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

CGA Studio Architects

Forever House
Hastings-on-Hudson, NY

BUILDER PROFILE

CGA Studio Architects
Hastings-on-Hudson, NY
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Project name: Forever House
- Location: Hastings-on-Hudson, NY
- Layout: 3 bdrm, 1.5 bath, 2 fls + bsmt, 1,713 ft²
- Climate: IECC 4A, mixed-humid
- Completed: June 2022
- Category: Custom for Buyer

Modeled Performance Data:

- HERS Index: without PV 32; with PV -17
- Annual Energy Costs: without PV $1,800; with PV $-705
- Annual Energy Cost Savings: (vs typical new homes) without PV $1,100; with PV $3,600
- Annual Energy Savings: without PV 7,450 kWh; with PV 19,000 kWh
- Savings in the First 30 Years: without PV $46,000; with PV $150,700

When Architect Christina Griffin bought this tiny 1905 cottage in the village of Hastings-on-Hudson, New York, she retained the physical footprint of the old home but gave the property an all-new carbon footprint, replacing the 998-ft² gas- and oil-burning house with a modern 1,713-ft² two-story carbon-neutral home that meets the U.S. Department of Energy's Zero Energy Ready Home certification requirements. Judges for DOE's Housing Innovation Awards were so impressed with the zero-carbon home that they gave it a grand award for decarbonization in the 2023 competition. The home also achieved a "Passive House + Source Zero" designation from Passive House Institute US (PHIUS) and was recognized by PHIUS with a Passive Project Design Competition award.

This project is the fifth for which Griffin has sought a Passive House designation, and the first home designed by her firm, CGA Studio Architects, to receive a DOE Zero Energy Ready Home certification. Griffin first heard about the DOE program through PHIUS, as the two programs have a collaborative relationship. "PHIUS makes it pretty clear on their website that Passive House is a path to DOE ZERH," said Griffin. Griffin's home energy rater, Anthony Lisanti of Integral Building & Design, Inc., also recommended she consider pursuing a DOE Zero Energy Ready certification.

Griffin has long been interested in sustainability. She built the first LEED for Homes platinum-rated project in Westchester County, NY, in 2010. (That home also earned a design award from the American Institute of Architects.) A speech by early Passivhaus pioneers Dr. Wolfgang Feist and Katrin Klingenberg in New York City in 2011 inspired Griffin to become a Certified Passive House Consultant with Passive House Institute US (PHIUS) in 2012 and with Passive House International (PHI) in 2015. Griffin is an active member of New York Passive House, a network of professionals, builders, and contractors working together to problem solve and promote Passive House projects. A math whiz since high school, Griffin taught herself the modeling programs used by Passive House. She said, with practice, she can now run a WUFI

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.

CGA Studio Architects constructed this 3-bedroom, 1.5 bath, 1,713-ft² home to the high-performance criteria of the DOE Zero Energy Ready Home program. The homeowners can expect utility bills of about $18 per month, thanks to the home's Passive House design, 10.8-kW solar photovoltaic panels, and 9-kW battery. ENERGY STAR appliances, lighting, and windows add to energy savings. An 80-gallon 3.61-ERI heat pump water heater supplies hot water to the home. The home is designed with stacked plumbing and short pipe runs to minimize hot water waste.

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

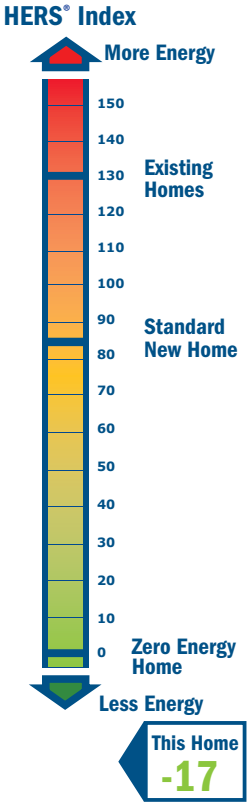
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



(moisture risk) 3D model on a home in 2 hours. Griffin said the WUFI model provides a clear picture of what impacts different energy-efficiency options can have on a home's performance.

While Griffin is passionate about Passive House design, she found that many of her clients were reluctant to embrace the approach because they were intimidated by unfamiliar brand names and construction practices. To help customers become more comfortable with the concepts, Griffin decided to construct a Passive House for herself and her husband that she could use as a model home. The resulting home, completed in June of 2022, has already hosted over a dozen tours to fellow architects, builders, school groups, and members of the public.

"The tours have sold out within two hours," said Griffin, who adds "Taking a tour takes the mystery out of Zero Energy and Passive House projects. It's really a revelation to people when they can see and feel the energy-efficiency features we include in these homes." One thing Griffin includes in the tour is a 90-second video comparing the thermal envelope of a Passive House to putting on a down jacket that has continuous insulation between outer and inner air-tight layers. "I've put a down jacket on this house," said Griffin.

The home's double walls are constructed of two 2x4 16-inch on-center walls set 8 inches apart, with exterior CDX plywood sheathing on the exterior. A smart vapor control membrane covers the inside face of the interior wall to hold in the 18 inches of dense-packed cellulose, which provides a whopping R-55 insulation value to the walls. The builder tacked 2x2 furring strips over this interior vapor retarder to provide a service cavity behind the drywall so electrical boxes could be set and wiring run without having to put holes in this air barrier layer. The exterior CDX plywood sheathing layer was topped with a 4-layer smart vapor-control waterproof membrane with a three-dimensional mesh, which serves as an integrated vented rain screen behind the tongue-and-groove random-width, horizontal knotty cedar siding with a semi-solid stain finish.

The attic is insulated with 18 inches (R-64) of dense-packed cellulose held in place from below by an air-tight smart vapor-control membrane. Like the walls, 2x2 furring strips create a space between this membrane and the ceiling drywall to provide an air-sealed space for electrical boxes and wiring. The attic itself is ventilated with continuous ridge and soffit vents. The CDX plywood decking is covered with a taped and sealed weather-resistant membrane and is topped with fiberglass roof shingles.

Like a thick down jacket, the home's thick exterior walls are stuffed with 18 inches of blown cellulose providing R-55 of insulation. On the exterior, the plywood sheathing is wrapped with a smart vapor-control membrane with a plastic mesh layer that provides a vented rain screen under the cedar siding. On the interior, the cellulose is held in place with an air-tight, smart vapor-control membrane that is tacked to the inside surface of the interior 2x4 walls. 2x2s are nailed over that air barrier to create a 2-inch space behind the drywall to run wiring and place electrical boxes without putting holes in the membrane.

Because Griffin is "totally committed to having the lowest carbon footprint we can" she was very conscientious about the materials she chose, like the cellulose insulation, which is made from recycled newspapers. That is one reason she chose to reuse the existing concrete foundation walls, rather than breaking them up and pouring new high-embodied carbon concrete. Because the basement walls and slab were already in place, she left the basement uninsulated and installed insulation below the subfloor with dense-pack cellulose insulation in the floor cavities and 1.5 inches of moisture-resistant rigid mineral wool insulation attached to the bottom of the floor joists over an air-tight smart vapor-control membrane. She was able to retain the original 2x8 joists and diagonal plank subfloor for 72% of the flooring. Where new flooring was installed, she used 2x10 floor joists; therefore, 72% of the floor was insulated to R-34 and 28% was insulated to R-41.

To complete this highly insulated building envelope, Griffin selected triple-pane windows with an insulation value of U=0.15 and a solar heat gain coefficient (SHGC) of 0.34. The PHIUS-qualifying windows were purchased from a nearby vendor in New Jersey. The house design included large south-facing areas of glass for beneficial solar gain in the winter. To minimize unwanted heat gain in the summer, these windows are shaded by trellises, roof overhangs, and a covered porch.

The air sealing strategy for the home consisted primarily of the air-tight smart vapor-control membrane that wraps the entire interior of the home, including beneath the ceiling insulation, on the interior of the wall insulation, and below the floor insulation, with service cavities between this membrane and the drywall in the walls and ceiling to maintain the air barrier. In addition, a smart vapor-control weather-resistant barrier and rainscreen was installed over the sheathing on the exterior walls and a similar membrane was installed over the roof sheathing. Also, a liquid-applied air barrier was applied at the window sills and basement sills. All of these techniques combined to achieve blower door test results of 0.82 air changes per hour at 50 Pascals pressure differential.

An energy recovery ventilator was installed to bring in fresh air that is tempered and filtered before distribution throughout the home via a separate duct system from the heating and cooling system. The ERV exhausts air from the bathrooms and kitchen. The ERV has controls to notify homeowners when the filters need to be changed.

HOME CERTIFICATIONS

ENERGY STAR Certified Homes Version 3.1

EPA Indoor airPLUS

DOE Zero Energy Ready Home Program - 100% Commitment

PHIUS + 2018 Certified

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.

Overhangs, pergolas, and balconies help to reduce unwanted solar heat gain in summer.

The 1,700-ft² home is heated and cooled by a single ducted mini-split air-source heat pump with a heating seasonal performance factor of 12.6 HSPF and a seasonal energy efficiency ratio of 18 SEER. The system has one outdoor compressor and one indoor air handler that is ducted to supply all of the rooms of the home. The heat pump has a rated output capacity of 21,600 Btu for heating and 18,000 Btu for cooling. Passive solar heat gain in the winter is provided by large south-facing windows in the music room, living/dining area, and all bedrooms.

The roof-mounted solar PV array has 28 panels that can provide 10,920 kWh per year of energy. As power is generated, it is sent to the home's 9-kWh battery to power the home. Surplus power is sent to the grid and the homeowner receives a credit for it on their utility bill. A data monitoring system tracks energy usage and solar power generation. During a power outage, a smart control device directs power from the batteries to specific locations, such as the computer, refrigerator, lights, etc. Griffin and her husband can control this from an app on their cell phones. The home's solar power generation is expected to exceed the needs of the house, but the system was oversized to take into account future electric cars.

Griffin built this home to not only "talk the talk" but to "walk the walk." She has also served as a Passive House consultant for several years. In 2013, she cofounded the Center for Sustainable Development, a non-profit that conducted seminars and workshops on Passive House and green materials for homeowners, architects, engineers, and builders.

Although Griffin has experimented with several building materials over the years, she settled on stud walls and blown cellulose, both for their low-embodied carbon content and because they are common in the construction industry. Griffin acknowledged that finding or training knowledgeable trades is a challenge. "Training is really difficult. Even if the head framer knows what's going on, the other guys often don't. There is a lot of retraining." She arranged to have the manufacturer of the vapor-smart membranes come to the site to teach the workers how to install the membranes and tapes. When she can't find a Passive House contractor, Griffin sometimes serves as her own general contractor. On this project she was fortunate to get an experienced contractor and site supervisor to help finish the project.

CGA Design Studio includes three architects and an interior designer. "We do about 15 to 20 homes per year, including single-family new homes, town homes, mixed use, renovations, and retrofits. We have quite a few 8- to 16-unit multifamily projects located in older downtowns along the Hudson River and we are dedicated to designing these buildings to achieve Passive House and DOE Zero Energy Ready Home certification," said Griffin.

Photos courtesy of CGA Studio Architects

KEY FEATURES

- **Walls:** Double wall, Total R-55: Two 2x4 16″ oc walls 8″ apart, R-55 dense-pack cellulose. Interior smart vapor-control membrane. Exterior CDX plywood, smart vapor-control membrane + mesh rain screen; cedar siding.
- **Roof:** Rafter gable roof: ⅝″ CDX plywood, 2x3 furring, ½″ CDX plywood, 3-layer air-tight, smart vapor-control house wrap, fiberglass roof shingles. Continuous ridge and soffit vents.
- **Attic:** Vented cathedral ceilings, R-64 total: 18″ dense-pack cellulose, airtight smart vapor-control, 2x2 furring service cavity.
- **Foundation:** Uninsulated basement, reused existing concrete slab, CMU walls, and 2x8 + new 2x10 joists dense packed with R-34-41 cellulose held in by air-tight membrane and 1.5″ rigid mineral wool.
- **Windows:** Triple-pane, Passive House-qualified, U=0.15, SHGC=0.34, shaded.
- **Air Sealing:** 0.82 ACH 50, interior walls and ceiling wrapped in airtight, vapor-open membrane. Fluid-applied airtight coating over subfloor, window and basement sills.
- **Ventilation:** ERV, with separate ductwork from HVAC.
- **HVAC:** Ducted mini-split air-source heat pump, 12.6 HSPF, 18 SEER, 1 indoor + 1 outdoor unit.
- **Hot Water:** Heat pump water heater, 80-gal, 3.61 EF. Compact plumbing, R-7 on pipes.
- **Lighting and Appliances:** LED lighting. ENERGY STAR appliances, induction cooktop.
- **Solar:** 10.8-kW solar PV; 9-kW solar battery.
- **Energy Management System:** Apps for tracking energy use, PV output, battery, and HVAC.
- **Other:** All electric; reused existing foundation; no foam.

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