

# Energize Delaware's ZeMod Program and Beracah Homes

DESEU State Fair House  
Lincoln, DE



## BUILDER PROFILE

Beracah Homes  
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## FEATURED HOME/DEVELOPMENT:

### Project Data:

- Name: DESEU State Fair House
- Location: Lincoln, Delaware
- Layout: 2 bdrm, 2 bath, 1 fl, 1,209 ft<sup>2</sup>
- Climate: IECC 4A, mixed-humid
- Completed: July 2021
- Category: Affordable

### Modeled Performance Data:

- HERS INDEX: without PV: 40; with PV: 1
- Annual Energy Costs: without PV: \$700; with PV: \$200
- Annual Energy Cost Savings: without PV: \$1,050; with PV: \$1,550
- Annual Energy Savings: without PV: 7,450 kWh; with PV: 14,350 kWh
- Savings in the First 30 Years: without PV: \$42,050; with PV: \$63,850

Energy costs as low as \$0 per year plus down payment assistance of up to \$25,000 for qualified buyers add up to a winning combination of savings for low-income home buyers in Energize Delaware's ZeMod program. Delaware Sustainable Energy Utility (DESEU), through its Energize Delaware initiative, collaborated with Milford Housing Development Corporation (MHDC), builder Beracah Homes, Inc., and energy consultant VEIC to bring zero energy modular homes to low-income home buyers in Delaware. Through the ZeMod program, homeownership is made affordable in part through renewable energy and net metering. The highly efficient modular homes also scored a win for the collaborative, earning a Housing Innovation Grand Award from the U.S. Department of Energy's Zero Energy Ready Home program. All of the homes offered through the ZeMod Delaware program are certified as DOE Zero Energy Ready Homes.

"Our mission is to provide decent, safe, affordable housing solutions to people of modest means," said Russ Huxtable, Vice President and CEO of Milford Housing Development Corporation. "Meeting the high performance home criteria of the DOE's Zero Energy Ready Home program helps ensure we meet these goals."

The first ZeMod home constructed, a 1,209-ft<sup>2</sup> 2-bedroom, 2-bath single-story home located in Lincoln, Delaware, received a grand award in DOE's 2022 Housing Innovation Awards in the affordable home category.

Meeting the requirements of the DOE Zero Energy Ready Home means that the home has also been certified to the criteria of ENERGY STAR Certified Homes Version 3.0, 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 latest International Energy Conservation Code; HVAC and water heating efficiencies;



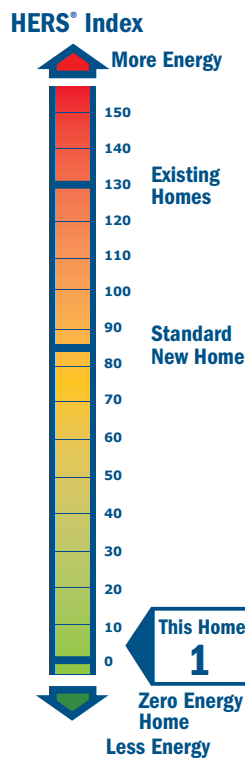
The U.S. Department of Energy invites home builders across the country to meet the extraordinary levels of excellence and quality specified in DOE's Zero Energy Ready Home program. Every DOE Zero Energy Ready Home starts with ENERGY STAR Certified Homes Version 3.0/3.1/3.2 for an energy-efficient home 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.

By building its homes from modules constructed in a factory, the builder is able to help ensure significant quality control. The builder found they are better able to control costs, reduce waste, improve quality, ensure consistency, avoid labor and scheduling constraints, and minimize exposure to poor weather conditions for both the materials and the crews. The modular construction process also helps them to avoid ad hoc design improvisation in the field.



### 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.



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 solar electric panels installed or have the conduit and electrical panel space in place for it.

With its 5.12 kW of PV panels installed on the roof, the award-winning home achieved a Home Energy Rating System score of 1. Even without the PV panels, it would achieve a HERS score of 40, well below the HERS 80 to 90 of new homes built to just meet code.

The home is located at Knoll Acres, in Lincoln, Delaware, a neighborhood of small lots with larger shared open spaces under development by Milford Housing Development Corporation, with sites qualified for low-interest financing through the U.S. Department of Agriculture mortgage program.

The home was assembled over a vented, uninsulated crawlspace. Framed assemblies were constructed off-site in a factory. Walls are double 2x4 framing with a one-inch gap to create an 8-inch insulation cavity, which is filled with blown fiberglass in the factory. Floors are insulated and sheathed in the modular factory. Windows, siding, and interior finishes are installed in the factory.

The roof comes to the site in two halves, with asphalt shingle roofing and solar panels already factory installed. Roof trusses create a 10-inch raised heel, allowing full R-50 cellulose insulation at the exterior wall top plates. The simple gable roof design is oriented with one side south-facing at an optimal angle for solar exposure.

“Constructing the home modules in a factory ensures a controlled environment which helps us to control costs, reduce waste, improve quality, ensure consistency, avoid labor and scheduling constraints, and minimize exposure to poor weather conditions for both the materials and the crews,” said Huxtable. The modular construction also helps to avoid ad hoc design improvisation in the field, which can sometimes result in quality and performance compromises. “Quality management is built into the modular process. No design-build decisions are made during construction. All construction details are designed and documented before the build begins,” said Huxtable.

The double-pane windows have a U factor of 0.25 and a solar heat gain coefficient of 0.20. The vinyl-framed casement style windows have an argon gas fill between the two glass panes both of which have a low-emissivity coating to minimize heat transfer.



A soffit is constructed within the home's conditioned space to house the rigid metal ducts of the energy recovery ventilator. The ERV pulls stale air from the home and delivers fresh filtered air to each room of the house while also circulating heated and cooled air from the home's single ductless minisplit heat pump.

Quality control in the factory helped to ensure an airtight envelope and the home was tested after assembly at just 1.5 air changes per hour at 50 Pascals of pressure.

Fresh air is provided using a ventilator equipped with a heat pump to precondition outdoor air. The ventilator provides MERV 13-filtered fresh air to each room of the home. Demand controls respond to measurements of temperature, relative humidity, carbon dioxide, and VOCs within the home. Controls also allow continuous or timed ventilation. In favorable conditions, the ventilator brings in outdoor air to provide free cooling. A recirculation mode provides mixing and filtering of indoor air.

The home's single ductless minisplit heat pump provides efficient heating and cooling in all weather conditions. Distribution and mixing of the heated or cooled air is assisted by the ventilator's fresh air ducts and recirculation mode.

Water heating in the all-electric home is provided by a 50-gallon heat pump water heater with a coefficient of performance (COP) of 3.45. The water heater is located in a utility room within the home where it derives heat from the condensing clothes dryer also located in the utility room. In addition the room is supplied with conditioned air by the ducted ERV.

The home is equipped with high-efficiency all-LED lighting and ENERGY STAR refrigerator, dishwasher, clothes washer, and clothes dryer. Several of the plumbing fixtures in the home are EPA WaterSense rated for water efficiency. The electric panel has room to add an electric vehicle charger when desired by the homeowners in the future.

As an EPA Indoor airPLUS certified home, all of the cabinets, flooring, paints, countertops, and doors are low-emission products.

Energy metering was installed in the home to meter individual circuits to determine energy performance during occupancy. Circuits that are metered include the major appliances (the clothes washer, clothes dryer, and refrigerator), the HVAC, water heating, and bedroom plug loads. This energy usage data will be analyzed to identify opportunities for further savings and to support changes to the design of future ZeMod homes. As of May 2022, four ZeMod homes had been purchased.

## HOME CERTIFICATIONS

DOE Zero Energy Ready Home Quality Management Guidelines

ENERGY STAR Certified Homes Version 3.1

EPA Indoor airPLUS

EPA WaterSense

DOE Zero Energy Ready Home Program - 100% Commitment



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 EPA Indoor airPLUS-certified home was constructed with low-emission cabinets, flooring, paint, counter tops, and doors to minimize indoor air pollutants.

“The driving forces behind the design of this home are affordability, comfort, health, and zero energy—all equally important,” said Huxtable. “The design and layout of the house were meant to be compact and simple, to minimize details, to help control costs and take best advantage of the benefits of modular construction. A simple form factor can help avoid costly problems associated with maintenance, for example, by reducing the likelihood of water damage at roof valleys and around windows, further supporting affordability. The size of the home is modest, again supporting the goal of affordable ownership,” said Huxtable.

The ZeMod program has just three standard designs to choose from: two 2-bedroom/2-bath models and one 3-bedroom/2-bath model. This award-winning home was actually first assembled as a model home at the Delaware State Fair. Hundreds of people toured the home and the developers received overwhelmingly positive feedback. To be eligible to purchase a ZeMod home, the family must earn less than 120% of the median income.

“We are hoping to attract those who likely did not think that homeownership, let alone ownership of a zero-energy home, was possible,” said Huxtable. “The success of the ZeMod program will be measured by the number of low-income families who can own and reside in a zero-energy home.”

*Photos courtesy of Energize Delaware's ZeMod Program and Beracah Homes*

## KEY FEATURES

- **Walls:** Double wall, R-33.5 total: two 2x4 walls, 1" apart, dense-packed fiberglass; coated OSB air barrier sheathing; vinyl siding. House sections constructed in factory.
- **Roof:** Gabled truss roof assembled in factory, asphalt shingles.
- **Attic:** Enclosed ceiling joists with R-30 dense packed fiberglass plus loose-fill fiberglass in attic to achieve R-50. 10-inch raised-heel trusses for full insulation over exterior walls.
- **Foundation:** House floor insulated with R-30 fiberglass batts in floor joists and enclosed with OSB.
- **Windows:** Double-pane, argon-filled, low-e, vinyl-framed, U=0.25, SHGC=0.18.
- **Air Sealing:** 1.5 ACH50, modular components are final sealed together on site.
- **Ventilation:** Ducted heat pump ventilator with MERV 13 filters; 2.6 CFM/watt. Demand control based on temperature, RH, CO, and VOC sensors. Continuous ventilation or circulation-only capability.
- **HVAC:** Ductless heat pump, 11 HSPF, 26 SEER, variable-speed compressor.
- **Hot Water:** Heat pump water heater, 50-gal, 2.78 EF.
- **Lighting:** 100% LED lighting, large windows.
- **Appliances:** ENERGY STAR refrigerator, dishwasher, clothes washer, clothes dryer.
- **Solar:** 5.12-kW rooftop panels.
- **Water Conservation:** EPA WaterSense-labeled fixtures.
- **Energy Management System:** End use energy submetering, solar production monitoring, air quality monitoring.
- **Other:** Low-emission cabinets, flooring, paint, counter tops, doors; hard floors minimize particulates. Modular construction.