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*

AquaZephyr

TREE at EcoVillage
Ithaca, NY

BUILDER PROFILE

AquaZephyr, Ithaca, NY
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: TREE at EcoVillage
- Location: Ithaca, NY
- Layout: 1 bdrm, 1 bath, 1 fl, 467 ft^2
- Climate: IECC 6A, cold
- Completion: Fall 2015
- Category: multi-family

Modeled Performance Data:

- HERS Index: without PV 58, with PV 26
- Projected Annual Energy Costs: without PV $1,050, with PV $583
- Projected Annual Energy Cost Savings: (vs home built to 2009 IECC): without PV $274, with PV $1,137
- Projected Annual Energy Savings: without PV 1,525 kWh, with PV 6,314 kWh
- Added Construction Cost: without PV $2,780, with PV $4,630 (per unit)

One reason people choose to live in the EcoVillage co-housing community is the community's commitment to sustainability. That commitment to sustainability, especially sustainable energy-efficient construction, is one reason why builder Kendall Carpenter of AquaZephyr, LLC, wanted to work on the co-communal housing project. And, it's one reason why the community's newest addition, a four-story 15-unit multi-family building, won a 2016 Housing Innovation Award from the U.S. Department of Energy's Zero Energy Ready Home program.

EcoVillage Ithaca was started in 1991 with the purchase of a 176-acre site 2 miles from downtown Ithaca, New York. It is a cooperative living organization that is part of a loose affiliation of EcoVillage communities around the world. The Ithaca community has been built in three phases and will eventually include housing for about 240 residents including families, couples, and singles in single-family, duplex, and multi-family homes clustered around ponds, open spaces, farm land, and green houses.

The multi-family building is part of the third phase at Eco Village, known as the TREE Neighborhood, and is the second project at EcoVillage to be recognized with a DOE Housing Innovation Award. In 2012 AquaZephyr began construction on 17 single-family and 4 duplex homes at EcoVillage that were also certified to the DOE Zero Energy Ready Home program.

The DOE Zero Energy Ready Home program requires homes to meet all of 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 solar electric panels installed or have the conduit and electrical panel space in place for future photovoltaic panel 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 (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.

AquaZephyr, LLC, built this 22,600-ft², 15-unit multi-family building in Ithaca, New York, to the performance criteria of the DOE Zero Energy Ready Home (ZERH) program. Furring strips provide a drainage gap between the cedar siding and the foil-faced rigid foam. Triple-pane doors and windows provide high-performance glazing on the south-side of the four-story building.

What makes a home a DOE ZERO ENERGY READY HOME?

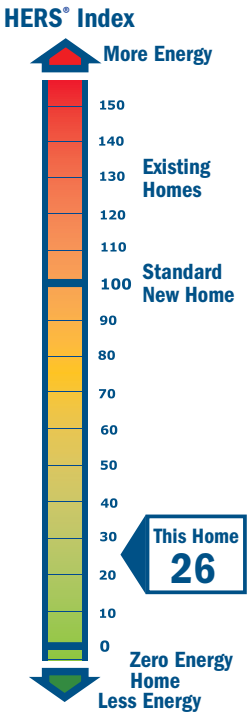
1 **BASELINE**
ENERGY STAR Certified Homes Version 3.0

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 2016 award winner is a multi-family building that has two studio apartments (450 ft² each), six 1-bedroom 1-bath apartments (690 ft² each), and seven 3-bedroom 2-bath units (1,150 ft² each). Each unit was tested per the program requirements; the units achieved Home Energy Rating System (HERS index) scores ranging from 55 to 57 (a typical home built to code would achieve 80 to 100). When the energy savings from the rooftop solar photovoltaic and solar water heating panels were included, the HERS scores dropped to 26 for the studio and 1-bedroom units and 40 for the 2- and 3-bedroom units.

"With each neighborhood we have tried to push the envelope on building energy efficiency a little bit further," says Jared Jones, site manager of the TREE Neighborhood.

The modern structure includes many design features to maximize the potential for passive solar heating and active solar production while minimizing the impacts of the often harsh upstate New York winters. Most of the windows are located on the building's long south side to capture passive solar gain along with views of the Ithaca valley. The south-facing roof is steeply angled to optimize solar gain and to encourage snow to slide off the panels. The north-facing roof has a shallower slope to deal with the northern winds and the north-facing wall of the building has minimal glazing to maximize its insulation properties. Most of the entryways are protected by overhangs. A community patio is located on the south side of the building where it can gain the most sun while the building's height protects it from northern winds.

The roof material is 29-gauge metal, with caulked overlapping seams, installed on 2x4 purlins that were attached to the engineered trusses. Additional bracing was installed to attach the 12 solar water heater collectors. The roof is equipped with gutters and downspouts to carry water away from the foundations and ice brakes to minimize the chances of large pieces of ice falling off the roof. Any penetrations through the ceiling to the attic were caulked or trigger foamed. The vented attic was insulated on the attic floor with 18 inches of blown cellulose, which completely covered the bottom chord of the trusses helping to prevent thermal bridging from the house to the attic.

The walls are wood framed with 2x6s typically set at 16 inches on center. The wall cavities were dense-packed with cellulose. The door and window headers were insulated with 2 inches of polyisocyanurate rigid foam. The walls were

A combination of insulation strategies, including rigid foam in headers over doors and windows, fiberglass batt and blown cellulose in wall cavities, and foil-faced rigid foam on the exterior provide thermal protection for the high-performance structure in this cold-climate location.

sheathed with ½–inch coated OSB and the seams were taped to provide a continuous air seal. The sheathing was covered with a fire-rated exterior-grade fiber rock sheathing. The proprietary tape was used to connect the wall sheathing with the top plate creating an air-tight seal along this corner at the top of the walls before the roof trusses were installed. This was covered with a 2-inch layer of foil-faced polyisocyanurate with the seams taped to provide a continuous drainage plane. Tape was also used at all doors and windows to seal the framing to the coated sheathing and again to seal the window and door frames to the polyiso foam board. One-inch furring strips were installed vertically over the polyiso to provide a ventilation gap and to provide a nailing surface for the fiber cement and wood siding.

The foundation is slab-on-grade. Under the full slab is a 3-inch layer of polyisocyanurate foam board providing an insulation value of R-20. A vapor barrier of 6-mil polyethylene separates the foam from the slab. The perimeter of the slab was fully insulated using foam board of various materials and densities depending on the location.

The ground floor concrete slab was left exposed as a sealed concrete flooring surface to better absorb passive solar heat during the winter when the solar angle is low. The slab floor also provides a cooling heat sink in the summer. It is protected from overheating by window overhangs that keep the high summer sun from reaching the surface. The concrete surface is also very durable and can tolerate tracked-in snow and mud.

The four-story building's concrete elevator shaft and interior stair enclosure have been folded into the building envelope by insulating beneath the slab and air sealing above to isolate the shaft from the vented attic space. The concrete shaft and stair well dramatically increase the mass of the conditioned space, which helps to moderate heat loss and gains. The insulation and air sealing removes a major source of potential heat loss during the cold months.

The only cooling in the building is a single mini-split heat pump that was installed to keep the elevator mechanical room cool. Radiant heat tubing was installed in the ground floor slab but it is not currently being used. If it is utilized at some future time, the uncovered slab will transfer heat efficiently. Heating for the units is currently provided by electric resistance baseboard heaters.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program

ENERGY STAR Certified Homes Version 3.1

EPA Indoor airPLUS

LEED for Homes

"Our customers are thrilled to be improving their building performance, reducing environmental impacts and pollution, and simplifying the management of their buildings,"

—Kendall Carpenter, builder
AquaZephyr, LLC

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.

On the exterior of the walls, foil-faced rigid foam is taped to provide a continuous thermal blanket, comprehensive draft protection, and a continuous wall water barrier.

The building was designed to meet International Building Code requirements for earthquake resistance with the necessary shear walls and tie downs. Although the building was not certified to the standards of the Passive House Institute U.S., Passive House modeling software was used for the initial design.

The multi-family building houses a community kitchen, children's playroom, and meeting and sitting areas on the first floor. The mechanical ventilation registers are located to isolate the kitchen area air from the rest of the first floor to keep heat and kitchen smells out of other areas. An exhaust hood over the stoves also helps control the cooking environment. The apartment units are equipped with energy recovery ventilators (ERVs) or heat recovery ventilators (HRVs) that run continuously to provide filtered fresh air. The ventilation ducts are insulated to R-15, fully sealed with mastic throughout, and spray foamed at exterior penetrations.

The building is equipped with triple-pane windows with a U-factor of 0.17. All appliances are ENERGY STAR rated, including the dishwashers, refrigerators, HRVs, clothes washers, water heaters, ceiling fans, and light fixtures. About 72% of the lighting is LED, and much of that is controlled by motion sensors in the common areas. Plumbing fixtures are low flow.

In addition to energy-efficiency and conservation features, only low- or no-VOC paints were used in the interior of the building and the design integrates locally harvested pine beams, hardwood on the cabinets, and cypress for the balcony decking. "We've tried to source as many materials as we could locally because we believe in supporting the local economy," said Jones. The multi-family dwelling also includes an electric vehicle charging station adjacent to the building.

The building's rooftop solar PV panels have a capacity of 50 kW. They are tied in with the grid and net metered for the building. In addition, twelve 4x8 solar hot water collectors are roof mounted and supply hot water to a 400-gallon pre-heat tank. These combined features provide an average estimated savings of $1,137 per unit per year.

"We are very happy with the results of EcoVillage," said Lois Arena, a senior engineer with Building America research partner Steven Winter Associates. "The occupants that we have talked to all say they feel very comfortable and are very pleased with the development. We feel we have definitely achieved our goals."

Photos courtesy of AquaZephyr

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance.
- **Walls**: 2x6, 16″ o.c. dense-pack cellulose. Door and window headers have 2″ polyisocyanurate. Sheathing is ½″ coated OSB, then fire-rated exterior-grade fiber rock, then 2″ foil-faced polyisocyanurate, all seams taped on all layers, then 1″ furring strips, then fiber cement and wood siding. Total wall value is R-32.
- **Roof:** Metal 29-gauge over 2x4 purlins over engineered trusses.
- **Attic:** Vented with 18″ blown cellulose for R-65. All penetrations caulked or foamed.
- **Foundation:** Slab-on-grade, 3″ R-20 polyisocyanurate under slab plus slab edge.
- **Windows:** Triple-pane, U=0.17.
- **Air Sealing:** 6,134 at 75 cfm.
- **Ventilation:** Continuous ERVs and HRVs.
- **HVAC:** Electric resistance baseboard.
- **Hot Water:** Solar with 400-gal pre-heat tank with back-up electric heater.
- **Lighting:** 72% LED, 28% CFL, motion sensors.
- **Appliances:** ENERGY STAR dishwasher, refrigerator, HRVs, clothes washer, water heater, ceiling fans, light fixtures.
- **Solar:** 50-kW PV grid-tied; twelve 4x8 solar hot water collectors.
- **Water Conservation:** Low-flow toilets.
- **Energy Management System:** Online tracking of PV production.
- **Other:** No-/low-VOC paints, LEED platinum, electric car charging station.

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