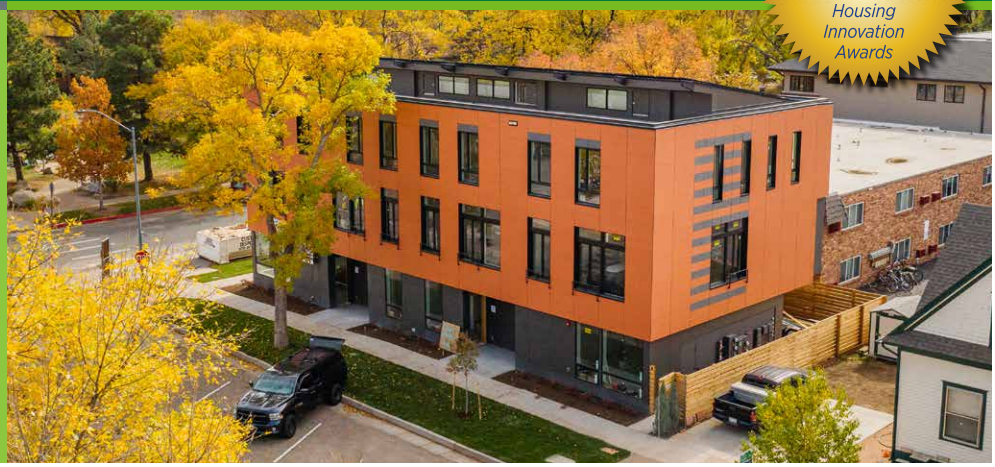
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

DOE ZERO ENERGY READY HOME™

U.S. DOE ZERO ENERGY READY HOME 2021 WINNER Housing Innovation Awards

Philgreen Construction

L'Avenir Townhomes
Fort Collins, CO



BUILDER PROFILE

Philgreen Construction
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: L'Avenir Townhomes
- Location: Fort Collins, Colorado
- Layout: 2 bdrm, 4 bath, 3 fl, 2,478 ft^2
- Climate: IECC 5B, cold
- Completed: December 2020
- Category: Attached

Modeled Performance Data:

- HERS Index: without PV: 40; with PV: -2
- Annual Energy Costs: without PV: $1,300; with PV: $0
- Annual Energy Cost Savings: (vs typical new homes) without PV: $1,950; with PV: $3,250
- Annual Energy Savings: without PV: 16,100 kWh; with PV: 27,100 kWh
- Savings in the First 30 Years: without PV: $79,300; with PV: $131,100

Something new has appeared in Old Town Fort Collins, a four-unit townhome project, dubbed L'Avenir, "the Future." The three-story project has a solid rectangular appearance and terra cotta-clad exterior that hint at the brick-clad 19th century commercial buildings along the streets of Old Town Fort Collins, but this collection of attached homes is something entirely new, a net zero community of live-work spaces that will cost its owners zero in electric bills thanks to a highly efficient building envelope and rooftop solar panels. Homeowners can expect energy savings of $3,250 a year compared to a home built to code. The energy savings were impressive enough to earn the builder, Philgreen Homes of Fort Collins, Colorado, a 2021 Housing Innovation Grand Award from the U.S. Department of Energy's Zero Energy Ready Home program in the attached homes category.

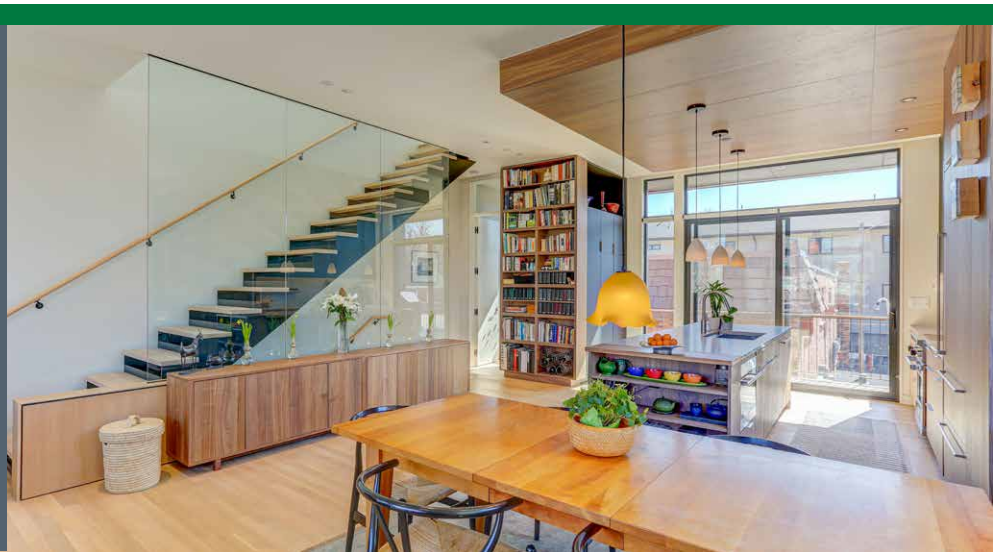
Dave Phillips, owner of Philgreen, collaborated on this project with Davis and Davis Architects, who designed the project and are committed to the idea that this is how homes should be built. "Net Zero Living was the core concept in marketing the project. It was not an after-thought, it was why it was built," said Phillips.

Phillips has constructed about 80 DOE Zero Energy Ready Home units since he first learned about the program in 2013; about 70% are attached and 30% are detached single-family homes. Phillips said he likes the DOE program because "the third-party verification ensures critical items are done properly." Every DOE Zero Energy Ready home must meet the requirements of the ENERGY STAR Certified Homes checklists. They must also be certified to the U.S. Environmental Protection Agency's Indoor airPLUS criteria and meet the hot water distribution requirements of the EPA's WaterSense program. DOE Zero Energy Ready homes must also meet above-code insulation requirements, be blower door tested for air sealing, comply with moisture management guidelines, have ducts inside conditioned space, and use ENERGY STAR-labeled windows, lighting, and appliances.

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.

Ground source heat pumps provide ultra-efficient heating and cooling, while energy recovery ventilators provide clean air throughout the three-story homes. Skylights and clerestory windows fill spaces with natural light, while automated blinds help to minimize overheating. LED lights with motion sensors provide efficient lighting when the sun isn't shining. Low and no-VOC paints, cabinets, flooring, and carpet also help to keep the indoor air healthy.



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

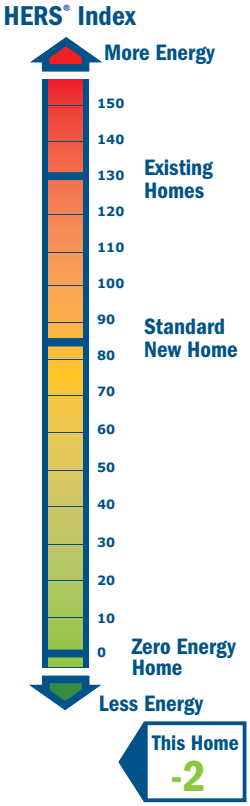
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



Homes must also have solar electric panels installed or have the conduit and electrical panel space in place for future installation of solar panels. Philgreen chose to add solar panels at construction and 7.13 kW was installed on each of the four units for a total of 28.52 kW of panels on the entire building. The winning home was equipped with a 9.8-kWh battery storage system integrated with a critical load panel for 72-hour emergency backup power. The home also has smart thermostats, a phone app that enables remote control of several home systems, and a solar production and energy usage monitoring system that includes real-time analysis of critical loads and monitoring of 18 circuits.

The three-story, 2,478-ft^2 townhomes feature flex spaces on the ground floor that could serve as shops or living space. Cantilevered above are second-floor living-dining-kitchen space, and third-floor bedrooms. There is no basement.

To keep out the chill in this cold climate location, the building's first floor is constructed of double walls consisting of a 2x6 wall next to a 2x4 wall, which allows more room for insulation and less opportunity for thermal bridging. The upper two floors are 2x6, 16-inch on center stud walls constructed with advanced framing features like 3-stud insulated corners and ladder blocking at interior wall intersections. The exterior walls are wrapped with 3 inches of continuous rockwool insulation. Wall cavities are filled with blown-in fiberglass and sheathed with $\frac{5}{8}$-inch coated OSB, which is beneath the rockwool on the upper floor walls. A rainscreen assembly covers this and the exterior of the building is clad with terra cotta clay tiles or fiber cement panels. The walls have a total insulation value of R-37.

The unvented, vaulted ceilings are constructed of 14-inch I joists. The joist cavities are filled with 3 inches of closed-cell spray foam that is topped with 11 inches of blown-in fiberglass for a total insulation value of R-51. The roof decking is $\frac{5}{8}$-inch OSB, which is topped with ice-and-water shield then asphalt shingles on the sloped roof and 80-mil thermoplastic polyolefin (TPO) on the flat roof.

The insulated basement is 10-inch poured concrete walls that are waterproofed and insulated with 2 inches of rigid EPS foam; above-grade portions of the basement wall are covered with prefinished flashings.

The 10-foot cantilever jutting out over the first floors consists of I-joists that are dense-packed with R-49 of blown-in fiberglass that is enclosed with $\frac{7}{16}$-inch OSB and $\frac{7}{16}$-inch cement board.

The walls are filled with fiberglass, sheathed with coated OSB with seams taped, then wrapped with 3 inches of rigid rock wool providing an exceptional wall insulation value to block out street noise and keep in warmth. Metal horizontal furring strips and vertical support channels hold the terra cotta tile cladding in place while providing a ventilating air gap behind the cladding.

The home's windows are highly efficient for double pane with an insulation value of U=0.22 and an SHGC of 0.34. They have low-emissivity coatings on two sides, are argon filled, and have frames that are aluminum-clad wood. The skylights also have interior motorized blinds to control heat and glare from the strong Colorado sun. Tall windows, a skylight over the open stairs, and highly light reflective wall and ceiling paint add to the brightness within the home. All electric lighting in the home is provided by LED lights and motion sensors add to their efficiency.

Philgreen employed some extra steps to ensure air sealing of the exterior walls. All seams in the exterior coated sheathing were carefully taped. All of the nail holes were filled with a liquid sealant. After installing drywall, an aerosolized acrylic sealant product was sprayed throughout the homes while they were pressurized with a blower door. The acrylic particles adhere to the edges of any holes in the building envelope and accumulate until all air leaks are sealed. These measures combined to give this home a whole-house blower door air leakage test result of 2.43 air changes per hour at 50 Pascals pressure differential (ACH50).

To provide fresh air to the home, an energy recovery ventilator was installed. In addition to the ERV, the air handler was equipped with MERV 10 filters in two locations.

A ground source heat pump provides both space heating and domestic hot water with a high heating efficiency of 4 COP and a cooling efficiency of 18.4 EER at full load and 25.4 EER at part load. The heat pump provides hot and cold air through two air handlers (one each for the second and third floor) and through radiant heating loops in the ground floor. Domestic hot water is heated through a reverse indirect tank.

Passive design elements were also incorporated into the building's design to provide passive heating: 1) The building is sited with the long side facing south for solar panel placement. 2) A deep (10-foot) overhang shades the first-floor large sliding doors. 3) The south-facing balcony is recessed 4 feet and surrounded by east and west vertical sun shades. 4) Glazing is minimized on the west elevation (17%).

The whole building is EPA WaterSense certified and employs WaterSense labeled low-flow fixtures inside and drip irrigation outside. Hot water faucets are equipped with hot water recirculation pumps that are activated by use of the hot water. The rear drive includes nearly 1,500 square feet of pervious pavers installed over a gravel filtration system connected to the roof drains to capture pollutants as well as providing other ecological benefits.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Quality Management Guidelines

ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

EPA WaterSense

LEED Certified

Living Building Challenge

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 warm water for the radiant floor loops and heat for the central air handler that warms the first and second floors.

The building has an electric vehicle charging station. It also has a shared electric car and electric bicycle for the four units' owners. Framing is in place for future elevators in the units and other aging-in-place features are included such as zero-threshold master showers.

For better indoor air quality, the homes meet all of the requirements of the EPA's Indoor airPLUS program, including low-emission carpets, oak floors, cabinetry, and paint.

To ensure the building met all of the high performance requirements of the DOE Zero Energy Ready Home program, the builder held preconstruction meetings with all contractors and weekly meetings with the architects. The builder constructed a mock up of the exterior wall as a model for the subs. The architects provided comprehensive construction documentation, including civil, structural, and architectural plans. Shop drawing submittals were requested from the subcontractors.

The architects and builder touted the "20 advantages of living in a zero energy home" in marketing literature. These included: combating climate change, lowering the cost of home ownership, enjoying cleaner fresher air, owning a more durable home, letting in the sun, pioneering the future, enjoying year-round comfort, relaxing in quiet, getting higher resale, using clean energy, enjoying lower maintentance, paying less for water, and investing wisely.

Said the designers Davis and Davis, "L'Avenir represents the future of homes. It is fully powered by the sun's energy and geothermal wells. The building enclosure is super insulated and virtually airtight, making for superior comfort year-round. Tall floor-to-floor heights and oversized windows at ceiling height create a spacious, light-filled environment. Targeting a sustainable and resilient goal of DOE Zero Energy Ready certification along with the Living Building Challenge, the design is also forward thinking with flexibility built in. L'Avenir residents can decide for themselves what use the first floor will have—from car storage to guest room to music studio."

Photos courtesy of Philgreen Construction

KEY FEATURES

- **Walls:** Double wall, R-37 total: first floor double wall 2x6 + 2x4, upper two floors 2x6, 16″ o.c., advanced framed 5.5″ fiberglass, ⅝″ coated OSB, 3″ rigid rock wool, metal horizontal furring for air gap and attachment of terra cotta tile siding.
- **Roof:** Rafter flat roof and shed roof: 14″ I-joist, ⅝″ OSB. Shed roof: self-adhered underlayment, Class 4 asphalt shingles. Flat roof: 2″ tapered insulation, cementitious board, 80-mil TPO.
- **Attic:** Unvented attic: R-51 total: 3″ R-21 closed-cell spray foam on underside of roof deck, 11″ R-30 blown-in fiberglass to fill rest of netted I-joist cavity.
- **Foundation:** Insulated basement, 2″ rigid foam on exterior over waterproofing.
- **Windows:** Double-pane, argon-filled, low-e2, motorized blinds, U=0.22, SHGC=0.34.
- **Air Sealing:** 2.43 ACH50, sealed all nail holes, taped all joints, aerosol sealed whole house.
- **Ventilation:** ERV, MERV 10 filter at 2 air handler locations, 60 SRE, 69 ASRE, 50 ATRE.
- **HVAC:** Ground-source heat pump with 2 air handlers, 1 radiant floor, 4 COP, 18.4 EER.
- **Hot Water:** Ground-source heat pump for space heat and hot water, reverse indirect tanks, 4 COP.
- **Lighting:** 100% LED, motion sensors, skylights, high LRV wall and ceiling paint.
- **Appliances:** ENERGY STAR refrigerator, clothes washer, dryer.
- **Solar:** 7.13 kW/unit, 9.8-kWh battery. Passive solar design.
- **Water Conservation:** EPA WaterSense-certified home.
- **Energy Management System:** Smart thermostats, PV/battery system tied to utility rates.
- **Other:** EV charging. Accessible shower, framed for future elevator, low/no-VOC carpet, floors, cabinets, paint; shared electric car and electric bike.

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