharge for usage over a high threshold. While the thermostats are located in each unit, the actual mechanical equipment for each apartment (including the heat pumps and energy recovery ventilators [ERVs]) is installed in common mechanical rooms accessible from the corridors, which allows easy access for building operations and maintenance staff to repair and maintain the equipment without needing access to the dwellings.

Each apartment has its own ERV. A dedicated fresh air supply is integrated into the return side of each unitary HVAC air handler so the ducted HVAC systems can distribute fresh air to every room of the dwelling unit. Dedicated exhaust terminals are located in each bathroom, the kitchen, laundry, and mechanical room. Regular operation of the ERV provides an exhaust airflow of 20 to 30 cubic feet per minute continuously per bathroom. A manual controller was installed in each bathroom to boost the ERV speed to 45 cfm for 20, 40, or 60 minutes. CO_2 sensors in each unit enable the system to adjust ventilation levels based on CO_2 levels. Occupants can

HOME CERTIFICATIONS

ENERGY STAR Certified Homes Version 3.1

EPA Indoor airPLUS

USGBC LEED, platinum

LEED Homes, Outstanding Multifamily Project Award

NYSERDA Buildings of Excellence Award

"Zero Place is only the second multifamily building in New York state to make 100% of its domestic hot water using a shared ground loop strategy. And Zero Place demonstrates the concept at scale at four times the size of the other building."

- Keith Libolt, builder and developer

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.

The building's ground-source heat pumps draw heat from fifteen 400-foot wells located underneath the building to heat water for space and domestic water heating.

also control the ERV to prevent excessive ventilation during periods of high exterior humidity, extreme temperatures, or wildfire smoke.

The kitchen exhaust terminal also operates continuously at 30 cfm constant speed and air flow can be increased to 45 cfm at the push of a button when needed. A re-circulating fan in the range hood over the stove operates to remove grease and other cooking particles from the air.

Like all DOE Zero Energy Ready certified homes, this building meets the requirements of the EPA's Indoor airPLUS program, which include a whole-house ventilation system like the ERVs described above, the use of low-and no-VOC paints and finishes, and good water management practices, among other measures. In addition, the builder chose to make Zero Place a completely emission-free project. There is no gas line into the building and no gas backup heating system. The all-electric building relies on the ground-source heat pump system for all of its water and space heating needs.

To enhance indoor air quality, induction stoves were installed, offering a cleaner cooking alternative to gas stoves. The project also incorporated heat pump clothes dryers, which significantly reduced the energy consumption typically associated with in-unit laundry. ENERGY STAR-rated lighting, ceiling fans, refrigerators, and dishwashers add to energy savings. Even the elevator is energy saving—it uses a unique regenerative power mechanism during descent to effectively offset its energy demands.

The builder installed a comprehensive energy monitoring system that has the ability to measure energy usage down to individual loads in each unit, enabling the detection of improperly functioning equipment to help identify excess energy consumption and address issues before they escalate. For example, by employing sensors on the domestic hot water circulation system, they were able to identify the possibility of slowing down the circulation pumps, resulting in a 20% reduction in energy usage.

"Combining ICF, geo, and solar to create a high-performance building system is incredibly effective. ICF walls require a lot less attention to detail in the field than other wall assembly systems to achieve the same or greater levels of air sealing and insulation performance," said Libolt. Geothermal is readily available and is two-to-three times more efficient than the next best system for relatively the same costs after incentives are capitalized. For Libolt, the project has been the fulfillment of a lifelong commitment to better housing, especially for the underserved. "I grew up in a very poor urban setting, so providing environmentally clean, safe places for people to live has always been important for me," said Libolt.

KEY FEATURES

- **Walls:** ICF, R-22 total: 11.25″, house wrap, brick veneer or engineered wood.
- **Roof:** Flat roof, 16″ open-web steel joists at 48″ o.c.; concrete deck, rubber membrane.
- **Attic:** 12″ R-46 open-cell + 4″ R-28 closed-cell spray foam under roof deck.
- **Foundation:** Insulated basement, 11.25″ R-22 ICF walls, 4″ R-26 cc spray foam under slab.
- **Windows:** Triple-pane windows, U=0.17, SHGC=0.27, vinyl-framed, low-e, argon fill, casement style. Fixed solar panel awnings.
- **Air Sealing:** 1.9 ACH50. All common wall connections spray foamed. Drywall sealed at top and bottom plates and corner studs of party walls.
- **Ventilation:** ERVs, one per apartment. Supplies fresh air thru ducted HVAC. Draws from bath, kitchen, laundry, mech room. Sensored and manual boost controls.
- **HVAC:** Ground source heat pumps, 3.4 COP. Variable speed pump.
- **Hot Water:** Two central ground source heat pumps (3.2 COP) with four 162-gallon tanks provide space and water heating to all units. Risers with recirculation pumps distribute water to each line of apartments. Each apartment has a manifold to distribute hot water to each fixture.
- **Lighting and Appliances:** LED lighting, ENERGY STAR appliances.
- **Solar:** 248 kW of PV on roof and as window awnings.
- **Energy Management System:** Energy monitoring system measures energy usage of each load in each unit. Mobile apps let tenants track their energy and water use.
- **Other:** Rooftop deck, handicapped-accessible units, walkable neighborhood. Several EV charging stations.

Photos courtesy of Affordable Housing Concepts

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