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Can We Adapt Instead of Migrating?

A DECISION POINT APPROACHES, IF CLIMATE TRENDS CONTINUE THEIR CHAOTIC RAMPAGE.

I've been keeping close watch on U.S. migration trends related to climate extremes. The good news is that so far, there's no sign of panic. To the contrary, Americans last year moved in droves to three of the least-resilient states in the nation: Texas, Arizona and Florida.

Forbes, for example, just published its "Best Places to Retire" [guide](#) for 2022, with not a single mention of climate-related threats. Occasionally, a mainstream news story highlights a single family that is uprooting to avoid wildfires, heat and uncertainty, but they're still considered outliers, not oracles.

The reality is that most people don't want to believe worse is coming. And who can blame them? They don't want to leave their homes, their towns, their lifelong communities.

So what will it take to endure and stay? Can we build homes, cities and energy grids to adapt to what the Earth throws at us?

Maybe. But there's a huge caveat: Allowing our expansive, consumptive fossil fuel dependent lifestyle to continue will fast track us past where technology can save us.

Let's say we do make the energy shift in time. What are the building science priorities?

First, we need to address the stuff that can kill us: extreme heat, poor air quality (largely from wildfires), long-term water shortages and wobbling food security.

We have tools to address many of these threats: insulation to tighten homes; heat pumps and geothermal systems for cooling;

air filters and energy recovery ventilators (ERVs) for air quality, ultra-low-flow fixtures, faucets and appliances, leak detectors, xeriscaped lawns, greywater and rainwater systems, and yes, composting toilets. With solar arrays to power the whole shebang, we might make it. The building science is here. It's operational and doable.

What's less certain is food. It's tough to grow most crops in 100-degree temperatures with minimal water.

Even if we can adapt, we have to think about the quality of life that we need to stay sane. It's tough to get excited about living indoors all the time. We might adapt, but we'd effectively end up living like colonists on a hostile planet.

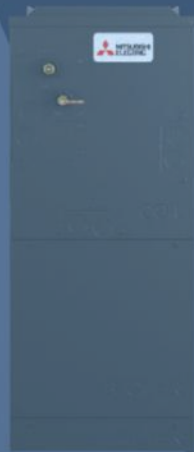
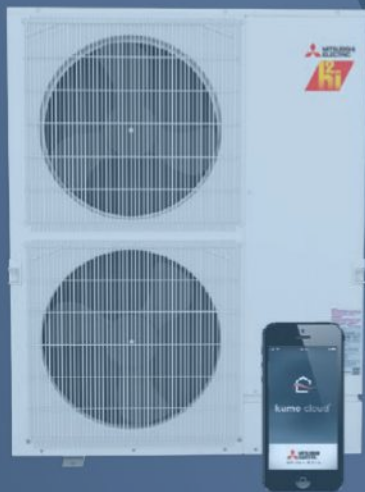
Instead of using technology as a crutch to prolong our current version of normal, can't we do both? Let's adapt and change: prepare for the worst, but strive to head off that scenario. Let Elon Musk fantasize about leaving Earth for greener pastures in an alien galaxy. We can send him postcards of the planet we preserved, regenerated and made whole by committing to do the work that's needed, with ingenuity and deep reverence for our rare and special place in the cosmos. **GB**



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BETTER HOMES, LOWER IMPACT

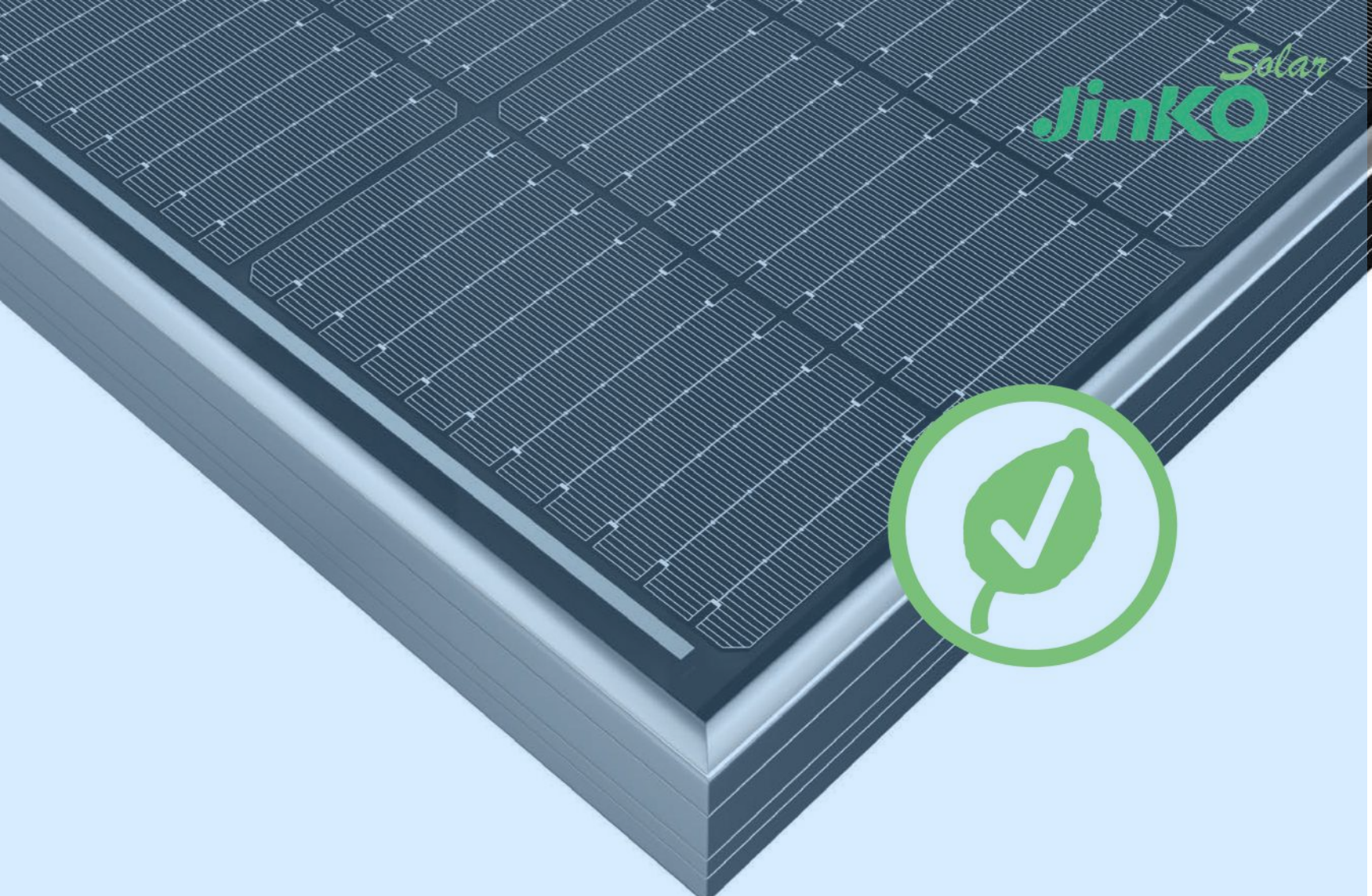


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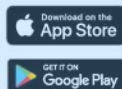
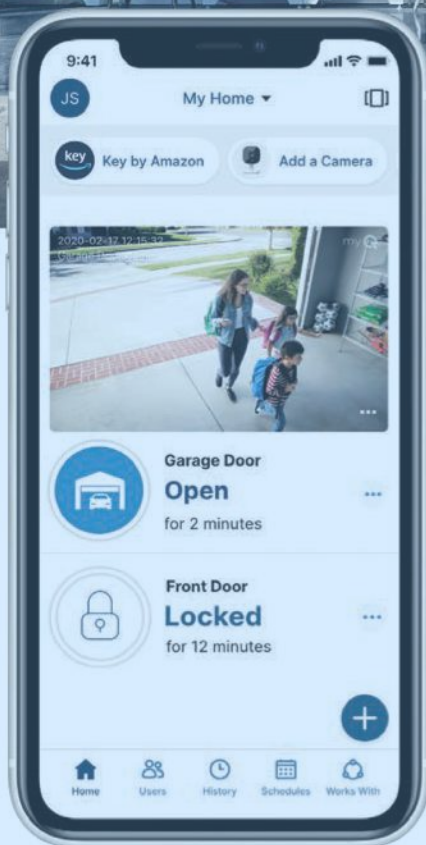
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U.S. Cities Move Toward Autonomous Housing

Los Angeles and San Francisco lead in the switch to off-grid urban homes.



Future world? Growing interest in passive or net zero homes has also led to increased popularity of self-sustaining homes, which function completely off grid.

Homeowners who want to build a home that is completely off grid are more likely to do so on the West Coast, according to a survey by national lawn care service [Lawn Love](#). The study, “[2022’s Best Cities for Self-Sustaining Homes](#),” ranks the top 200 U.S. cities by 17 attributes such as solar power generation, friendliness to off-grid lifestyles, and the number of existing green and LEED-certified homes.

Los Angeles ranked No. 1 overall, followed by San Francisco and San Diego. Eight of the top 10 cities were in California, Washington or Oregon. Cities in these areas are subject to more-stringent building codes, making them more conducive to autonomous homes—which are made almost entirely of sustainable materials, and can function independently in terms of heating and cooling, energy and water use, landscaping and more, according to the survey.

In contrast, Anchorage, Alaska, finished at the bottom (No. 200), largely due to low solar energy availability and higher dependence on oil, as well as limited access to sustainable contractors. Six of the survey’s bottom 10 cities were on the East Coast, including three in Florida.

The study also ranked cities by categories such as highest solar power generation (Lancaster, California), available sustainable home builders (New York City and Jersey City, New Jersey, tied for first), and most LEED-certified surface areas (Los Angeles).

Hawaii Pulls the Plug on Coal Power

Closure of the state’s last carbon-fired power plant signals the end of an era.

Hawaii has shut down its last coal-fired power plant, ending its reliance on a carbon-based energy source used by the island chain for more than 150 years. The facility has been operating since 1992 on the island of Oahu, home to the state capital of Honolulu. It provided up to 20 percent of Oahu’s electricity but also emitted 1.5 million metric tons of carbon dioxide each year.

In 2020, Hawaiian lawmakers approved legislation to phase out coal-fired power plants by the end of 2022. That legislation built on previous climate commitments, including the nation’s first state law, passed in 2015, mandating 100 percent renewable electricity generation by 2045.

The challenge now is ensuring Hawaii has enough renewable capacity to meet its energy needs, according to Scott Glenn, Hawaii’s chief energy officer. Hawaiian Electric, the state’s largest electricity supplier, expects that some coal-fired power generation will have to be replaced with oil,



Burned out. The coal-fired AES Hawaii Power Plant generated 20 percent of Oahu’s energy. State officials hope to replace that productivity with clean energy sources by 2024. CREDIT: TONY WEBSTER/FICKR

at least in the near term. Meanwhile, the power plant’s owner, AES, says that it supports the transition from coal and is working on six renewable energy projects across the Hawaiian Islands. Statewide, regulators have approved at least nine other solar, battery, or geothermal projects that are set to begin operating by 2024.

Self Aware Systems Are Becoming a Regular Residential Amenity

Use of household sensors is expected to rise by more than 250 percent by 2027.

The residential home is about to get smarter. According to a report by global technology intelligence firm [ABI Research](#), by 2027 4.6 billion sensors of various types will be included in smart home devices, robots, and appliances, up from 1.8 billion in 2021. Some of these sensors are already key to the functionality of devices, while others support additional functionality that will push into more products as manufacturers and service providers look to make their products more appealing.

The report examines 15 types of sensors and the technologies leveraged across them to determine which smart home devices and systems are best suited for which sensors. According to Jonathan Collins, ABI Research's smart home research director, demand for microphones, image sensing, air quality, ambient light, water flow, and moisture sensing will all see



significant increased adoption over the next five years.

"Smart home device manufacturers will have to determine which specific technologies will meet their system or system partner's demands for functionality, cost, and power demand," Collins says. "For example, a single sensor for something such as lighting levels or motion could be leveraged across a range of applications to support home environment management, such as automated lighting and window shading, heating, cooling, and more." **68**



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FEATURES

12

DOE ANNUAL BUILDING SCIENCE ROUNDUP: New Horizons

Zero Energy Ready Home award winners are upping their game when it comes to efficiency and environmental safety.

SMALL BUT MIGHTY: With the Custom Ridgeline F home, size doesn't matter. Energy efficiency does.

IN A GRAND MANOR: Insight Homes' latest award winner, The Brenner, is energy efficient, resilient and built for the green future.

MANDALAY RANGE: When it comes to sustainable features, this Arizona-based builder covers the bases with its single-family homes.

FORT COLLINS CLASSIC: The L'Avenir project's futuristic look at sustainability breaks old barriers.

NOTHING LIKE NEOHOUSE: TC Legend's latest effort showcases passive solar heating, an air-to-water heat pump, seismic resistance, and more.

FIRST LOOK: Here are the homes up for top honors at DOE's next Housing Innovation Awards.



12

36

THE GREAT MIGRATION

Millennials are on the move—out of state, into their first homes and taking advantage of remote work. Here's where they're going, and how they'll get there.



36

42

VISION HOUSE MARIPOSA MEADOWS: Elevated Elegance

Green Builder Media's latest VISION House project is a stunning net zero compound high in the Southern Colorado mountains.

46

TRANSCEND: HOME EVOLVED Transcend Communities Aim to Transform Housing

A prototype modular home will be sited in rural Colorado this fall, but the bigger goal is to breathe life into new communities nationwide.



46

DEPARTMENTS

02 Editor's Note

06 Green Building News

52 Housing 2.0

56 Building Science

60 Smart Cities

64 Tailgate

HERE'S A SAMPLE OF WHAT'S INSIDE:

"The reality is that most people don't want to believe worse is coming. And who can blame them? They don't want to leave their homes, their towns, their lifelong communities." PAGE 2

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A winning debut. The Abbott's Alley Net Zero home in Sedro-Woolley, Washington, marks builder Martha Rose Construction's first time as a Department of Energy Housing Innovation Awards Grand Winner, in the Custom Homes on Spec category. COURTESY OF MARTHA ROSE CONSTRUCTION





DOE Annual Building Science Roundup 2022

NEW HORIZONS

CONTENT COURTESY OF
THE U.S. DEPARTMENT OF ENERGY
EDITED BY GREEN BUILDER STAFF

ZERO ENERGY READY HOME AWARD WINNERS ARE UPPING THEIR GAME WHEN IT COMES TO EFFICIENCY AND ENVIRONMENTAL SAFETY.

IT'S BEEN "BACK TO BUSINESS" FOR THE CONSTRUCTION INDUSTRY OVER THE PAST YEAR, as the world settles down from the pandemic and attempts to integrate "the new normal" into everyday lifestyles. But some things have not improved: construction supplies are still running short, prices are continuing to rise, and skilled labor is hard to come by.

In this year's showcase of recent U.S. Department of Energy (DOE) Zero Energy Ready Home (ZERH) Housing Innovation Awards winners, we feature builders who have overcome operational challenges while also trying to catch consumers' eyes.

There were ground rules: Every DOE ZERH 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 ZERH 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. Homes must also have solar electric panels installed or have the conduit and electrical panel space in place for future installation of solar panels.

The project also had to combine tradition with the future of building. After all, there are no new horizons without "new."

Triple power. The Custom Ridgeline F home's location, small size and energy-saving features result in a monthly utility bill that's less than the cost of two gallons of gas. PHOTOS COURTESY OF DELTEC HOMES AND OLD SCHOOL REBUILDERS.



Project Info

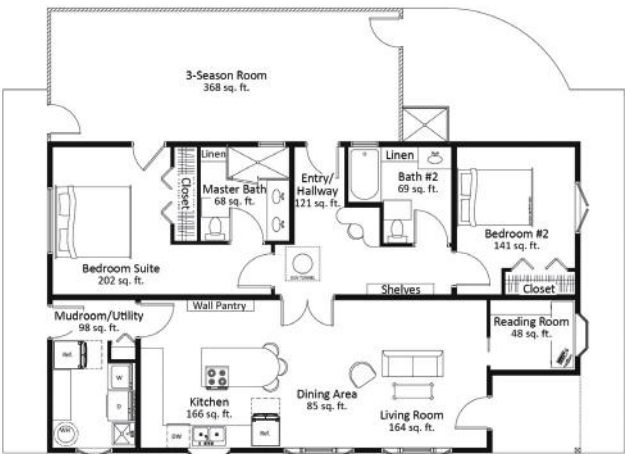
PROJECT NAME: Custom Ridgeline F, Wilmington, North Carolina

BUILDER: Deltec Homes, Asheville, North Carolina, www.deltechomes.com; and Old School Rebuilders, Wilmington, N.C., www.oldschool-co.com

COMPLETED: March 2021

HERS Index: -21

This home's score with PV



Deltec Homes and Old School Rebuilder & Co., Custom Ridgeline F, 2021



Small But Mighty

With the Custom Ridgeline F home, size doesn't matter. Energy efficiency does.

The tongue-and-groove vaulted wood ceilings and three-season room with large windows, ceiling fans and a wood stove, lend a summer cottage feel to this 1,288-square-foot home—a.k.a. Custom Ridgeline F—near the shore of Wilmington, North Carolina. But there is nothing campy about the efficiency of the small home, which is so packed with energy-saving features that it is literally a powerhouse of high performance. The dwelling has a utility bill of about \$10 per month, and it produces enough electricity to run the home and an electric car year round.

The custom home also earned a Housing Innovation Grand Award from the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) program. The award is shared by the designer and manufacturer of the components of this kit home, Deltec Homes of Asheville, North Carolina, and Old School Rebuilders, a Wilmington, North Carolina, builder who assembled the home on site from panels constructed by Deltec Homes at its Asheville plant.

Deltec has a unique business model. The company produces custom home kits of premade panels, which are shipped all over the United States for assembly on site by local builders. Deltec has developed ongoing relationships with builders in some markets, including Old School Rebuilders. The company, which ships about 50 homes a year, has developed a reputation for energy-efficient

construction in the 55 years since its founding, thanks to CEO Steve Linton's passion for sustainable construction.

The award-winning Custom Ridgeline F is one in a line of Deltec homes designed for passive solar, with ductwork inside conditioned space, high performance insulation, and stringent air tightness. This home is only Deltec's second DOE ZERH; the first one netted several interested clients, including the owners of this home, according to Deltec Sustainability Manager Leigha Dickens.

As Deltec's in-house green homes consultant, Dickens shows home buyers the benefits of a DOE ZERH certified home and often tries to steer them toward certification. To make the program even more enticing, Deltec has recently created its own in-house rebate program to encourage buyers to get their homes certified.

The rebates are tiered, where Deltec will offer our customers and their builders each a rebate if they submit proof of certification. Rebates start at \$150 for ENERGY STAR, up to \$750 for DOE ZERH, and \$1,200 for Passive House Institute U.S. (PHIUS+2015), Dickens notes. Custom Ridgeline F's owners are the first to take advantage of this rebate.

"Many of our clients build in rural areas where there is less recognition and fewer rebate opportunities from other sources," Dickens explains. "The rebate program is our way to assist homeowners and their builders in overcoming financial barriers to certification."

QUALITY BUILDING IN MIND

Deltec is also known for its hurricane-resistant design. Custom Ridgeline F is in a coastal area where high moisture load and significant wind speed risks need to be considered. The panelized shell package from Deltec included passive resiliency features to reduce those risks, including a factory-applied borate mold- and termite-resistant treatment on all structural framing members, and a high-wind hardware package, including continuous metal strapping from the top plate to the bottom plate, wall panels held to the foundation with a hold-down unit anchoring system, and 5/8-inch plywood sheathing with tighter nailing patterns than required by code.

Construction of Deltec's homes, including this award-winning model, starts in the factory, where the stud wall panels are assembled to order as specified in the chosen home design. The 2-by-6, 24-inch on-center walls incorporate advanced framing techniques like insulated headers and ladder blocking at interior wall intersections.

The sheathing, rigid foam, and windows are installed in the factory; cavity insulation, drywall, house wrap, and siding are installed on site. A low-expanding foam gasket is factory installed on the outside face of the studs at the perimeter of each piece of plywood sheathing, prior to factory installation of the 5/8-inch plywood sheathing, for increased wall air tightness. One inch of graphite-enhanced

Annual Energy Costs	Annual Energy Cost Savings*	Annual Energy Savings	Savings in the First 30 Years
\$850 (without PV)	\$1,000 (without PV)	5,700kWh (without PV)	\$39,900 (without PV)
\$150 (with PV)	\$1,650 (with PV)	15,400kWh (with PV)	\$66,200 (with PV)
* vs typical new homes			

Key Features

AIR SEALING: 2.46 ACH 50, open-cell spray foam at roof deck and rim joist; all plates, joints and holes caulked; sill seal; factory installed plywood-to-framing gasket.

APPLIANCES: ENERGY STAR refrigerator, dishwasher, clothes washer, heat pump dryer, bath fans.

ATTIC: Unvented, vaulted ceilings: 6-inch R-21 open-cell spray foam on underside of deck.

ENERGY MANAGEMENT SYSTEM:

Photovoltaic production and energy use tracking; Wi-Fi connected fridge, water heater, oven; smart thermostat; water leak detection.

FOUNDATION: Slab-on-grade: R-10 rigid foam at slab edge, plus under perimeter to 3 feet.

HOT WATER: Heat pump water heater, 50-gallon, 3.55 UEF.

HVAC: Central air-source heat pump, 11 HSPF, 18.5 SEER, AC variable speed compressor.

LIGHTING: 100 percent LED, 2 solar tubes, 6 clerestory windows.

ROOF: Truss monoslope: vaulted parallel chord 16-inch open-web trusses at 24 inches o.c.; 5/8-inch plywood sheathing; synthetic roof underlayment; Cool Roof Rating Council-certified asphalt shingles.

SOLAR: 7.2-kW rooftop panels, passive solar.

VENTILATION: Dehumidifier with fresh air intake tied to air handler; MERV 13 filter; bath fans.

WALLS: 2-by-6, 24-inch o.c., panelized, R-24 total: advanced framed, 5.5-inch cellulose in cavity, 5/8-inch plywood sheathing, 1-inch R-5 graphite EPS, drain wrap, fiber cement lap siding and trim.

WATER CONSERVATION: Low-flow fixtures: hot water recirculating pump; drip, predictive irrigation; rain garden; pervious driveway.

WINDOWS: Double-pane, argon-filled, low-e3; fiberglass-wood frames; U=0.27, SHGC=0.20.

OTHER: Electric vehicle charging. Accessible doorways, handles, showers, sinks. Sustainable certified lumber and sheathing.

Light year. LED lighting throughout the house, along with a solar grid, help keep the electric bill to less than \$120 per year.



expanded polystyrene (EPS) is installed over the plywood. “We use EPS rather than XPS because of the high-global-warming potential blowing agents in the XPS,” says Dickens, who noted that the graphite-infused EPS product offers the same R-value but is more vapor open than XPS, allowing slightly better outward drying for mixed-humid climates.

All top plates, bottom plates, wall panel joints, wall panel centers, and electrical, plumbing, and HVAC penetrations are thoroughly caulked. A sill-sealing gasket is installed underneath the sill plate of each wall panel. Low-expanding foam is installed around all window and door openings. Open-cell spray foam is installed on the roof deck and at the outside perimeter of the truss band.

WORKING AT WRAPPING

The windows are installed in the factory and are properly integrated with the house wrap, following the sequencing details described by Joe Lstiburek in his book, “Water Management Guide.” First, the sill is lined with a formable pan flashing, then a 12-inch-wide piece of house wrap is installed around the perimeter of each window and integrated with the flashing. Factory-painted window trim is installed in the factory. “Factory installation results in a tighter rough opening

due to our tight tolerances,” Dickens says. “[It also] provides the ability to get the water-management flashing details applied consistently and in an ergonomic environment.”

Rolls of the drainable house wrap are shipped with the panel package for the builder to install on site, so that the house wrap can wrap continuously around the house, without having a seam at every wall panel joint. This field-installed house wrap is integrated shingle-fashion with the pre-installed house wrap around the windows. Any seams are taped. The wall cavities are filled on site with 5.5 inches of Grade 1 blown cellulose and surfaced with 5/8-inch drywall covered with vapor-open paint. The exterior walls are covered with fiber cement lap siding and trim. The entire wall assembly has a total insulation value of R-24.

DESIGN FACTORS

The home’s design incorporates a split monoslope roof with a 6/12 roof pitch on the back half of the house and a 3/12 roof pitch on the front. The panelized vertical 4-foot wall connecting the two halves provides space for six clerestory windows. The vaulted parallel chord roof trusses are manufactured with high-quality machine stress-rated truss lumber in the same Deltec panel plant that makes the wall panels.





The 16-inch-deep open-web parallel-chord trusses are spaced at 24-inches on-center and are filled with R-21 (6 inches) of open-cell spray foam insulation along the roof deck of the unvented vaulted attic space.

The roof is topped with 5/8-inch plywood roof sheathing, synthetic roof underlayment, and Energy Star cool roof-certified birch-colored asphalt shingles. The ceilings of the living areas and kitchen are vaulted and lined with 3/4-inch tongue-and-groove wood ceilings. The rest of the house has 5/8-inch drywall and vapor-open paint. The interior ceilings are dropped to 8 feet over the bathrooms, entry way, and center hallway. This dropped ceiling area creates a conditioned attic space for the heat pump, water heater, and fresh air system.

The foundation is a monolithic slab-on-grade with R-10 insulation on the slab

edge and installed horizontally 3 feet in around the perimeter of the home.

The windows are double pane with frames that are fiberglass on the exterior and wood on the interior. The window panes have a low-emissivity coating on three sides (lowe3). The argon-filled windows have a U-factor of 0.27 and a solar heat gain coefficient (SHGC) of 0.20.

When faced south, as this home does, the standard model features 16-inch overhangs on the east, west, and north sides. There are covered porches on the east and west ends and limited glass on the north. Most of the glass is south-facing and is protected from too much solar gain by 2-foot overhangs. In the right climate, clients can modify the design to add thermal mass and more south-facing windows to cover a large portion of their space heating needs with passive solar heating.

An energy recovery ventilator (ERV) was considered for this home but, upon the advice of the Home Energy Rating System (HERS) rater, a ventilating dehumidifier was chosen instead due to the high humidity of the coastal climate, according to Dickens. The dehumidifier is tied into the home's duct system. The fresh air intake operates continuously and the dehumidifier runs 30 minutes per hour.

The home is equipped with a heat pump water heater that operates at an efficiency rating or Uniform Energy Factor (UEF) of 3.55. The 50-gallon water heater is in the conditioned dropped attic space along with the central air-source heat pump, whose branch ducts are all inside conditioned space with supplies and returns in the attic knee walls adjacent to each room. The heat pump operates at a heating efficiency of 11 HSPF and a cooling efficiency of 18.5 SEER, well above the federal minimum of 13 SEER. The heat pump uses a rigid plenum duct system with flex branches.



CLASSY GLASS.

The Custom Ridgeline F home's windows are double-pane, argon-filled, low-e3 units that help with environmental control.

UNDER THE ROOFTOP.

Vaulted ceilings in the living areas and kitchen are lined with 3/4-inch tongue-and-groove wood.

POWER PACK.

ENERGY STAR appliances include the refrigerator, dishwasher and oven. Some household appliances are also Wi-Fi enabled.

AIRTIGHT NATURE. Doors and windows are thoroughly caulked and sealed with spray foam to create energy-saving air tightness.

Repeat performer. A series of environmentally friendly elements inside and outside The Brenner model have garnered Insight Homes its second U.S. Department of Energy Housing Innovation Grand Award. PHOTOS COURTESY OF INSIGHT HOMES.

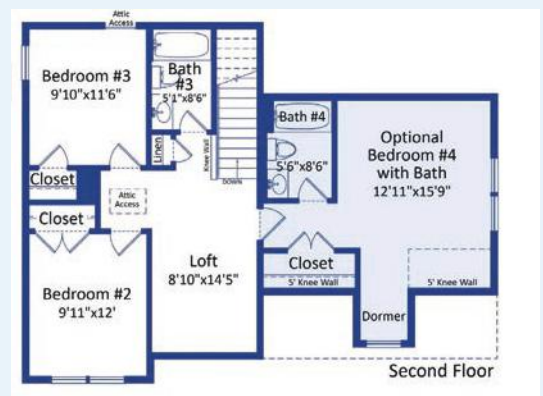
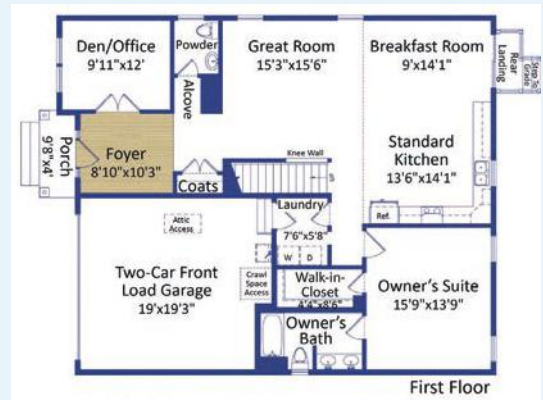


Project Info

PROJECT NAME: The Brenner, Felton, Delaware

BUILDER: Insight Homes, Bridgeville, Delaware, www.itsjustabetterhouse.com

COMPLETED: May 2020



HERS Index: 51

This home's score with PV



In A Grand Manor

Insight Homes' latest award winner, The Brenner, is energy efficient, resilient and built for the green future.

Success has become a habit for Insight Homes. In 2021, the Felton, Delaware builder garnered a handful of home construction awards, including its second consecutive Housing Innovation Grand Award from the U.S. Department of Energy (DOE). That award goes to the contractor who builds the greatest number of homes certified to DOE's Zero Energy Ready Home (ZERH) criteria—in this case, 218.

The production home builder constructs about 200 homes a year, all of them to the requirements of DOE's ZERH program, a commitment it made in 2018. "The program lines up with the whole reason our founder started the company," Insight Vice President of Operations Kevin Brozyna says. "[Our goal is] to build a better and more energy-efficient home, and to challenge the rest of the builders in our area to build better homes above state code as well."

Insight chose not to add solar panels at construction, even though the home is equipped for future installation of the panels. Even without the photovoltaics, homeowners who purchase Insight's Brenner model can expect energy cost savings of more than \$2,000 per year compared to a home just built to code.

Insight Homes employs a panelized wall system consisting of 2-by-6 framing at 24-inch on-center stud spacing, and other advanced framing techniques like insulated headers and two- and three-stud corners. Every panel is made in a climate-controlled indoor environment

where materials are protected from the elements while they are precision cut and attached with laser-guided pneumatic nailers and self-squaring roller tables. This process ensures that every panel is constructed with an accuracy within 1/16 of an inch. The wall panels have a 7/16-inch coated oriented strand board (OSB) exterior sheathing, which saves time and money by serving as the structural sheathing and the primary weather barrier when all seams between panels are taped. The wall cavities are insulated with R-23 of netted and blown fiberglass. No plumbing or HVAC is installed in the exterior walls. The walls are clad with vinyl siding.

OUTER AND INNER SPACE

The exterior walls sit on an unvented conditioned crawl space consisting of poured concrete walls that are protected on the exterior with a liquid-applied waterproofing. An interior perimeter drain is installed and connected to a sump pit. The ground of the crawl space consists of 4 inches of clean gravel for a capillary break. It is topped by a 10 mil fiber-reinforced poly vapor barrier that is taped and sealed at all penetrations, and wrapped 18 inches up the foundation wall. The crawl-space walls are insulated with 2 inches (R-10) of extruded polystyrene rigid foam board that is applied to the interior from the top of the wall to the top of the footer. The band joist is insulated with R-19 of open-cell spray polyurethane foam.

The vented attic is constructed with

engineered roof trusses that include an 18-inch raised heel design to allow for full-depth insulation over the top plates of the exterior walls. Insulation baffles are installed in each attic bay to prevent wind washing from the soffit vents and to provide a path for ventilation air to flow up to the ridge vents. In the mixed-humid climate, this airflow provides several benefits: It helps pull heat and humidity out of the attic in the summer; in the winter, it keeps the deck surface cooler, which helps prevent the ice dams that can occur when snow melts on a warm roof deck, then refreezes at the roof's edge.

The attic is insulated with 16.25 inches of loose blown fiberglass insulation to achieve R-49 across the full ceiling plane. For any vaulted ceiling areas, R-38 fiberglass batts were used. Attic hatches located in the side walls or the ceiling plane are insulated with multiple layers of extruded polystyrene rigid foam board and are gasketed for air sealing. No mechanical equipment or HVAC ductwork is permitted in the attic. All top plates along interior walls are sealed with canned foam, as are any penetrations for light fixtures, exhaust fans, or similar items, through the ceiling plane.

Every home certified through the DOE ZERH program is inspected by a HERS rater and tested for air tightness. Insight's home achieved an air tightness of 1.9 air changes per hour at 50 Pascals (ACH50).

Air sealing occurred in two stages. The first occurred before drywall was installed and after mechanical rough-in, when all

Annual Energy
Costs

\$1950
(without PV)

Annual Energy
Cost Savings*

\$2,100
(without PV)

* vs typical new homes

Annual Energy
Savings

7,800kWh
400 gallons of gas (without PV)

Savings in the
First 30 Years

\$102,600
(without PV)

Key Features

AIR SEALING: 1.9 ACH50; ceiling penetrations spray sealed.

APPLIANCES: ENERGY STAR refrigerator, dishwasher, tankless propane water heater.

ATTIC: Vented attic, R-49 total: 16.25-inch blown fiberglass, 18-inch raised heel trusses, spray foam over all top plates, attic hatches gasketed and insulated with XPS.

ENERGY MANAGEMENT SYSTEM: Wi-Fi connected thermostats.

FOUNDATION: Unvented conditioned crawl space: 4-inch clean gravel, 10-mil vapor barrier, 2-inch R-10 XPS on interior, R-19 open-cell spray foam in band joist. Interior footing drain to sump.

HOT WATER: Tankless propane water heater, 0.97 EF.

HVAC: Gas furnace, 97.5 AFUE, AC variable-speed compressor, secondary central air source heat pump, 9.3 HSPF, 18.8 SEER; manual damper at each branch.

LIGHTING: 100 percent LED.

ROOF: Truss gabled roof: 7/16-inch OSB sheathing, 15# felt, self-adhered membrane in valleys; composite shingles, doubled at rakes; ridge and soffit vents; 15-inch overhangs.

SOLAR: N/A.

VENTILATION: Exhaust only, MERV 13 filters, 100 CFM, 12.5 Watts.

WALLS: Panelized, 2-by-6 at 24 inches o.c.; R-23 total: advanced-framed, R-23 blown fiberglass, 7/16-inch coated OSB taped, vinyl siding.

WATER CONSERVATION: Low-flow fixtures, central manifold with PEX piping.

WINDOWS: Double-pane, argon-filled, vinyl frame, double-hung, U=0.28, SHGC=0.19.

OTHER: Low-VOC paints, adhesives, carpeting; National Green Building Standard Gold.

Bright sides. Natural lighting throughout the home keeps use of interior lamps (shown here in operation for I.D. purposes) to a minimum.



penetrations through the subfloor to the crawl space, through the top plates and chases to the attic, and through the exterior walls were sealed using expanding foam sealant. Rough openings around the windows and door frames were sealed with low-expansion foam sealant. The second stage occurred after drywall was installed, when spray foam was used to seal the back side of the ceiling drywall, along the top plates of all interior partition walls, and any penetrations through the ceiling drywall and partition walls (e.g., light fixtures, exhaust fans, plumbing stacks).

ENVIRONMENTAL ASSETS

The home is heated and cooled with a 97.5 annual fuel utilization efficiency (AFUE) modulating gas (propane) furnace and heat pump with a variable speed compressor and a heating efficiency of 9.3 heating seasonal performance factor (HSPF) and a cooling efficiency of 18.8 seasonal energy efficiency ratio (SEER).

The indoor equipment is in the conditioned crawl space. The duct system trunk lines are rigid round metal ducts, while branch takeoffs are insulated flex ducts with a manual balancing damper at

each branch. Two dedicated 4-inch supply lines provide air to condition the crawl space. The MERV 13 air filter is in a central return box in a wall of the living space. This provides ease of access for replacement. All systems are equipped with a Wi-Fi-enabled thermostat. Ventilation is provided by exhaust fans in the bathrooms.

Given the longer shoulder seasons in the mixed-humid climate, space conditioning demands for sensible load may be minimal. Coupled with the high-performance windows, 6-inch exterior walls, and larger overhangs, the heating and cooling load is significantly reduced for a home of this size (1,940 square feet). When the space conditioning system is used for heating or cooling, the homes are designed to have the central air handler fan (with an electronically commutated motor [ECM] motor) run in manual mode at 30 percent fan capacity. This runs for a set period each hour, between 15 and 45 minutes. Ceiling fans are installed in the central living spaces, including the living room, loft, morning room, and main bedroom.

The periodic cycling of the air handler, coupled with the standard ceiling fans, can help ensure proper mixing of the air





throughout the home and prevent stratification when there is no demand for heating and cooling.

All of the home's lighting fixtures use LED light sources. The home's refrigerator, dishwasher, and tankless water heater are all ENERGY STAR rated. The home's plumbing system consists of a central manifold with PEX piping. The home-run distribution system supply lines are sized for each specific end use, and shutoff valves are installed at each point of use. The fixtures are EPA WaterSense-labeled. Landscape irrigation was installed with weather sensors to prevent system operation during periods of rainy weather.

All homes certified through the DOE ZERH program must meet EPA Indoor airPLUS requirements. Insight Homes uses low-VOC paints and construction adhesives, non-VOC carpeting made from recycled 2-liter bottles, and other materials that allow the home to achieve Gold level certification under the National Green Building Standard (NGBS).

In addition to meeting the DOE ZERH designation, Insight Homes has also committed to building all of its homes to be

certified to the NGBS. These performance programs require third-party inspections, as well as performance testing at several stages of construction to ensure compliance with strict guidelines. Also, Insight Homes' HVAC suppliers require system commissioning and airflow testing prior to occupancy.

GETTING THE WORD OUT

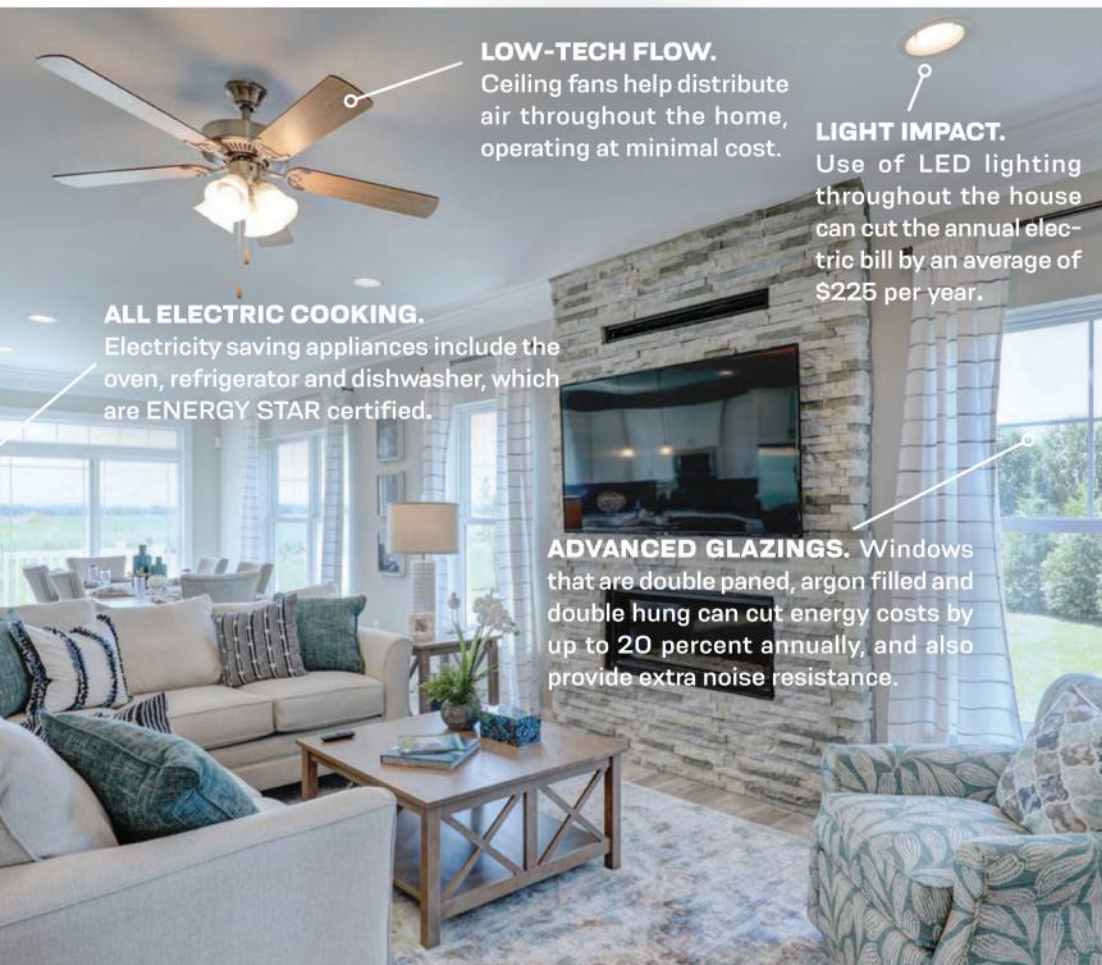
Insight Homes is unique among Mid-Atlantic home builders for dedicating most of its website and marketing literature to explaining the science and performance features that go into its homes.

Insight also converted the garages of several of its model homes into building science demonstration centers. These building science centers include mock-ups of building sections, explanations of the high-performance home features through graphic and interactive displays, and video explanations of the science that makes the homes unique.

To ensure that the high-performance aspects of its dwellings are consistently explained, Insight Homes uses only in-house sales staff that are specially trained in giving high performance home tours, and explaining the features and benefits of health and comfort that come with living in an Insight home. "No other builder in this region dedicates this level of effort to educating the customers and explaining why they should be demanding high performance from their builder," Brozyna says.

Insight's efforts have not gone unnoticed. In addition to the DOE ZERH Housing Innovation Award and Grand Award, in May 2021, the Builders and Remodelers Association of Delaware named Insight Home's Brenner model as Best Green Community Home of up to 2,000 square feet, as well as Best Single Family Community Home of up to 2,000 square feet, for a production builder constructing 75 or more homes per year.

While awards are great, "our biggest reward is hearing from our customers a year later, five years later or more," Brozyna says. "They are still amazed at how low their energy bills are, and they are still happy they made the decision to build 'justabetterhouse.'"



LOW-TECH FLOW.

Ceiling fans help distribute air throughout the home, operating at minimal cost.

LIGHT IMPACT.

Use of LED lighting throughout the house can cut the annual electric bill by an average of \$225 per year.

ALL ELECTRIC COOKING.

Electricity saving appliances include the oven, refrigerator and dishwasher, which are ENERGY STAR certified.

ADVANCED GLAZINGS. Windows that are double paned, argon filled and double hung can cut energy costs by up to 20 percent annually, and also provide extra noise resistance.

Net zero newness. L'Avenir townhomes combine a nostalgic exterior with a modern-day interior to create dwellings that are attractive and energy efficient.

PHOTOS COURTESY OF PHILGREEN CONSTRUCTION.



Project Info

PROJECT NAME: L'Avenir Townhomes, Fort Collins, Colorado

BUILDER: Philgreen Construction, Fort Collins, Colorado, www.philgreenco.com

COMPLETED: December 2020

HERS Index: -2

This home's score with PV



Fort Collins Classic

The L'Avenir project's futuristic look at sustainability breaks old barriers.

Something different has appeared in Old Town Fort Collins, Colorado: a four-unit townhome project, dubbed L'Avenir, "the Future." The three-story unit 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 (DOE)'s Zero Energy Ready Home (ZERH) program in the attached homes category.

Dave Phillips, owner of Philgreen, collaborated on this project with Davis and Davis Architects, who designed the building 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," Phillips says. "It was not an afterthought; it was why it was built."

Since he first learned about the program in 2013, Phillips has constructed more than 80 DOE ZERH units; 70 percent are attached and 30 percent are detached single-family homes. Phillips says he likes the DOE program because

"the third-party verification ensures critical items are done properly."

INTERNAL ELEMENTS

Philgreen chose to add solar panels at construction; 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-square-foot 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 2-by-6 wall next to a 2-by-4 wall, which allows more room for insulation and less opportunity for thermal bridging. The upper two floors are 2-by-6, 16-inch on center stud walls constructed with advanced framing features like three-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 5/8-inch coated oriented strand board (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 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 pre-finished 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 7/16-inch OSB and 7/16-inch cement board.

TWICE AS TIGHT, TWICE AS BRIGHT

The home's windows are highly efficient 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

Annual Energy Costs

\$1,300
(without PV)

\$0
(with PV)

Annual Energy Cost Savings*

\$1,950
(without PV)

\$3,250
(with PV)

Annual Energy Savings

16,100kWh
(without PV)

27,100kWh
(with PV)

Savings in the First 30 Years

\$79,300
(without PV)

\$131,100
(with PV)

* vs typical new homes

Key Features

AIR SEALING: 2.43 ACH50; sealed all nail holes, taped all joints, aerosol sealed whole house.

APPLIANCES: ENERGY STAR refrigerator, clothes washer, dryer.

ATTIC: Unvented attic: R-51 total; 3-inch R-21 closed-cell spray foam on underside of roof deck; 11-inch R-30 blown-in fiberglass to fill rest of netted I-joist cavity.

ENERGY MANAGEMENT SYSTEM: Smart thermostats; PV/battery system tied to utility rates.

FOUNDATION: Insulated basement; 2-inch rigid foam on exterior over waterproofing.

HOT WATER: Ground-source heat pump for space heat and hot water; reverse indirect tanks, 4 COP.

HVAC: Ground-source heat pump with 2 air handlers, 1 radiant floor, 4 COP, 18.4 EER.

LIGHTING: 100 percent LED with motion sensors; skylights; high LRV wall and ceiling paint.

ROOF: Rafter flat roof and shed roof: 14-inch I-joist, 5/8-inch OSB. Shed roof: self-adhered underlayment; Class 4 asphalt shingles. Flat roof: 2-inch tapered insulation; cementitious board; 80-mil TPO.

SOLAR: 7.13 kW/unit, 9.8-kWh battery; passive solar design.

VENTILATION: ERV, MERV 10 filter at 2 air handler locations, 60 SRE, 69 ASRE, 50ATRE.

WALLS: Double wall, R-37 total: first floor double wall 2-by-6 plus 2-by-4, upper two floors 2-by-6; 16-inch o.c.; advanced framed 5.5-inch fiberglass; 5/8-inch coated OSB; 3-inch rigid rock wool; metal horizontal furring for air gap and attachment of terra cotta tile siding.

WATER CONSERVATION: EPA WaterSense certified home.

WINDOWS: Double-pane, argon-filled, low-e2, motorized blinds, U=0.22, SHGC=0.34.

OTHER: Electric vehicle charging; low/no-VOC floors, cabinets, and paint.



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 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 space heating and domestic hot water with a high heating efficiency of 4 coefficient of performance (COP), and a cooling efficiency of 18.4 energy efficiency ratio (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 percent).

EPA AUTHORIZED

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 provide other ecological benefits.

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. 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 structure met all high performance requirements of the DOE ZERH program, the builder held preconstruction meetings with the 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 maintenance, paying less for water, and investing wisely.

According to 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."



SMART LIGHTING. LED lights with motion sensors provide efficient lighting when the sun isn't shining.

BREATHE EASY. Low- and no-VOC paints, cabinets, flooring and carpet help keep the indoor air healthy.

DAYLIGHTING. Tall floor-to-floor heights and oversized windows at ceiling height create a spacious, light-filled environment.

WARM AIR REMOVER. Skylights and clerestory windows combine with automated blinds to moderate indoor temperatures.

Solar standards. Mandalay Homes' Foothill Lot 8 development uses a combined photovoltaic panel system and a backup battery to provide homeowners with clean energy day and night.

PHOTOS COURTESY OF MANDALAY HOMES.



Project Info

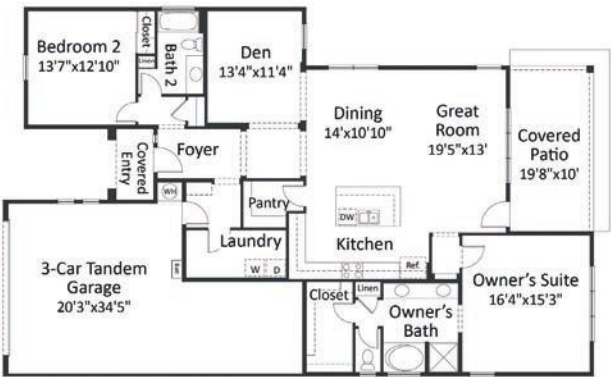
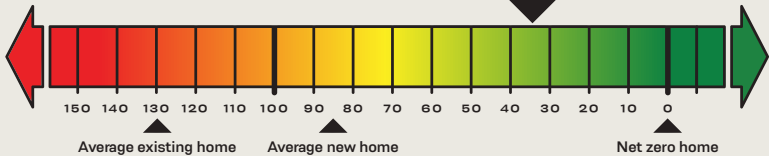
PROJECT NAME: Foothills Lot 8, Prescott, Arizona

BUILDER: Mandalay Homes, Prescott, Arizona, www.mandalayhomes.com

COMPLETED: June 2020

HERS Index: 34

This home's score with PV



Mandalay Homes, Foothills Lot 8, 2021

Mandalay Range

When it comes to sustainable features, this Arizona-based builder covers the bases with its single-family homes.

Not very many builders can say they've had to cut back on their social media to reduce the number of potential buyers, but that has been the case for Mandalay Homes. This production builder constructs high-performance homes in and around Prescott, Arizona, and has experienced such an unprecedented increase in visitors to its communities over the past year, the company has had to cap sales and sell from a waiting list.

But that hasn't exactly slowed things down, according to Mandalay Homes President Dave Everson. "Despite cutting back on social media and online advertising to better control demand, our organic website traffic has more than doubled, and lead acquisition is four times higher than 2019 numbers," he notes.

Every home Mandalay builds is constructed to the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) program criteria. This designation is a key to Mandalay's success, Everson stresses. "Our DOE Zero Energy Ready homes sold for \$15,000 to \$20,000 more, with less square footage on smaller lots against the competition's code-built offering," he says.

FOOTHILL EFFICIENCY

Sustainable features abound in the various Mandalay Homes. The company offers solar as standard on its 600 and 700 series homes, and as an optional upgrade on its 500 series homes. The system available may seem meager—only six panels,

totaling 1.9 kW of photovoltaics (PVs). But Mandalay includes a 10 kW battery storage system. Also, the local utility uses a time-of-use rate structure and offers incentives for residential solar power produced during the late afternoon/early evening peak demand period. The 10 kW battery size is large enough to get most of Mandalay's homeowners through the daily peak period that the rate plan incentivizes. Some homeowners are even able to power their houses at night with stored energy until the sun comes up the next day and the battery starts re-charging.

Energy efficiency is a key factor for Mandalay. For example, the company's Foothills Lot 8 development has a Home Energy Rating System (HERS) score of 45 without PV. When the 1.9 kW of PV is included, the energy modeling software brings the HERS score down to a 34. However, according to Everson, that score doesn't accurately account for the battery storage and the impact of time-of-use rates. If the software were able to accurately account for the home's use of its own stored power during peak rate periods, the HERS score would look more like a 10 or 12. Overall, the system should save homeowners at least \$1,400 a year in energy costs compared to a home built to code.

Mandalay maximizes the power production from the PV panels installed on each home by placing them at the ideal orientation toward the sun. To provide the builder with uninterrupted space for panel placement, Mandalay has taken

pains to eliminate all pipes and stacks through its unvented roofs by moving exhaust fan vents to gable walls or soffits, and employing Studor vents for plumbing stacks. A clean roof deck is less prone to leakage down the road, has better thermal properties, is easier to install, and is more appealing aesthetically.

ROOFS, WALLS, SLABS AND SLIDING DOORS

The unvented roofs are insulated on the underside of the plywood roof deck with 7 inches of open-cell spray foam for an insulation value of R-30. Most of the ceilings are vaulted, providing a sense of spaciousness in homes with compact floor plans like the one-story, 1,872-square-foot 2021 award-winning home.

The exterior walls consist of 2-by-6 studs spaced 16 inches on center. The stud walls incorporate advanced framing techniques like three-stud insulated corners, open and insulated headers, and ladder blocking at interior wall intersections to increase the amount of space in the walls for insulation. The walls are filled with open-cell spray foam in the cavities, then wrapped with taped house wrap and covered with a continuous 1-inch-thick layer of rigid expanded polystyrene (EPS) foam, for an R-21 total wall insulation value. The walls are covered with stucco cladding.

Mandalay Homes uses a post-tensioned-slab foundation with an interesting slab-to-wall detail. The 2-by-6 wall bottom plates are placed on the perimeter of the slab so that they extend beyond

Annual Energy Costs

\$1,300
(without PV)

\$950
(with PV)

Annual Energy Cost Savings*

\$1,000
(without PV)

\$1,400
(with PV)

* vs typical new homes

Annual Energy Savings

8,200kWh
(without PV)

11,100kWh
(with PV)

Savings in the First 30 Years

\$41,200
(without PV)

\$55,900
(with PV)

Key Features

AIR SEALING: 0.63 ACH50; open-cell spray foam in walls and attic; aerosol whole house sealant.

APPLIANCES: ENERGY STAR refrigerator, dishwasher, exhaust fan.

ATTIC: Unvented attic: 7-inch R-30 open-cell spray foam on underside of roof deck.

ENERGY MANAGEMENT SYSTEM: PV tracking; battery usage timed to avoid peak rates.

FOUNDATION: Slab on grade.

HOT WATER: Heat pump, 50-gallon; 3.42 EF.

HVAC: Central air-source heat pump, 9.6 HSPF, 17 SEER, two-stage compressor.

LIGHTING: 100 percent LED.

ROOF: Truss gabled roof: 3/4-inch plywood, synthetic underlayment, asphalt shingles.

SOLAR: 1.9-kW PV rooftop panels, 10-kWh battery storage, rooftop panels.

VENTILATION: ERV with MERV 12 filter; exhaust fans in baths and laundry, master bath fan has humidity sensor; MERV 8 filters in returns in hall and bedrooms; 16 SRE, 73 CFM, 52 watts.

WALLS: 2-by-6, 16-inch o.c.; R-21 total: advance framed; R-21 open-cell spray foam in cavity, house wrap, exterior lath, stucco.

WATER CONSERVATION: Low-flow fixtures; central manifold PEX piping; recirculation pump, drip and predictive irrigation; stormwater management practices.

WINDOWS: Double-pane, argon-filled, low-e2, vinyl frame, U=0.29, SHGC=0.23.

OTHER: EV charging; low/no-VOC cabinets, carpets, flooring, paints, caulks and glues; in-duct hydrogen-peroxide air purifier.

Cost cutters. ENERGY STAR appliances and high-efficiency HVAC reduce energy usage, resulting in more than \$1,000 in savings per year.



it by 2 inches, including sheathing. The entire perimeter of the slab edge (to a depth of about 18 inches) is then covered with 1.5 inches of a dense 3-pound closed-cell spray foam, which adheres to both the slab edge and the bottom edge of the overhanging bottom plate, forming an air- and water-tight seal over the plate-to-slab seam. This dense spray foam hardens to a durable surface that requires no additional covering other than a layer of UV paint.

Mandalay's home designs feature large windows and sliding doors. To help complete the efficient building envelope, Mandalay installs ENERGY STAR-rated, double-pane, vinyl-framed, argon-filled windows with an insulation value of U-0.29 (R-3.57) and a solar heat gain coefficient of 0.23. To minimize unwanted solar heat gain, the sliding doors are protected by covered porches or deep overhangs and windows typically have two layers of low-emissivity coatings on the glass to limit heat transfer. Mandalay is also transitioning from sliding and single-hung window styles to more airtight casement and awning style windows.

For heating and cooling, the home is equipped with a properly sized, two-stage, heat pump with a fully variable electronically commutated motor (ECM). It also has a smart home connected user control with

a reported cooling efficiency of 17 SEER and heating efficiency of 9.6 heating seasonal performance factor (HSPF). However, Mandalay found that the actual heating performance was better than stated. The HVAC equipment will use up to 50 percent less power than a comparably sized standard heat pump in a code-built home of equal size.

Mandalay has recently switched from gas tankless water heaters to heat pump water heaters, making the homes all electric (unless the home buyer requests an optional gas stove or fireplace). The heat pump water heater has an energy factor (EF) rating of 3.42 EF and is in the garage, which in Arizona typically provides a source of warm air year round. The water heater employs a central manifold with PEX piping, and distant hot water faucets use a smart programmable recirculating pump to reduce wasted water. All plumbing fixtures are EPA WaterSense labeled for energy and water savings. Outside the home, the builder implemented WaterSense guidelines for irrigation and graded the lot to encourage onsite collection, retention, and percolation of storm water.

IAQ ASSETS

One other area that has caught the attention of Mandalay's homebuyers is healthy homes. "Indoor air quality is as





foundational to the Mandalay Homes brand as energy efficiency,” Everson says. “To achieve the energy efficiency we do, our homes must be extremely airtight. As such, every home we build includes an ERV fresh air exchange and filtration system.”

In 2020, the company added a hydrogen-peroxide ion, in-duct air purification system as a standard feature in its iON Series homes. The system works in conjunction with the ERV and HVAC to capture even more airborne particles and provide an additional layer of antimicrobial protection, killing up to 99 percent of bacteria, mold, and viruses. It can also help maintain IAQ in instances where the ERV has to be turned off, such as during a forest fire, Everson notes.

In addition to the air purification system, Mandalay Homes meets all requirements of the EPA’s Indoor airPLUS program, including the use of low-emission products like low/no-VOC cabinets, carpets, flooring, paints, caulks and glues.

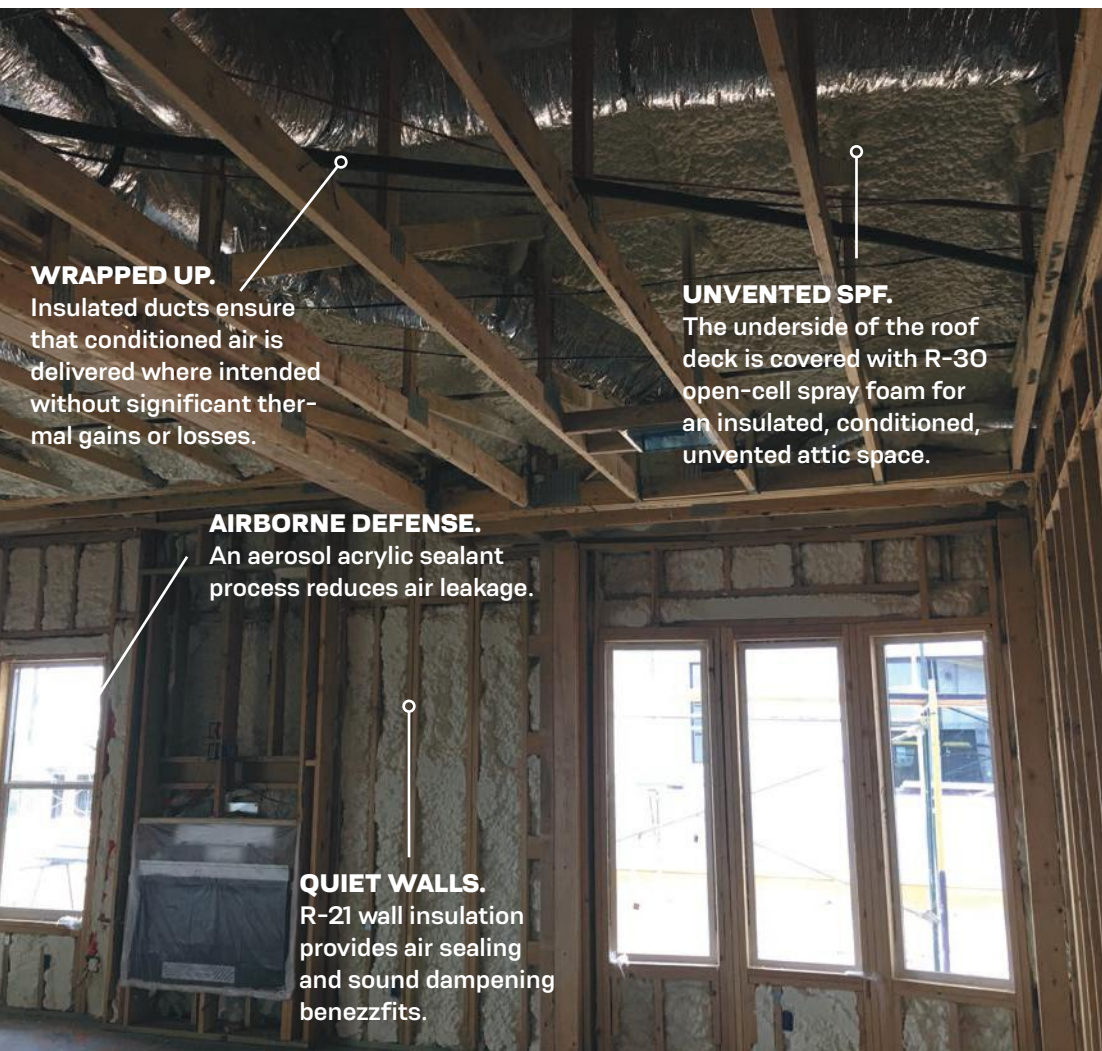
ATTRACTIVE OFFERINGS

From the moment visitors step into Mandalay’s sales offices and model homes, they are greeted with the message that “Mandalay Homes is the industry leader in energy efficiency and indoor air quality.” The numerous certifications and awards from DOE ZERH, EPA Indoor airPLUS, ENERGY STAR, and others posted throughout the sales offices and model homes back up that statement. Several customers have noted that this recognized level of excellence is something that stuck with them after a long day of home shopping.

Everson notes that a recent innovation in Mandalay’s sales offices designed to improve customer service worked in more ways than one. The company decided to go paperless by moving information about the homes to touch screen sales kiosks. With 40 or more groups going through the models daily, the sales kiosks allow customers to educate themselves until a sales rep is available. But Mandalay has found that return visitors, including realtors, home buyers, and even current Mandalay homeowners, are so enthusiastic about the homes’ high-performance features that they will often jump in to guide new visitors through the models.

Mandalay makes sure its customers get what they’ve paid for. Every home design goes through an extensive review and departmental checks before being released for construction. During construction, weekly meetings are held with the superintendents, customer care, customer experience manager, and sales team. In these meetings, the progress of the homes and the customers’ satisfaction level are discussed. The sales team also takes weekly photos of the home throughout the build. The photos keep the homeowner updated on progress, and act as an additional layer of quality control, Everson notes.

The company also employs a comprehensive in-house quality assurance program, with inspections performed at pre-slab, pre-drywall, post insulation, upon completion, and in the warranty process. Mandalay also uses a web-based collaborative construction management system. “This allows us to further improve efficiency and trade communications,” Everson says.



WRAPPED UP.

Insulated ducts ensure that conditioned air is delivered where intended without significant thermal gains or losses.

UNVENTED SPF.

The underside of the roof deck is covered with R-30 open-cell spray foam for an insulated, conditioned, unvented attic space.

AIRBORNE DEFENSE.

An aerosol acrylic sealant process reduces air leakage.

QUIET WALLS.

R-21 wall insulation provides air sealing and sound dampening benefits.



Complete coverage. TC Legends' Neohouse covers all the bases, offering green features such as graphite-enhanced SIP walls, solar panels and ENERGY STAR appliances.

PHOTOS COURTESY OF TC LEGEND HOMES.

Project Info

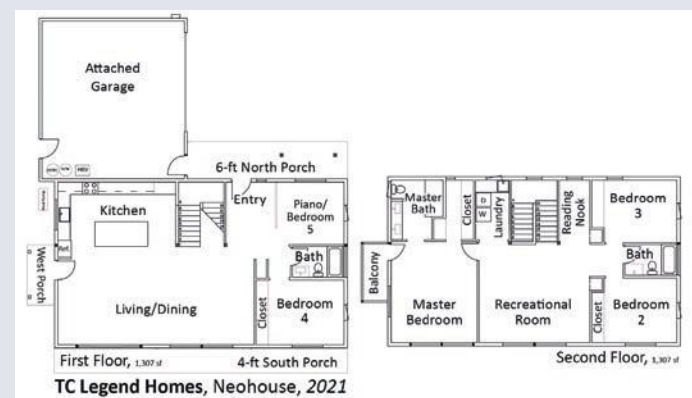
PROJECT NAME: Neohouse, Bellevue, Washington

BUILDER: TC Legend Homes, Bellingham, Washington, www.tclegendhomes.com

COMPLETED: February 2021

HERS Index: -22

This home's score with PV



Nothing Like Neohouse

TC Legend's latest effort showcases passive solar heating, an air-to-water heat pump, seismic resistance, and more.

A continuous desire to improve an already incredibly high-performance home led the way for TC Legend Homes of Bellingham, Washington, to achieve its eighth Housing Innovation Award and third Grand Award from the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) program.

Case in point: Neohouse, a four-bedroom, three-bath, 2,614-square-foot custom residential home in Bellevue, Washington, a showcase of TC Legend's sustainable features, presented during and after construction.

Over the years, this builder of custom homes in the Bellingham-Seattle area of western Washington state has perfected its tried-and-true formula of structural insulated panels (SIP) walls and roof, and an insulated concrete form (ICF) stem wall wrapping a slab foundation. But with each home constructed, builder Ted Clifton and crew seek ways to reduce waste and improve performance. That penchant for reducing waste has helped the builder trim costs to \$300 per square foot, on par with what local just-to-code builders are paying to construct market-rate homes, while TC Legend's homes routinely achieve zero energy performance scores of 10 to 20 below net zero on the Home Energy Rating System (HERS) index. These "positive energy" homes achieve enough energy savings and photovoltaic power production to run the home and an electric car or two.

Since 2015, all TC Legend homes—20

and counting—have earned DOE ZERH certification. This year's award-winning home, Neohouse, achieved a HERS score of minus 22 and should save its homeowners more than \$2,500 per year in utility bills compared to a home built to code, based on 2021 prices. Cost savings will go up as energy costs increase, notes Clifton.

OF STEMS, SLABS AND SIPS

To reduce heating and cooling loads, TC Legend Homes relies on its tried-and-true base design. A 4-inch slab is poured over 4 inches (R-20) of an EPS rigid foam product certified as zero-VOC. The stem walls around the slab are made of insulated concrete form (ICF) blocks consisting of a 6-inch reinforced concrete core wrapped with 2.625 inches of rigid foam on the interior and exterior for an R-23.6 total stem wall. TC Legend often seals the concrete slab to serve as the finished floor of the home because the exposed concrete readily absorbs passive solar heat and also easily transfers warmth from the radiant floor loops. On this home, the buyers requested hardwood flooring.

The home's above-grade walls consist of 6.5-inch (R-29) structural insulated panels (SIPs) that use a graphite-enhanced expanded polystyrene core wrapped with OSB. The walls are finished with house wrap and fiber cement siding. The roof is constructed of 10.25-inch (R-49) graphite-enhanced SIPs, topped with underlayment and asphalt shingles. Clifton notes that choosing a thicker, stronger roof panel allows the builder to use

foam inter-panel connection splines in the roof rather than lumber or I-joist splines, which have some inherent thermal bridging heat losses; and the cost of the thicker panels is offset by eliminating the cost of the I-joist splines.

SIP provide seismic category D resistance and are rated to last 100 years. SIPs also make a very airtight structure with very little thermal bridging compared to stick-frame construction. The home is slab on grade, so there is no air leakage from the floor. All SIP panel joints are double-bead mastic sealed and taped at the seams internally with 6-inch SIP tape. Windows are foamed-in and sill plates are also sealed with SIP mastic.

After the mechanical trades have completed their work and all windows and doors are sealed, the builder uses a proprietary aerosolized acrylic product that is distributed throughout the home while it is pressurized with a blower door fan to seal any remaining cracks in the building envelope. The final blower door test on Neohouse was 0.47 ACH50.

TIME-TESTED FOOTPRINTS

TC Legend Homes designs their homes with simple rectangular footprints and simple rooflines whenever possible for reduced cost and greater energy efficiency. "The TC shell system is tried and tested, has not changed over the last few years, goes up fast, and works brilliantly," Clifton says. "It is designed in-house for easy assembly and great thermal performance."

Annual Energy
Costs

\$1,300
(without PV)

\$0
(with PV)

Annual Energy
Cost Savings*

\$1,500
(without PV)

\$2,500
(with PV)

Annual Energy
Savings

12,100kWh
(without PV)

24,300kWh
(with PV)

Savings in the
First 30 Years

\$61,700
(without PV)

\$103,500
(with PV)

* vs typical new homes

Key Features

AIR SEALING: 0.47 ACH50; all SIP joints taped and sealed with double-bead mastic tape; whole-house aerosol sealant.

APPLIANCES: ENERGY STAR refrigerator, dishwasher, clothes washer.

ATTIC: No attic, vaulted ceilings.

ENERGY MANAGEMENT SYSTEM: PV production and usage monitoring.

FOUNDATION: R-23.6 Slab on grade; 11.25-inch ICF stem walls.

HOT WATER: Combi air-to-water heat pump for space and water heating, 50-gallon, 3.92 COP; electric tankless back-up water heater.

HVAC: Air-to-water heat pump with 50 percent central air handler; 50 percent radiant; 3.92 COP AC variable speed compressor; 23.02 EER.

LIGHTING: 100 percent LED.

ROOF: SIP gable roof: 10.25-inch R-49 graphite-EPS SIPs; asphalt composite roofing.

SOLAR: 12.87 kW rooftop panels.

VENTILATION: HRV; HEPA filter; CO₂ sensor, 88 SRE, 110 CFM, 32 Watts.

WALLS: SIPs, R-30: 6.50-inch graphite SIP panel (R-29); house wrap; fiber cement.

WATER CONSERVATION: EPA WaterSense fixtures; rainwater collection system.

WINDOWS: Triple-pane, argon-filled, low-e3, vinyl frame, U=0.15-0.22, SHGC=0.27-0.46.

OTHER: EV charging, accessible floorplan, doorways; no-VOC paint and cabinets.

Structural integrity. The home is constructed of SIPs, consisting of two sheets of OSB sandwiching a layer of rigid foam that help provide a continuous air and thermal barrier layer around the house.



Neohouse is designed to take advantage of passive solar heating and shading with a floorplan that is longer in the east-west direction, and puts a majority of the windows on the south sides of the house. The triple-pane windows on the south side have a U value of 0.15 and a solar heat gain coefficient (SHGC) of 0.46. In winter, sunshine can pour in the well-glazed south side of the house and heat up the floors like a thermal battery. In summer, the 2.5-foot roof overhang upstairs and full-length 3.5-foot covered porch downstairs shield windows from direct summer sun.

In addition, east-, west-, and north-facing sides of the home have fewer windows. Movable shades on the east and west windows also help prevent heat gain in the summer. Windows and doors are triple-pane glass with three low-emissivity coatings and argon fillings that reduce heat transfer, reaching U=0.15 to 0.22 depending on glass type. The home's windows are supplemented by reflective white paint to take advantage of daylight, and when the sun is down, 100 percent LED light fixtures illuminate the interior.

The solar panels are also aligned on the

south side of the house along the second floor, with space along the porch cover for additional panels. These panels power the all-electric house including the electric vehicle charging station, ENERGY STAR appliances, and air-to-water heat pump for space and water heating.

AIR QUALITY CONTROL

Mechanical ventilation is a necessity in the super-tight homes. In 2021, after another summer marked by forest fires and days of dangerously bad air quality across the Northwest, TC Legends' owner Ted Clifton and lead designer Jake Evans decided to tackle air quality issues.

The builder was already routinely installing a heat recovery ventilator (HRV) as the standard ventilation system in all of its homes. An HRV brings in outdoor air that is tempered with outgoing stale air in a heat exchanger to warm incoming air in winter and cool incoming air in the summer. TC Legends added a HEPA filter unit to the fresh air intake of the HRV that included an inline fan to pull in air that passes through the HEPA filter, which filters out 99.97 percent of particles down





to 0.3 microns.

The fan-powered filter unit is operated by the same variable speed switch that controls the home's powerful range hood fan, so when the range hood fan is on, instead of depressurizing the home or pulling in makeup air through cracks in the building envelope or an imperfect backdraft damper, just the right amount of makeup air is brought in through the HEPA filter. The incoming air is tempered through the heat exchanger on the HRV to minimize blasts of cold or hot air from the incoming air.

After some experimenting with the HEPA fan filter at our test house, Clifton was able to get the indoor air quality down to 54 micrograms/m³, when it was 217 micrograms/m³ outside [an extremely smoky day]. On a typical day, indoor air pollutants were down to 1.5 micrograms/m³. "This HEPA filtration unit is easily operated on a variable-speed switch that also controls the range hood," Clifton says. "The end user doesn't have to think about any of that mumbo-jumbo; they can just dial the ventilation up or down as needed, with the added benefit of making their range hood almost twice as effective at

eliminating kitchen odors, which is actually the worst source of indoor air pollution for atypical home."

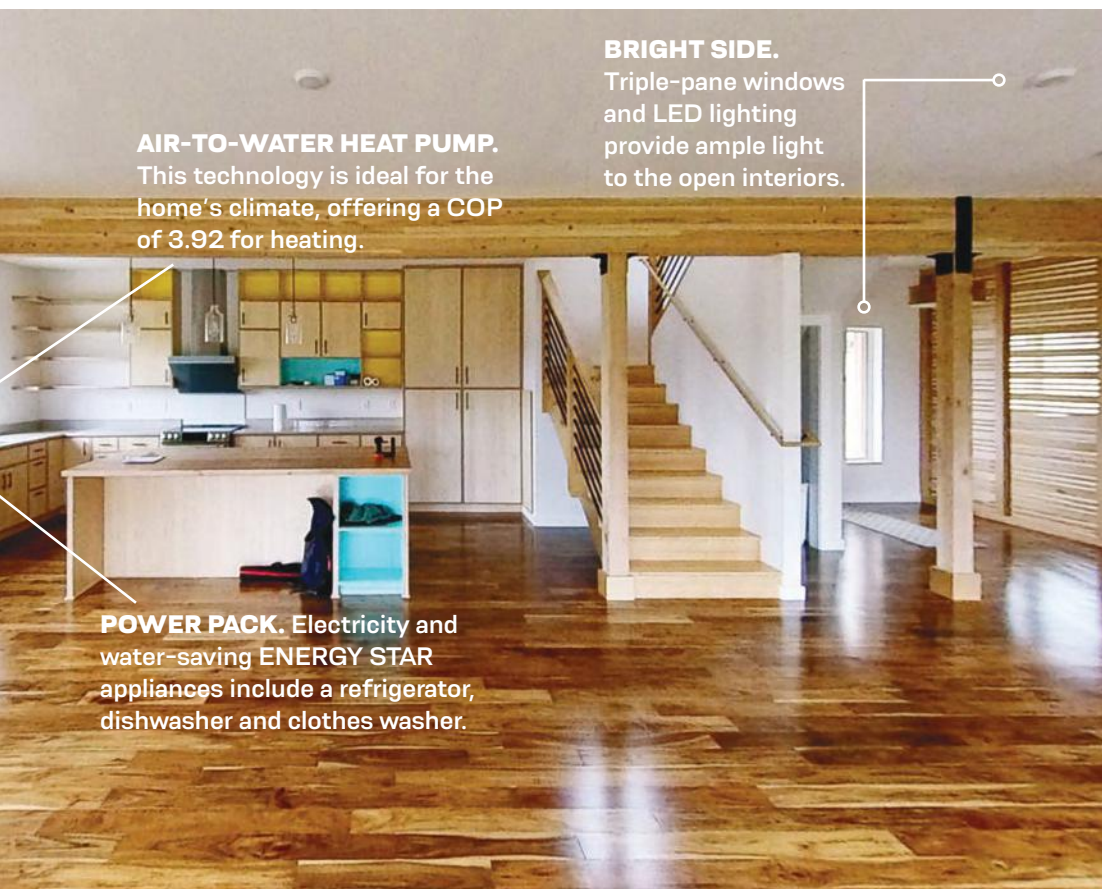
The HRV is set for continuous operation and has timer-controlled boost settings of 10, 30, and 60 minutes for the bathrooms. There is also a CO₂ sensor in the main living area that will boost the system as needed to keep CO₂ below 500 parts per million.

Although not a new feature with this home, TC Legend uses a unique heating and hot water system. The company has installed an air-to-water heat pump that provides domestic hot water with a coefficient of performance (COP) of 3.92 (i.e., the heat pump is 3.92 times as efficient at making hot water as a regular electric water heater.) Clifton notes that this is much more efficient than a "heat pump water heater." It has the added benefit that the compressor and fan are located outside, so it is not pulling heat from the air inside the home and it is keeping the fan noise outside as well.

This air-to-water heat pump also provides space heating to the home with a COP of 3.92 for heating, and 6.75 for cooling. "This is the most efficient way to heat and cool a house for our climate, that I have been able to find," Clifton says. The heat is delivered hydronically via radiant floor loops downstairs and a fan coil unit upstairs, as well as via a heating unit in the supply side of the heat recovery ventilator (HRV).

The house is designed for aging-in-place with a bedroom and full bath on the first floor. Doorways on this floor are sized to ADA specifications and an oversized entry and music room can be repurposed as an additional bedroom for potential live-in care.

Overall, the homeowners are amazed. "We are loving our new home," one owner says. "It's still almost unbelievable to us how airtight it is in here. It's so quiet inside, we barely hear any exterior sounds...We definitely underestimated the amount of light and heat that would come in, both on the west side alone and in the home overall. It is so bright in here. I love it!" **GB**



AIR-TO-WATER HEAT PUMP. This technology is ideal for the home's climate, offering a COP of 3.92 for heating.

BRIGHT SIDE. Triple-pane windows and LED lighting provide ample light to the open interiors.

POWER PACK. Electricity and water-saving ENERGY STAR appliances include a refrigerator, dishwasher and clothes washer.

First Look

Here are the homes up for top honors at DOE's 2022 Housing Innovation Awards.

BY GREEN BUILDER STAFF

For 10 years, the U.S. Department of Energy's annual Zero Energy Ready Home (ZERH) Housing Innovation Awards have honored the very best projects that are headed to net zero. The awards also recognize forward-thinking builders who are delivering a better experience to American homebuyers.

Winners of this year's competition were selected for each of six main award categories in August, and a Grand Winner was announced from each category during the **Energy & Environmental Building Alliance High Performance Home Summit** in September (results were not available at press time).



Eleven time winner? Thrive Home Builders seeks its 11th straight Grand Winner award in DOE's 2022 competition. Shown here is Thrive's 2021 winner from its Vitality Collection in Denver. COURTESY OF THRIVE HOME BUILDERS.

Affordable Homes

HABITAT FOR HUMANITY NORTH CENTRAL CONNECTICUT,
Hartford, CT

**ENERGIZE DELAWARE AND ZEMOD PROGRAM AND
BERACAH HOMES**, Greenwood, DE

Attached Homes

GARBETT HOMES, Salt Lake City, UT

K. HOVNANIAN NORTHEAST DIVISION INC., Edison, NJ

MCSTAIN NEIGHBORHOODS, Denver, CO

Custom Homes for Buyer (less than 2,500 square feet)

CLIFTON VIEW HOMES, Coupeville, WA

FORGE CRAFT ARCHITECTURE + DESIGN, Austin, TX

RED TREE BUILDERS, Asheville, NC

TC LEGEND HOMES, Bellingham, WA

UNDER THE SUN BUILDING AND REMODELING,
Greenwich, NY

More about these award-winning homes
may be found at the **DOE Tour of Zero** site:
energy.gov/eere/buildings/doe-tour-zero

Custom Homes for Buyer (more than 2,500 square feet)

ENERGY VISION HOMES, Hollis, NH

SCOTT NORMAN LLC AND WATERSHED, Fairhope, AL

S.D. JESSUP CONSTRUCTION, Pilot Mountain, NC

STOCKELL CUSTOM HOMES, Eureka, MO

TIM O'BRIEN HOMES, Pewaukee, WI

ZERO NET NOW, Esopus, NY

Custom Homes on Spec

C & B CUSTOM HOMES, Cottonwood, AZ

CHARIS HOMES, North Canton, Ohio

SCC GROUP AND WATERSHED, Fairhope, AL

Production Homes

HEALTHY COMMUNITIES, Williamsburg, Virginia

INSIGHT HOMES, Bridgeville, Delaware

K. HOVNANIAN NORTHEAST DIVISION INC., Edison, NJ

MANDALAY HOMES, Prescott, Arizona

PROVIDENCE HOMES, Jacksonville, FL

THRIVE HOME BUILDERS, Denver

WOODSIDE GROUP, Salt Lake City, UT

Empower your clients with Smart, Healthy Homes for good indoor air quality

Panasonic has created a simple yet robust ventilation strategy to help builders deliver healthy homes. Swidget smart controls and mobile app pair with Panasonic ventilation products to monitor, detect and auto-activate the proper fan when unhealthy air and moisture are detected. Removing harmful contaminants ensures homeowners breathe the highest quality air around the clock.

Monitor. Detect. Auto-activate. It's that simple and that effective.

Choose a Swidget sensor to monitor

 Motion
  Temperature
  Humidity
  Air Quality



SWIDGET
POWER TO LIVE SMART

Learn more about breathing fresh air into your ventilation projects, visit SmartHealthyAir.com



AS SEEN ON
HOLMES
FAMILY RESCUE



THE GREAT MILLENNIAL MIGRATION

Millennials are on the move—out of state, into their first homes, and taking advantage of remote work. More than half of remote workers are millennials, and they're also nearly 50 percent of all homebuyers.

BY MICHELE LERNER



For Kristen Fulmer, a sustainability team leader for the Oak View Group, which owns and operates sports and entertainment venues, working from home in the early days of the pandemic—beside her husband and their cat in a one-bedroom apartment in Harlem, New York City—was nearly impossible.

"My husband didn't have explicit permission to move, so at first we kept our apartment while we stayed in an Airbnb in Portland, Maine," says Fulmer. "We soon realized our New York apartment wasn't worth the rent, so we sold everything, moved in with family for a bit to save money, and then bought a house sight unseen in Portland."

The couple paid well over asking the price for its small single-family home and won out over nearly two dozen other offers.

"This is not the ideal house, and it's not in the ideal neighborhood, but we think it's a good investment at our price point," says Fulmer. "The main issue is that it has horrendously expensive oil heat, so we're installing high efficiency heat pumps and air conditioning. Sadly, houses in Maine now need air conditioning because of climate change."

Fulmer and her husband are just one example of millennial migration patterns. Millennials and members of the Gen Z generation are not only moving out of state in greater percentages than current baby boomers and Gen Xers, they're also moving more often than those generations did when they were in their 20s and 30s, according to **research by TransUnion** credit reporting agency.

WHERE MILLENNIALS ARE MOVING

While plenty of millennials are exploring new locations all over the country in small towns and major cities, a recent **study by Commercial Café**, a commercial real estate listing service and division of Yardi, a real estate software provider, found that the percentage of millennials is largest in Austin, Texas; Seattle; Denver; and Salt Lake City. In those locales, millennials represent from 16.4 percent to 17.4 percent of the population.

The millennial population grew the fastest between 2016 and 2020 in Seattle, Austin, Denver, Nashville, Tennessee, Raleigh, North Carolina, Columbus, Ohio, San Jose, San Francisco, Boston and Salt Lake City, according to the study.

MILLENNIAL PRIORITIES

When it comes to choosing where to live, millennials' top priorities include a healthy home, proximity to open space and trails, affordability, a high-quality and safe neighborhood, quality schools, resiliency to climate change impacts, and proximity to activities, according to COGNITION Smart Data from Green Builder Media.



ON

City seekers. In terms of population percentage, more millennials live in Austin, Texas, than anywhere else in the U.S. Nearly 1 in 6 residents were born during the last two decades of the 20th century, with most coming from places that were more expensive, culturally restrictive, or less “exciting.”

CREDIT: SBMEAPER1/Flickr

HOAs

Should you buy in?



Whether they love them or hate them, more than **74 million people** live in a community with a homeowner's association (HOA). While some people resent HOA restrictions on their property rights, others appreciate the group's advocacy role against absentee landlords and annoying neighbors. For homebuyers, it's important to review HOA rules to see if they can live with them and evaluate what they get for their association fees.

PROS OF HOAS:

- Shared amenities such as a pool or sports courts.
- Shared expenses for trash pick up, snow removal and road maintenance.
- Guidelines for aesthetics that may increase home values.
- The association can function as a mediator between neighbors.
- An HOA can set rules to benefit the community, such as minimizing investor owners.

CONS OF HOAS:

- Dues can be costly and will always go up.
- Special assessments can be levied for big projects.
- Overly restrictive rules can impact a home business or homeowner preferences.
- Board leaders can overrule homeowner rights to make changes to their property, park their vehicles, and operate a home business.
- HOAs can ignore the rights and interests of renters in the community.

When Max Rohr, education and industry engagement manager at Caleffi Hydronic Solutions, suddenly had the opportunity to work from anywhere, he and his wife opted to leave the expensive Washington, D.C., area for Salt Lake City.

"We sacrificed the museums and cultural life of D.C. to get more access to open space, and to be able to buy a less-expensive house that's also newer and nicer than what we could afford in the Northern Virginia suburbs," says Rohr. "Salt Lake City offers enough of a city that there are events, museums, restaurants, and parks to enjoy, so it's not exactly off the grid, either."

Rohr and his wife bought a three-story townhouse built in 2018, a property which would have been out of their price range in the D.C. area. They both work remotely and now have a child. Rohr says day care costs would have been extremely expensive in D.C., which was recently identified as having the highest childcare costs in the country.

According to a recent Realtor.com survey, the top four reasons millennials plan to buy a home this year include the need for more space; wanting to build equity; an expanding household with a partner, kids or parents; and the desire for outdoor space. Among millennials, 40 percent plan to move within their current city or town and 22 percent plan to move to a nearby town, while 20 percent plan to move to a city or town in a different part of their state or to another state. Among those moving away, the top reason is for a lower cost of housing.

For Climate First Bank Marketing Director Holly Bridwell and her partner, moving from Mississippi to Orlando, Florida, was an opportunity to escape a place that didn't match her lifestyle or her political values.

"My partner and I compromised on the location of the single-family home we bought because I wanted to be in downtown Orlando and she wanted to be farther out," says Bridwell. "But we both agreed we wanted an opportunity to renovate and add value to the house."

Bridwell and her partner plan to do most of the renovations throughout the 2,000-square-foot house, including replacing the carpet with new floors, opening the floor plan, redoing the primary suite, and eventually upgrading the kitchen.

"The roof is just three years old, so we can add solar without replacing it," Bridwell says.

Where the Millennials Are



As the new generation of decision makers starts to take hold, they're looking for somewhere to make their home base. The 72 million members of the millennial generation can be found primarily in the suburbs of the nation's largest cities. But according to [CommercialCafe.com](#), there are 10 metropolitan markets favored by millennials now and in the near future, based on factors such as population growth rate, household income, and education level:

Rank	Metropolitan market	Millennial population growth rate, 2016-2020	Millennial as a percentage of total population	Median household income	Percentage with a Bachelor's degree or higher
1	San Jose, California	8.0 %	16.2 %	\$150,806	61.4 %
2	Austin, Texas	12.8 %	17.4 %	\$84,921	49.1 %
3	Seattle, Washington	13.7 %	17.0 %	\$100,953	48.7 %
4	Salt Lake City, Utah	4.7 %	16.4 %	\$81,427	37.4 %
5	San Francisco, California	6.5 %	16.3 %	\$133,778	58.9 %
6	Denver, Colorado	12.8 %	16.9 %	\$88,772	47.8 %
7	Nashville, Tennessee	11.0 %	15.5 %	\$72,919	44.5 %
8	Raleigh, North Carolina	10.3 %	14.3 %	\$83,792	52.4 %
9	Columbus, Ohio	8.8 %	15.7 %	\$72,775	42.6 %
10	Boston, Massachusetts	6.4 %	15.1 %	\$106,661	60.0 %

SOURCE: CommercialCafe.com



Living room. The top reasons that millennials plan to buy a home include the need for more space for partners, kids or parents.

Dream home. Many first-time homebuyers opt for existing houses which require upgrades or repairs. Renovation experts can help buyers tackle those projects in the smartest order by incorporating price, sustainability and return on investment (ROI).



What do millennials want most, when they buy a home?



Convenience is key. Millennials place health, proximity to open space, location and affordability as major determining factors in home purchases.

SOURCE: COGNITION SMART DATA

ARE MILLENNIALS CHANGING THEIR COMMUNITY OR ADAPTING TO IT?

Whether they're moving to a city popular with millennials such as Orlando, a smaller town like Portland, Maine, or to a mid-size city like Salt Lake, younger homebuyers are changing the demographics in each place. But are they changing the priorities of those communities?

"Orlando is progressive compared to Florida overall and it's becoming one of the most sustainable cities, too," says Bridwell. "The people we know here are all working towards the same things. It can be an uphill battle politically, but it's easier than trying to make a difference in Mississippi."

About half the people Bridwell meets are not originally from Orlando. This makes the city a place that's open to change, she notes.

Fulmer says more people have moved to Portland (Maine) from out of town over the past five years.

"The locals say, 'you're from away' if you didn't grow up here," says Fulmer. "Definitely they resent it that the out-of-towners have driven up prices here, especially people from New York."

That's problematic. For example, the town has more breweries and restaurants downtown now that more millennials live there. But locals avoid the downtown area, especially during tourist season.

"Climate change has already made Portland less cold in the winter and warmer in the summer," says Fulmer. "The water temperature in the bay has changed dramatically, too. The locals are very aware of climate change because of this, which is something they have in common with most of the younger new people moving here."

In Salt Lake City, Rohr says the neighbors are a mix of people who grew up in the area, people who went to college in the city and remained, and others who've migrated to the area from out of state.

"Utah has a very White demographic, but Salt Lake City is surprisingly multicultural," Rohr says. "Especially downtown, near the University of Utah, where you get people from all over the world and have diverse kinds of restaurants."

Rohr's neighborhood is primarily filled with young families with parents who work remotely and enjoy hiking and biking.

"But Utah has a lot of work to do on sustainability," Rohr says. "Utah hasn't been built around using its resources wisely, especially water. But that's starting to change a little with things like local incentives for xeriscaping."

Rohr isn't sure if that has anything to do with the popularity of Salt Lake City among millennials. But, given the focus on sustainability among that age cohort, it can't hurt. **GB**

HOW MUCH RISK IS TOO MUCH?



Great responsibility. Buying a home is the biggest financial commitment that a person can make. Not accounting for the cost of homeownership is one of the worst mistakes.

Double-digit home price increases and rising mortgage rates are tilting monthly housing costs to dangerously high levels for some buyers. Here are some ways to avoid making a big financial mistake:

Make a budget. Most lenders want to see a borrower's total debt-to-income ratio (the minimum payment on all recurring debt, such as credit cards, compared to the monthly gross income) below 40 percent, says Brian Leslie, director of financial planning for Edelman Financial Engine in Omaha, Nebraska. The housing portion (mortgage principal and interest, property taxes, and insurance) typically must be below 30 percent. "If your housing expense is so large that it's keeping you from saving at least 10 percent of your gross income for retirement, then it's probably too much," Leslie says. He suggests budgeting based on a 15-year loan and then taking out a 30-year mortgage for the extra flexibility.

Avoid ARMs. A 30-year, fixed-rate mortgage is generally the best choice, because it's easier to budget when you know your principal and interest payment for the next 30 years, Leslie says. "An adjustable-rate-mortgage (ARM) is an option that can be useful if you're not planning on being there for more than seven years," he says. "But if you're not planning on being there for very long, you need to consider whether buying is the best option in the first place."

Be ready for more bills. Failing to realize the total costs of ownership is one of the biggest financial mistakes people make, Leslie says. Ongoing expenses such as homeowner's insurance, maintenance, HOA fees, parking, and upkeep eat into a buyer's monthly budget, and they are rising. For example, the average annual homeowner's insurance bill for a \$300,000 house is \$2,305, according to Insurance.com, but rates are higher in states such as Oklahoma, Kansas, Florida, Texas, Arkansas and Mississippi, and depend on multiple factors.

Weigh the utility burden. Many people are surprised at the cost of utilities. For example, it costs a lot more to heat a three-bedroom home than a two-bedroom apartment, says Leslie. A prospective buyer should determine in advance whether a house has a modern heating, ventilation and air conditioning (HVAC) system, or an old furnace that burns through a small fortune in fossil fuels every winter.

Don't rely on the bank of "Mom and Dad." Leslie recommends against parents providing the entire down payment for their kids. "If the child is unable to save for a down payment on their own, the parent may only be masking the real problem," he says. Instead, Leslie suggests that parents match their adult kids' savings to provide them with a boost, yet teach them to budget and save.



Seeing is believing. The VISION House at Mariposa Meadows demonstrates the benefits of net zero, small footprint, resilient, healthy, and high-performance building.



Elevated Elegance

The VISION House at Mariposa Meadows, the latest in Green Builder Media's VISION House Series, is a stunning net zero compound high in the Southern Colorado mountains.

STORY AND PHOTOS BY SAMANTHA CARLIN

Majestic fall has arrived at Mariposa Meadows, a high-alpine paradise at 10,000 feet in the San Juan Mountains of Colorado near Telluride. The trees are putting on a colorful display, and the project's finishing touches are wrapping up.

Located in the remote Gunnison National Forest, this off-grid, net-zero compound will demonstrate the art of the possible with respect to small-footprint, cost-effective, resilient, healthy, high-performance building.

According to Ron Jones, president of Green Builder Media, and owner and builder of [VISION House at Mariposa Meadows](#), it all started with the land. Mariposa Meadows is defined by a high alpine meadow surrounded by aspen and spruce forests.

"Since the property is so majestically wild and pristine, we have been extremely careful to leave as much as possible untouched," Jones asserts. "There is nothing that we could do to improve upon Mother Nature's work." Each building in the compound is deliberately designed to leave as light of a footprint on the ecosystem as possible.

"To execute a successful project, one capable of matching the sometimes extreme conditions there, our design approach and product selections are of paramount importance," Jones asserts.

Jones and his team selected products that were market-available, and could showcase the long-term economic value of sustainable design and building.

"Some of the high-performance materials we selected had a higher upfront cost than conventional products," Jones

says, “but if we’re just using the lowest upfront cost as our valuation metric, we’re missing the point.” Everything featured at Mariposa Meadows has been intentionally chosen to optimize the energy efficiency, water conservation, indoor air quality, intelligence, and resiliency of the compound. This will not only enhance the performance and comfort of the structures, but also yield substantial cost savings over time, Jones notes.

“Part of our goal at Mariposa is to bust the outdated myth that green buildings are unattainable for average American families and only for the wealthy,” Jones adds. “That may have been a valid argument years ago, but it’s just not true anymore.”

Jones insists that if he can build ultra-green homes in the most-remote county in the lower 48 at 10,400 feet elevation, they can be built in any urban, suburban, or rural setting.

FOUNDATION CONSTRUCTION FACTS

The project’s three structures—Aspen Cabin, Atrium Duet, and Iris Studio—feature foundations constructed from **insulated concrete forms** (ICFs), and walls and roofs made from **structural insulated panels** (SIPs) placed on a carefully prepared site. These durable building envelope systems offer extreme energy efficiency and durability.

Jones opted for **James Hardie fiber cement siding** and **trim**. The vertical board-and-batten product is fire resistant and durable, while its solid color qualities and dimensional stability eliminates cracking or peeling. James Hardie offers the siding prefinished with *ColorPlus* technology, giving Jones 25 colors to choose from and the promise of low maintenance even with the project’s high elevation, severe weather and intense ultraviolet rays.

For the roof, a **standing seam metal roof from Fabral** provided the best benefits for the project. It was chosen for its wildfire risk mitigation, resiliency, and durability properties. Jones designed the project so that there would be no penetrations in the roof, thereby optimizing energy efficiency.

The **masonry veneer wainscoting** by Creative Mines uses natural pumice pozzolan in its 70 percent post-industrial recycled content, replacing smokestack-produced fly ash.

Grundfos pumps will efficiently deliver hot and cold water to and from the homes. The combination of submersible pumps, **UPS 26-99** and **UPS 15-58** are three speed circulator pumps designed for heating and air conditioning systems.

OFF-GRID ENERGY EFFICIENCY

Since Mariposa Meadows’ closest grid infrastructure is nearly 20 miles away, self-sufficiency is necessary. Therefore, the electrical needs of the structures will be provided by an impressive array of JinkoSolar **bifacial solar photovoltaic panels**, along with a Blue Planet Energy **battery storage system** with Schneider Electric **inverters**. To complement the solar and storage system, Kohler is providing a **generator** for backup power.

Jones says he sought out Euroline Windows **products** because they allow for large expanses of glass without sacrificing overall energy performance, and the **tilt-and-turn hardware** allows for controlled ventilation. “We have triple glazed R-10 efficiency, and the stability of inside temps is amazing,” he boasts. “Also, they cut out almost all noise from outside.”

Similarly, Jones specifically chose a Clopay **garage door** for added energy efficiency and resiliency from the weather.



Grid be gone. Mariposa Meadows utilizes a solar array, battery storage system and backup generator to meet its electrical needs.



A natural VISION. Salvage lumber is used throughout the house to create a unique dining room table, nightstands, bed frames and more.

The door is insulated with *Intellicore* insulation technology and operates to keep the heat inside. The durable garage door ensures protection against 100 mile-per-hour winds.

For energy demand minimization, all appliances are from *Whirlpool*, a leader in energy and resource efficient appliances and corporate *environmental, social and governance* (ESG). Jones has confidence that products such as ranges, dishwashers and refrigerators will perform without overloading the solar array and battery system.

Regarding the heat source, Uponor's *in-floor radiant heating system* efficiently warms the buildings when the outside temperature can plunge below negative 20 degrees Fahrenheit. The serpentine tubing runs under the foundation circulating hot water throughout the thermal mass, preserving heat and energy.

Uponor is also providing the *AquaSAFE fire suppression system*. The combined plumbing and fire sprinkler unit is heat activated to provide extra time when a smoke detector isn't enough to wake up inhabitants at night.

Indoor air quality (IAQ) is top of mind due to COVID-19 and the rampant wildfires in the West. The VISION House at Mariposa Meadows will utilize Panasonic's *WhisperGreen* ventilation fans and *energy recovery ventilators* (ERVs) to ensure energy-efficient spot ventilation, as well as whole-building fresh air exchange.

NATURAL HOME DETAILS

The unique finishes and bold grain of Aronson Woodworks *furniture* will add to the natural aesthetic of VISION House at Mariposa Meadows. The company upcycles millions of ash trees cut down due to the infestation of the emerald ash borer beetle. The hand-finished *pieces* with contrasting paints and centuries-old wood joinery techniques are sealed and preserved by the low-VOC glaze. This finishing technique helps Aronson Woodworks' *furniture* stand the test of time.

Similarly, *Deadwood Revival's* mission is to salvage urban lumber and create exquisite furniture. Beds, nightstands and dining room tables are handcrafted using lumber destined for the landfill. These masterpieces celebrate each tree's unique character while storing carbon and giving a second life to quality lumber.

Lee Industries will round out the *furniture* at the homes, providing non-toxic *pieces* meant to last. The company uses water-based finishes and a barrier fabric for smolder-promoting properties instead of harsh chemicals, which both help to increase IAQ. They are also dedicated to reducing carbon emissions and supporting local economies.

The beautiful window sills and wide panel wood floors are from *Delta Millworks*. The colors at VISION House at Mariposa Meadows range from light brown to blue. The company is committed to a sustainable supply chain, waste reduction and the use of reclaimed wood.

INTERIOR FINISHING TOUCHES

Fresco Harmony's gypsum-based [wall finishes](#) elevate the design and create a fresh atmosphere. The product infuses color into drywall clay, minimizing the emissions generated during the transportation process. This solution is a cost-effective way to achieve custom walls. At VISION House at Mariposa Meadows, the light blue accent walls open up the space, and create depth and movement.

The VISION House at Mariposa Meadows boasts an incredible 1,400-square-foot [deck](#) by Trex, which includes a stunning [pergola](#) and artistic [railing](#). The deck extends the living space into the outdoors, creating a deeper connection to nature. The expansive deck is a composite material, a mixture of wood and plastic, to create an impenetrably durable surface to be enjoyed for generations to come.

[TruStile](#) doors bring a unique touch to the homes, with accents like leather, glass and copper inserts. The company is dedicated to including high recycled content with its products, and also sources FSC-certified lumber and specifies low-VOC glues for assembly, for a healthy indoor environment.

The newest upgrade to the project has been the long-awaited Caesarstone [countertops](#). Caesarstone's raw quartz countertops are molded with resin and pigments to create a uniquely natural design. These nonporous, stain-resistant,

heat-resistant, scratch-resistant and easy-to-clean countertops are ideal for this multi-use retreat.

Crossville Tile has been used for bathroom flooring at VISION House Mariposa Meadows. These beautiful [porcelain tile floors](#) have a subtle texture and are impervious to moisture and resistant to tread wear and slip. Crossville Tile also has a porcelain tile recycling program and includes recycled content in their products.

After the countertops were installed, Kohler's plumbing fixtures finished out the kitchens, bath, and laundry to perfection. The satin nickel faucets, showerheads and [accessories](#) used throughout the structures are sleek and elegant, and the [large single-basin apron sinks](#) are functional and beautiful.

The [toilets](#) include a dual flush system to reduce unnecessary water use. Shower wall set and sliding doors, shower heads with [arm and flange](#), and grab bars make the bathrooms at Mariposa Meadows accessible and safe. The [vanities](#), utility sinks and convenient [accessories](#) round out the stylish Kohler offering. **GB**

Check out the [VISION House Mariposa Meadows website](#) and watch for updates as Ron Jones and his crew complete this magnificent, off-grid project over the next few months.



Long-lasting beauty. An extra-durable Caesarstone countertop, attractive Kohler satin nickel faucet and energy-efficient Whirlpool appliances help create a kitchen that will remain stylish for years to come.

TRANSCEND

HOME  EVOLVED



New millennial lifestyle. Transcend Communities offers a blend of sustainable housing, shared garden space and creative areas for a completely healthy way of living.

Transcend Communities Aim to Transform Housing

BY MICHELE LERNER AND MATT POWER

A prototype modular home will be sited in rural Colorado this fall, but the bigger goal is to breathe life into new communities nationwide.

Trascend, a series of sustainable communities developed through a partnership between Green Builder Media and California-based prefab homebuilder Dvele, hopes to demonstrate a new approach to U.S. homebuilding and performance.

Featuring precision-built, ultra-high-performance, healthy, connected, and resilient Dvele homes, Transcend Communities offer a bold approach to sustainable development. Working from a baseline of net-zero homes and energy-smart infrastructure, this new hybrid approach to development addresses the personal, economic, social and environmental design imperatives that can fashion neighborhoods,

not just homes, where people will want to settle down for generations.

"After several years of searching for just the right prefab home builder partner, Green Builder Media has joined forces with Dvele to create Transcend Communities and the prototype VISION House Transcend," notes Sara Gutterman, CEO of Green Builder Media. "We couldn't be more excited."

As far as the homes go, "we set out to create a product that is a high-efficiency and healthy, a fully electric, self-powered home," says Kurt Goodjohn, CEO of Dvele. "We monitor every aspect of the performance including health and wellness and use precision engineering to build every module."

The homes have a solid building science story right off the factory floor, so develop-



Prefab perfection. Transcend's design and manufacturing process results in a home that is 87 percent more energy efficient than the average site-built home.

ers can focus on macro amenities in each community, literally plugging in homes to suit as the rest of the community plan takes shape. The key difference between Transcend Communities and the typical “greenfield” development: human scale.

“We’re bringing years of real-world construction experience in the high-performance sector of housing to the table,” says Gutterman. “Plus expertise from our many contacts in the development, finance and architecture fields.”

DESIGNED FOR REAL LIFE

Built at a right-sized scale, Transcend Communities offer residents easy access to greenspace, walking trails and bike paths. With many transportation modes to choose from, autos become optional amenities, because the community itself is a destination.

No one is left behind in a Transcend master plan. For the kids (and their guardians), example amenities include splash pads, innovative playgrounds made from sustainable materials and flexible ballfields. For all ages, there are picnic areas, community gardens, coworking areas, and community centers.

WORK-FRIENDLY RESIDENTIAL LIVING

Remote workers will feel instantly at home in a Transcend Community, but designs also make space for small business owners and shops, along with traditional service providers.

The goal is not to create a commercial street, but to encourage “hybrid” business models that can operate with both a virtual and sticks and bricks façade. Special two-level net-zero modular buildings on “main street” include live-work spaces on the bottom floor and ample space for delivery trucks.

SOCIALLY INVITING LIFESTYLES

Homes and shared assets encourage coming together as a community, sharing garden space, entertainment areas and creative spaces, and at the same time create compact havens of privacy for each home. Easy-to-use online booking systems allow residents to “rent” out the com-



Nature walk. Trails and greenspaces allow residents, visitors, and pets to connect with nature every day.



All about amenities. Transcend Communities will include numerous amenities to make living there easier and greener—such as bike self-repair stations, which can encourage residents to cut down on use of carbon-emitting vehicles.



Choice offerings. Buyers will be able to choose among several base modules and customize their homes for their lifestyle, preferences and climate.

munity’s communal spaces for an evening or a day at a nominal cost if they want to have a party, wedding or fundraising event.

Most of the time these amenities are included in a modest monthly fee that goes toward long-term maintenance for the whole community. A built-in theater presents monthly educational sessions on environmental topics as well as other entertainment options. Guest lectures keep residents of all ages engaged and active.

POWERED BY A MICRO GRID

Although each community differs somewhat, the principle of “net-zero-plus” performance serves as a foundational benchmark, which means that the total energy used by the community is produced onsite with renewable energy (primarily community solar, battery storage, and demand-side energy management systems), to the point where a surplus of power can be shared with nearby communities.

Geothermal and heat pump heating and cooling technologies are deployed, along with passive solar siting, and of course, innovative modular homes that arrive on site with a net-zero impact balance sheet.

NET ZERO CARBON-AND MORE

Transcend Communities will create the lightest possible footprint. For example, leapfrog technologies like atmospheric generators (which capture water out of the air for potable uses) will be used to achieve

net zero water, and products will be specified based on Environmental Product Declarations (EPDs), Life Cycle Assessments (LCAs), embodied carbon calculations, and corporate Environmental, Social, and Governance (ESG) policies.

OTHER HOMEOWNER AMENITIES ARE LIKELY TO INCLUDE:

- Composting centers
- Recycling bins
- Natural shading from trees and landscaping; cool roofs
- Pet areas and dog walks
- Self-repair stations for bikes
- Solar charging rest stops
- Shared transportation with self-driving buses, community electric vehicles (EVs), and e-bikes
- Lawn alternatives (to minimize mowing) and/or electric/manual mowers
- Onsite telehealth offices with virtual doctor appointments available 24 hours a day

The shortage of housing in the U.S., estimated by [Freddie Mac](#) at 3.8 million missing units, doesn’t include the millions of outdated, energy inefficient homes that need renovation or replacing. Yet the technology to



Air freshener. Transcend’s design includes ventilation to extract air from kitchens, bathrooms, laundry rooms and hobby spaces.

build smart, energy efficient, healthy, resilient homes is available. That technology just needs a coalition of companies to provide these options to homebuyers throughout the country.

ABOUT THE HOMES

Dvele's factory currently produces about 220 modules for 70 homes per year, but demand for their modular homes has increased dramatically, and the company is scaling up its manufacturing capabilities rapidly.

Goodjohn says Dvele's system of designing and manufacturing homes is a good match for the partners' shared goal of a better future.

"Our philosophy is that housing is everything, so if you can create a better house, you can improve quality of life," says Goodjohn.

Beyond the features and benefits of the homes, the Transcend initiative will contribute to decarbonization: Green Builder Media and Dvele will plant 10,000 trees for every Transcend home that is built in the future.

PREFAB HOUSING MEETS ITS MOMENT

The era of prefab construction is here, says Gutterman.

"Building high-performance homes in factory conditions with precision engineering is especially important, given labor and material shortages and soaring construction costs," says Gutterman.

Prefab housing used to be thought of as glorified manufactured housing, says Goodjohn, but now it's become more acceptable.

"You don't have car parts dumped in your driveway, and have someone build your car, so why would we continue to build houses that way when we don't need to?" says Goodjohn. "Transcend is a perfectly calibrated product that we've designed and built on the Dvele platform."

The first Transcend demonstration model will be built in Lake City, Colorado near Telluride, and will include significant upgrades to showcase an aspirational version of the house. Buyers will be able to choose among several base modules and customize their homes for their lifestyle, preferences and climate. Dvele can make design and product suggestions for buyers based on their climate and lot configuration. Builders and developers will also be able to purchase Transcend modules, to create communities of these homes.

Transcend's design and manufacturing process results in a home that is 87 percent more energy efficient than the average site-built home, says Goodjohn. The factory setting for the modules reduces materials waste, and the goal is to have the modules delivered to each home site by electric vehicles.

"This is a self-powered home that takes a conservation-first approach to energy and solely uses electricity," says Goodjohn. "Then, we layer on solar panels and battery storage. You can't just slap solar panels on a home and call it self-powered; you must start with the building science and materials that create an energy efficient home in a factory-controlled environment."

Health and wellness are also prioritized in the design of Transcend, including ventilation to extract air from kitchens, bathrooms, laundry rooms and hobby spaces. Fresh filtered air from the outdoors is brought into the living and sleeping areas throughout the home with energy recovery ventilation (ERV) units.

The VISION House Transcend will feature:

- Ground-source heat pump air and water heating technologies with radiant heating and cooling by Uponor
- Energy and water saving electric appliances by Samsung and Dacor, including an induction cooktop and heat pump dryer
- Water conserving plumbing fixtures by LIXIL-owned companies GROHE and American Standard
- Super-efficient windows and exterior doors by Arq-Espacio
- High performance insulation by ROCKWOOL
- Whole-home indoor air quality system by Broan-NuTone
- Solar photovoltaics, inverters, and batteries by JinkoSolar
- Smart electrical system and EV charging station by Schneider Electric
- Air and water barriers by PROSOCO
- Sustainably manufactured antimicrobial and slip-resistant tile by Daltile
- Beautiful and sustainable quartz countertops by Caesarstone
- Innovative speakers and sound solutions by Sonos
- Sustainably harvested engineered wood floors by CRAFT
- High-design, sustainably manufactured doors by TruStile
- Elegant natural furniture by Lee Industries
- High-style cabinets by Norelco
- Temperature and humidity mitigating drywall by USG



The Transcend house, to be built along the San Juan River in Colorado's San Juan Mountains, will include extensive water conservation measures among its other sustainable features.



The dwelling will be sited for maximum passive solar gain as well as optimal solar panel efficiency.



The house will be built with light gauge recycled steel, with high fire ratings for resilience to fires, extreme temperatures and storms.



"We work with manufacturers and suppliers who list every ingredient in their products, so we know they are healthy, non-toxic and non-polluting for better indoor air quality," says Goodjohn. "We monitor indoor air quality, so the ventilation system automatically kicks in to introduce fresh air when a certain threshold is reached."

Particulate matter, volatile organic compounds (VOCs), mold, formaldehyde and other toxins are thus eliminated from the house. In addition, the homes have radon detection systems. Wellbeing is also enhanced with biophilic design, water filters throughout the house, sound attenuating materials for a quieter home, and a Circadian rhythm lighting system that is designed to mimic the human biological clock.

BUILT-IN INTELLIGENCE

Transcend's next-level smart home features optimized energy efficiency, safety and a healthy home.

"There are about 300 sensors in every home to monitor energy efficiency, provide energy and water use data and healthy home data," says Goodjohn. "Our *Dvele IQ* system ties everything back to one centralized brain for the house, which uses the information to learn how the home operates, and to suggest how to make improvements

that will increase the comfort of the residents and lower the cost of ownership."

Homeowners will have one easily programmable interface that connects everything, including the geothermal heat-pump powered radiant heating and cooling system—which also heats the home's water, indoor air quality sensors, leak detectors, lights, speakers and security technology.

"The data is totally secure for the privacy of the homeowners," says Goodjohn.

SUSTAINABILITY BUILT IN FROM THE BEGINNING

Transcend is designed for longevity.

"Homeowners should look at the long-term cost to own and run a house," says Gutterman. "We intentionally didn't create homes at the lowest possible price, because all that would mean is that we're doing the bare minimum to meet code. Instead, every decision was made to build a quality house with long-term savings that will be more comfortable, healthier and create generational wealth."

As Transcend scales up with more modules built, and *Dvele* increases its automation capabilities in its factories, the price of the modules is anticipated to be reduced. All the modules are built with

health and wellness features, energy efficiency and intelligent technology.

“Buyers can choose different configurations and different levels of features from a standard level that currently costs around \$180 per square foot, up to an advanced level that costs \$275 to \$300 per square foot,” says Goodjohn.

Dvele’s goal for Transcend is to set an example that can be replicated.

“The future of our society depends on making changes in the way we live,” says Goodjohn. “We want to see more companies doing what we’re doing. We’re in this for our children and we’re trying to leave the world a better place than how we found it.” **GB**



Partners

Product and support for Transcend is being provided by these partners. We’ll have more on their role in coming months, as the house takes shape.



While the Transcend prototype home will occupy a secluded location outside Lake City, CO, the larger idea is to build sustainable communities close to existing urban hubs.

The self-powered dwelling, an all-electric, highly energy efficient net zero house with solar power and battery storage, can be completely off-grid if necessary.

HOUSING 2.0

READY FOR ZERO

High-performance enclosures are a lot more risk. **Who knew?**

BY SAM RASHKIN

This is Sam Rashkin's latest in a series of articles based on his second book, "Housing 2.0: A Disruption Survival Guide." It is intended as a roadmap for high-performance builders to become the most successful in the industry.

While recruiting engaging and supporting builders with the U.S. Department of Energy (DOE) Zero Energy Ready Home (ZERH) program, I would always lay out the greater risks when constructing high-performance enclosures that are critical to ZERHs. When senior management became aware of this message, they got extremely upset. Viscerally upset. How could the chief architect of the Building Technologies Office be telling housing professionals that zero is greater risk, and impugn DOE's efforts at promoting more-rigorous codes requiring high-performance enclosures? The answer is that early failures are devastating with any market transformation effort, and the truth had to be shared. That's what I'm doing with this article.

ZERO HAS LEFT THE STATION

Before I get to the higher risk, it's critical for all housing professionals to understand that "zero has left the station." Consider the following observations:

More than 300,000 new homes were HERS rated in 2021, with an average HERS Index Score of 58.¹ This is significantly better than the average HERS Index score of 70 for the 2015 IECC code.

Speaking of the IECC codes, they have gotten 40 percent more rigorous since 2009. The latest codes (2015 and greater) meet the national program requirements for ZERH.²

Seven states and territories have announced plans to move forward with zero energy codes: California, Oregon, New Jersey, New Mexico, New York, Puerto Rico, and Washington.³ Of course, California's zero energy code is already underway.

Eighteen states have 100 percent clean energy or renewable energy policies substantially aligned with zero energy buildings.⁴

As of 2020, nearly 28,000 housing units had been certified to zero energy and zero energy ready performance programs.⁵

The Inflation Reduction Act locks in the 45L Tax Credit from 2023 to 2032, with \$5,000 per single-family home and \$1,000 per unit for multi-family homes certified to ZERH.

Environmental, social and governance (ESG) factors are increasingly driving investment decisions (follow the money). It is already attracting 10 publicly owned builders to prepare reports. Zero energy performance will be a significant opportunity for these builders to attract investors.

Maybe even more compelling than these compelling indicators is the superior user experience (UX) associated with ZERHs compared to code homes. This includes no/ultra-low energy bills, comfort taken to a new level, enhanced convenience, low maintenance, greater safety, healthier living, and enhanced resilience. Integrate with best practices for UX optimized communities and design from Housing 2.0, and you now have the Tesla car equivalent with new zero energy homes. Everyone will want one.

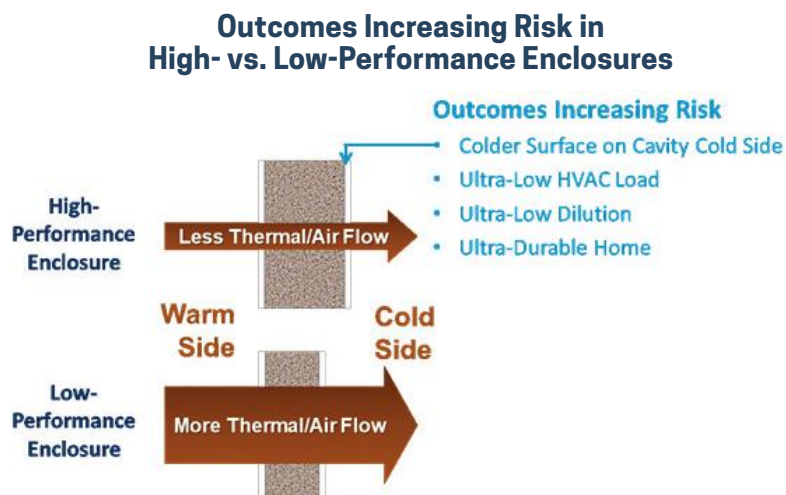
WHY IS ZERO A GREATER RISK?

When performance is significantly ramped up with any product, higher risk typically comes along for the ride. Consider airplanes: Going from open cockpit single-engine prop planes to modern jets is a huge jump in performance, including faster, better and more-comfortable travel. But instead of flying at 10,000 feet elevation at 140 miles per hour, modern jets fly at 35,000 feet elevation and 500 miles per hour. This higher performance results in far greater risks, with less oxygen at higher elevations, more structural stress with dramatically higher wind loads, incredibly low temperatures (e.g., minus 70 degrees Fahrenheit), and more exposure to collisions with thousands of planes flying at high speeds.

Of course, we didn't reject modern jets because of these greater risks; we managed the risks. Airplanes now have pressurized cabins and oxygen masks, incredibly strong and light-weight structural framing, airtight and well-insulated cabins, and advanced radar warning systems to avoid collisions. And now, airplane travel is statistically the safest mode of transport, with just 0.07 deaths per 1 billion passenger miles. The most popular form of transport, cars, has 100 times greater risk.⁶

The same increased risk scenario plays out when moving from low-performance enclosures to high-performance enclosures in ZERHs. The superior UX with ZERHs includes ultra-low utility bills, plus more comfort, health, durability and safety. However, just like with modern airplane travel, high-performance homes and there substantially reduced thermal and air flow, resulting in outcomes that bring far greater risks, including (see figure below):

- Colder surface on the cavity cold side increases moisture risk
- Ultra-low dilution increases indoor air quality risk
- Ultra-durable home increases future readiness risk



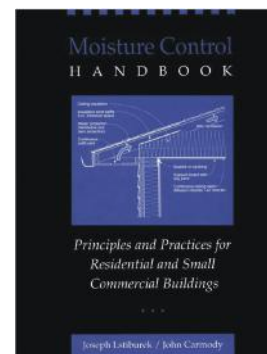
The following paragraphs explain each of the resulting risks and how they are easily managed in zero energy and zero energy ready homes.

MOISTURE RISK

Since the inside surface on the cold side of a high-performance construction assembly experiences much less thermal and air flow getting to it, it is much colder than with a low-performance enclosure. This means it has much greater wetting potential with greater propensity for temperatures below the condensation point, and much less drying potential, with less thermal flow to dry it out. In cold climates, this risk occurs on the inside surface of exterior wall sheathing, and in warm

climates it occurs on the inside surface of interior drywall. As a result, any bulk moisture leaks create greater risks in cold climates for moisture damage, and any air flow leaks that allow warm air to reach the cold surface create greater risks of condensation in all climates.

Managing these risks requires diligence with all four building science control layers: air flow, thermal flow, bulk moisture, and moisture vapor. It is precisely this moisture risk that explains the title of Joe Lstiburek and John Carmody's building science book, **"The Moisture Control Handbook."** It is an outstanding reference for this moisture risk management. Moisture risk is also managed with HVAC best practices that locate heating and cooling equipment and ducts inside the conditioned space, and tightly airseal and properly size the ducts. Lastly, whole-house ventilation is important for diluting internally generated moisture (e.g., breathing, cleaning, cooking, and washing), but the impacts of bringing in outdoor moisture during humid weather also have to be fully considered.



IS THERE A COMFORT RISK?

High-performance enclosures that are air-tight and well-insulated result in dramatically reduced heating and cooling loads. This significantly increases comfort risks in a housing industry where quality HVAC installation has been a huge problem. Research on hundreds of homes by the National Renewable Energy Laboratory revealed that 70 to 100 percent of field measure HVAC systems evidenced at least one performance-compromising fault, including 31 to 93 percent with oversized equipment, 29 to 78 percent with low refrigerant charge, 67 to 100 percent with duct leakage, and 50 to 93 percent with inadequate air flow.⁷

Ultra-low HVAC loads could be expected to significantly increase risk with a HVAC installation infrastructure that is quality challenged. This is because there will substantially less air flow in ducts that have a high-propensity for sizing and air leakage issues, shorter cycles resulting in coils that are less likely to be cold enough to meet latent loads where there is a high-propensity for over-sizing, and longer swing seasons that may reduce sensible cooling on the front and back end of the summer cooling season, when significant latent cooling is still needed.

Again, these risks can readily be managed with HVAC quality installation best practices for ensuring proper air flow, refrigerant charge, and duct airtightness. Further, builders add insurance by using variable-speed equipment that can throttle up and down and effectively mitigate issues with oversizing. This may also protect production builders who seek to specify one size per HVAC system per model, where variation in orientation can result in more than a one-ton variation in sizing requirements. And lastly, dehumidification, which has been ignored or addressed as an afterthought, needs to be an integral part of comfort systems in all climates with humid summer conditions, including northern states that are getting increasingly hot and humid summers with climate change.

INDOOR AIR QUALITY RISK

Substantial progress has been made improving airtightness in all homes constructed today. ZERHs are becoming ultra-airtight. As a result, contaminants introduced in homes will accumulate without adequate whole-house ventilation. These contaminants include those embedded in construction materials (e.g., paints, carpets, sheathing,



By the code. Seven states and territories have plans to move forward with zero energy codes, while 18 states have 100 percent clean or renewable energy policies aligned with zero energy buildings.

cabinets, adhesives) and those introduced by occupants (e.g., furnishings, shoes, cooking, moisture, and cleaning products).

This risk is managed first with good air sealing best practices that keep outdoor contaminants from entering the home (e.g., dust, pollen, pests, and moisture), HVAC quality installation best practices that ensure airtight ducts inside the conditioned space and proper air balancing, and a comprehensive indoor air quality strategy that ensures source control, dilution, and filtration. The best recommendations for ensuring good indoor air quality are to certify all homes to the EPA’s Indoor airPLUS program, along with educating homebuyers about effective behaviors for healthy living (e.g., using kitchen exhaust fan when cooking, using bathroom exhaust fan when bathing, taking shoes off at entrance, vacuuming carpets regularly, checking furnishings for dangerous fire retardants, and cleaning gutters).

“FUTURE READY” RISK

Of all the risks discussed here, this one may be the most surprising. If a home is “ultra-durable,” why is “future ready” a risk? The answer is that a ZERH with a high-performance enclosure is now ready to last longer, with greater durability and being able to meet future homebuyer expectations. With these capabilities comes additional responsibility to stand the test of time—this is a home that should last hundreds of years. However, there are now far greater risks to this persistence associated with rapidly increasing disaster risks, drought-induced water risks in a growing part of the country, and a major movement to all-electric homes. All ZERHs should be prepared to meet these future challenges.

These risks can be readily addressed by integrating comprehensive resilience strategies (e.g., Institute for Business and Home Safety’s FORTIFIED Home Program), water conservation strategies (e.g., EPA’s WaterSense certification), and electric ready capability including high amp outlets for fossil-fuel appliances (e.g., space heating, cooktop, oven, and clothes dryer), solar ready mea-

sures in homes with significant access to solar insolation (e.g., ZERH solar ready checklist), electric vehicle ready (e.g., wiring for Level 2 chargers), and battery storage ready (e.g., 225 amp busbar, back-up power circuits, transfer switch, and subpanel).

We know for certain this is the future of housing. Why bake in obsolescence in the ultimate consumer product that should last more than a hundred years?

THE RISK MANAGED ZERO ENERGY HOME BUILDING BLOCKS

Now it is time to put all of this risk management together and start building ZERHs that will stand the test of time. Why? Because people, communities, and the planet will all live better. What we must follow is a four-step process outlined in the figure below.

Comprehensive Zero Energy Ready Home Strategy

Why	Live Better: People, Communities, & Planet			
What	Step One: Optimize Efficiency	Step Two: Minimize Risk	Step Three: Be Future Ready	Step Four: Get on Path to Zero
How	Efficient Enclosure	Water Protection	Resilience	Zero Energy Ready
	Efficient Equipment	Ensured Comfort	Water Efficiency	Net Zero Energy
	Efficient Components	IAQ System	Electric Ready	Net Zero Carbon

First, optimize efficiency. This includes an energy-efficient enclosure, equipment and components throughout the home.

Second, minimize risk. Now that we have a high-performance enclosure, it is critical in the next step to manage the risks discussed earlier. This includes comprehensive water protection

to minimize moisture risk, ensured comfort system to minimize comfort risk, and a comprehensive indoor air quality system to minimize health risk.

Third, be future ready. Integrate regionally appropriate resilience strategies to address prevailing disaster risks, comprehensive water efficiency in locations likely to experience water shortages, and electric ready features that allow a smooth transition to all-electric homes at minimal cost and disruption.



Innovative thinking. The benefits of Zero Energy Ready Homes (ZERHs), such as this Department of Energy Housing Innovation Award finalist from 2021, include ultra-low utility bills plus more comfort, health, durability and safety.

COURTESY OF S.D. JESSUP CONSTRUCTION

Fourth, get on the path to zero carbon. Start with the basic high-performance home programs: ENERGY STAR, Indoor airPLUS, and WaterSense. When you're ready, move up to zero energy ready performance with ZERH or Passive House. Next is zero energy homes with on-site renewables or micro-grids (e.g., special recognition labels available from PHIUS and soon ZERH). Complete the journey with zero carbon homes that are all-electric and minimize embodied energy. There should be no judgment about where you are for any step of the process. The important part is to begin the journey and to manage your risks. **6B**

¹"Number of HERS Rated Homes in U.S. in 2021 Tops 300,000 Mark," RESNET, Jan. 18, 2022

²Building Energy Codes Program: National Benefits Assessment, 1992-2040

³"How to Zero Out Emissions? More US States use Energy Efficiency," Annie Gileo, ACEEE Blog Post, July 16, 2019

⁴Advancing Toward 100 Percent: State Policies, Programs, and Plans for Zero-Carbon Electricity," Bentham Paulos, Clean Energy States Alliance, Updated April 2021

⁵"To Zero and Beyond: Zero Energy Residential Buildings Study, 2019-2020 Inventory of Residential Projects on the Path to Zero in the U.S. and Canada," EBBA Team Zero

⁶"Why Air Travel is the Safest Mode of Transportation," Sheffield School of Aeronautics, <https://www.sheffield.com/air-travel-safest-mode-transportation>

⁷U.S. DOE Summary Report on Residential HVAC Installation: www.osti.gov/servlets/purl/1470985

Sam Rashkin's two-decade career as a licensed architect includes serving on national steering committees for the U.S. Green Building Council (USGBC)'s LEED for Homes, Green Builder Media's Green Builder Guidelines, the Environmental Protection Agency (EPA)'s WaterSense label, and EPA's Indoor airPLUS label. He has partnered with Green Builder Media to develop the **Housing 2.0 program**, which empowers building professionals to design and construct higher-performance, healthier and more-sustainable homes at a fraction of the cost.

The Housing 2.0 program is sponsored by Mitsubishi Electric, Panasonic Healthy Indoor Living Solutions, Schneider Electric, and Westlake Royal Building Products.

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THE PROGRAM IS GENEROUSLY BROUGHT TO YOU BY THE FOLLOWING PARTNERS:

The Housing 2.0 program is a comprehensive training and education program designed to teach building professionals how to prepare themselves for the massive transformation that the housing sector is experiencing. The program is helping building professionals design and construct higher-performance, healthier, more-sustainable homes, optimizing the total housing user experience with an estimated 30 to 70 percent hard cost savings/added value.

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PANASONIC HEALTHY INDOOR LIVING SOLUTIONS is helping builders across the country differentiate themselves with powerful, code compliant and cost effective indoor air quality solutions that provide a safer environment for home buyers. reinventingventing.com

WESTLAKE ROYAL BUILDING PRODUCTS specializes in the innovation, design and production of a diverse range of exterior and interior building products, including siding and accessories, trim and mouldings, roofing, stone, windows and outdoor living. The company manufactures high-quality, low-maintenance products to meet the specifications and needs of building professionals, homeowners, architects, engineers and distributors. westlakeroyalbuildingproducts.com

◀PUMPED↑UP▶

NETWORKED GEOTHERMAL TECHNOLOGY IS POISED TO BECOME THE MOST-EFFICIENT WAY TO DELIVER AND REMOVE HEAT IN HOMES AND BUSINESSES.

Hidden asset. Networked geothermal can produce up to six times more energy than it needs to function with, especially when it includes a diverse group of buildings, from residential to commercial.

BY JOE DAMMEL

At Fresh Energy, we're fond of saying that heat pumps are having a "moment." Electric heat pumps are super-efficient heating and cooling appliances that stand to replace gas-burning furnaces and air conditioners in homes and businesses. On their own, heat pumps can offer improvements over existing heating/cooling appliances under the right conditions. But what if I told you that there is a way to utilize heat pumps that can achieve up to 600 percent efficiency?

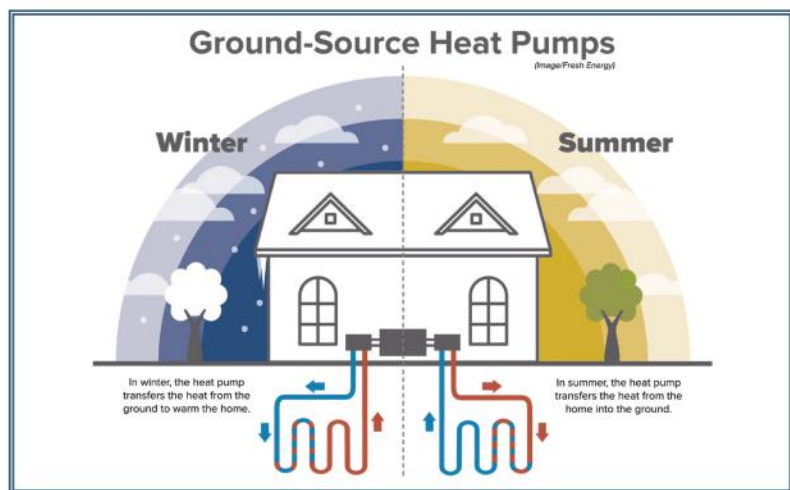
ENTER: NETWORKED GEOTHERMAL

The term "networked geothermal" describes the technology—geothermal—and the mode of delivery, a network. For our purposes, "geothermal" means using a heat pump to deliver heat ("thermal") from the ground ("geo") to warm a building. This type of device is called a ground-source heat pump.

At the most basic level, heat pumps simply transfer heat between two places via liquid in a looped pipe system. For the type of heat pump we're talking about today, heat is transferred between



Move over, methane. The traditional underground natural gas line, the longtime energy source for millions of homes nationwide, is giving way to environmentally friendly options such as electrification and networked geothermal. COURTESY OF FRESH ENERGY



Dual action. Ground-source heat pumps offer a mirror image-type operating principle when it comes to operation during winter vs. summer. COURTESY OF FRESH ENERGY

a building and the ground via the loop. In heating mode, a ground-source heat pump pulls heat from the ground and transfers it indoors. In cooling mode, a ground-source heat pump pulls heat from inside and transfers it outside and into the ground. Ground-source heat pumps are highly efficient because the ground remains a relatively constant temperature throughout the year, about 55 degrees, at the depth most systems are installed. This temperature also just happens to be optimal for maximizing the efficiency of heat pumps.

If this concept still seems incomprehensible, have no fear—just take a break from this blog post and walk to your refrigerator to grab a refreshing beverage or a snack. But before you walk back, take a moment to really think about your fridge. Ever notice the warm air coming out of the back of the fridge when it's running?

Your fridge is approximating a heat pump operating in cooling mode: It's pulling heat energy from inside and transferring it outside, thereby cooling your tasty beverage and blowing warm air out the back. Now, think of a building as a giant refrigerator. A heat pump operating in cooling mode pulls out heat from indoors and transfers it outside.

Boom—you understand heat pumps!

NETWORK KNOW-HOW

Okay, so we now understand the geothermal aspect of networked geothermal. But what about the “network” aspect? “Networked geothermal,” also called “geogrids,” describes the connection of a number of ground-source heat pumps to one another to form a shared loop network. In English, this means connecting nearby homes and businesses to form a system or network of heat pumps. A networked geothermal system can achieve upwards of 500 to 600 percent efficiency, which means that for every unit of energy that goes in, five or six units come out! Is this magic? No!

Recall that heat pumps simply move heat from one place to another. Ground-source heat pumps move heat from the ground to a building, and vice versa (in cooling mode). A network of ground-source heat pumps can move heat from the ground to a building, and between a building and another building. Sharing (heat) is caring!

In a geothermal network—as in life—having diversity in your network is a good thing. [Studies have shown](#) that having a diverse group of buildings with different heating and cooling needs can help balance out the system. For example, if you look at the roof of a hospital or grocery store, you will probably see large fans that work to remove the heat generated by cooling (think back to our refrigerator example). This type of heat is called “waste heat” and is, as its name suggests, considered an undesirable byproduct. But for networked geothermal systems, one person's trash is another person's treasure: All that waste heat can be captured and put back into the system, and delivered to buildings that need it.

HERE, THERE, BUT NOT EVERYWHERE—YET

At this point in the blog, if I've done my job, you should be on the path to becoming an expert about a few things. First, you should have a better understanding of what a ground-source heat pump is and how it can transfer heat in the ground to buildings, and vice versa. (Get up and make another visit to your fridge to really lock down your heat pump knowledge!) You should also have this loose concept that a diverse network of ground-source heat pumps can unlock even greater potential out of an already-impressive technology. If networked geothermal systems are so good, you might well ask, then why aren't we using them everywhere?

The answer to this question is multifaceted and complex. But to start, if you have ever walked down the street in a neighborhood that is currently served by fossil gas, you would be standing directly over the problem.

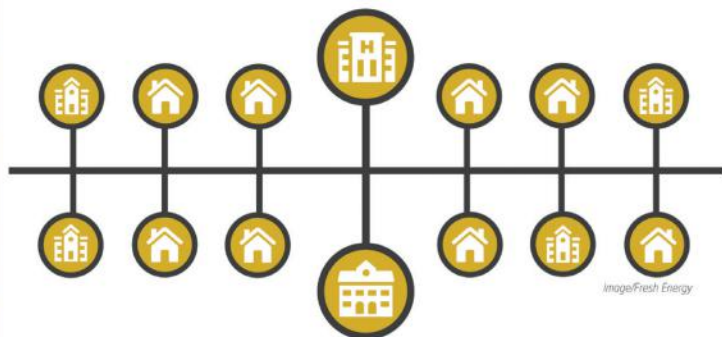
Beneath your feet lies a vast network of pipes that deliver fossil gas directly to each house and to each building. For decades, delivery of this gas has been a relatively uncontroversial proposition. The legal monopoly power that gas utilities enjoy in Minnesota means that they are often the only provider of these services to heat your homes, your water, and your food. But as we [begin to learn more](#) about the climate impacts of the fossil gas system, the health impacts of burning gas indoors, and the causes of increasing energy bills, important discussions about alternatives such as electrification and networked geothermal have begun to take place.



Heat pump principle. To illustrate how heat pumps “move” heat, consider how the wall behind your refrigerator is about 9-10 degrees warmer than the front of the unit. COURTESY OF FRESH ENERGY

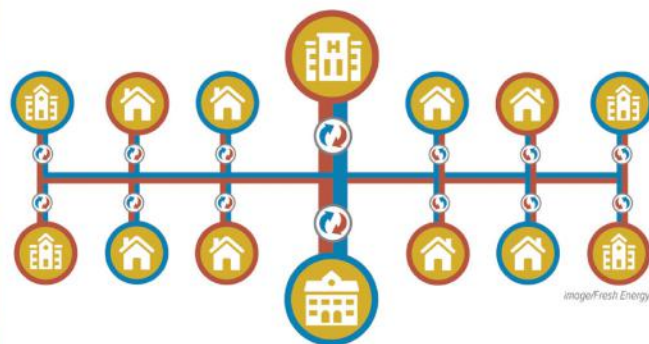
Birds-eye View: Existing Fossil Gas System

(Image/Fresh Energy)



Birds-eye View: Networked Geothermal

(Image/Fresh Energy)



Superior sharing. An existing natural gas system can move heat from the ground to a building, but a network of ground-source heat pumps can move heat from the ground to a building, and between a building and another building. COURTESY OF FRESH ENERGY

1. Efficiency. This was mentioned earlier, but it bears repeating: networked geothermal systems are super efficient—almost magically so. (It's not magic; it's just engineering and science at work). Using less energy to heat and cool our buildings is a no-regrets approach.

2. Cost. Networked geothermal systems can be cost-effective. Today, your gas bill has two components: the distribution rate and the cost of the gas. Over time, as a result of [utility rate cases](#) driven by investments in the existing gas system, distribution rates have increased year-over-year. More recently, the cost of gas has increased and the gas market has shown volatility. Both of these factors hit consumers' pocketbooks all the same. Networked geothermal systems take the cost of gas out of the equation, as they rely only on electricity to operate the heat pumps and pull energy out of the ground.

3. Air quality. Removing appliances that combust fossil gas inside of homes will increase health outcomes. Let's face it, indoor air quality has long been a neglected topic of consideration, but studies have shown the detrimental health impacts of burning gas inside our homes. Transitioning away from burning gas in our buildings will help improve health outcomes everywhere, but especially in traditionally under-resourced communities that bear the brunt of air pollution impacts from a variety of sources.

4. Jobs. Networked geothermal systems can provide jobs for skilled labor, possibly the same folks who installed that vast network of gas pipes that crisscross our neighborhoods. At its core, networked geothermal systems and gas distribution systems are not so different. Both require infrastructure to be installed in the ground, and that requires a legion of skilled, local workers who know the ins and outs of installing pipes and operating networks.

5. The energy transition. Networked geothermal can serve as a way for traditional gas utilities to begin the transition away from gas delivery companies and toward thermal/heat companies. This one is important: If we can find a solution that supports labor, allows utilities to transition their business models, and combats climate change, we should focus on finding ways to implement this solution equitably and rapidly. Gas utilities across the country have begun to [install networked geothermal systems](#).

For many, gas utilities have long been the only game in town. But there are growing calls for change from the status quo. Networked geothermal systems are an intriguing alternative that address efficiency, cost, health, labor, and utility needs.

At this point, feel free to head back to the refrigerator and grab your favorite cold beverage, because congratulations: You are now an expert on networked geothermal! You can now thrill friends and family with your expertise on this exciting, innovative resource. **GB**

Joe Dammel is managing director of buildings at Fresh Energy, a nonprofit that helps develop policies to achieve equitable carbon-neutral economies, and move Minnesota and the Midwest toward a clean energy economy. To learn more, visit Fresh Energy's website.

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SAM RASHKIN

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Future Look

HERE'S WHAT THE COMING OF 3D INTERNET (THE METAVERSE) MEANS FOR GREEN BUILDING.

BY TERRY BEAUBOIS

The ongoing digital transformation of businesses worldwide continues to affect all industries, including those of the Architecture, Engineering and Construction (AEC) industry...and of green building.

In 1993, AOL advanced the use of email. In the 1990s, we saw the introduction of digital cameras, CD-ROMS, and the start of the public internet and websites. The iPhone was introduced in 2007. Now, in 2022, the next big development in internet technology is underway. It is the beginning of the 3D internet, which some people are calling "the Metaverse."

The conditions imposed by the COVID pandemic in 2020 and 2021 further accelerated the use of computers in the building industry and green building, in the form of increased adoption of online meeting technologies. People had to be isolated, but still needed to be in communication with other people, schools and places of business. This affected the design of homes, businesses and schools to accommodate "working remotely, learning remotely." Now, as things begin to go back to normal, many people have

found there are some advantages to remote working and continue to explore technologies that encourage it. There has already been an increased demand for home offices in residential design, as some people are continuing to work remotely several days a week.

My own experience during the pandemic included designing a house to be built in Montana, for clients currently living on the East Coast. We were able to design the house, coordinating with the clients in Maryland and the contractor in Montana, from my location in California. The meetings with the clients took place online and included the general contractor. This was excellent, in that we were able to incorporate the contractor's advice, preferences and experience during early discussions of the project design. This was easier than limiting our interaction to in-person meetings. Also, everyone enjoyed the convenience of meeting from their own locations. The clients did travel to the site to coordinate selections and perform a number of site visits. And, we were available during the construction period to answer any on-site building questions.

The real-time 3D visualization software we were using allowed

us to create a 3D model of the house to show during online discussions with the contractor and client. We could make changes and incorporate suggestions in real time, during our meetings. There's more to come. This new aspect of visualization technology for buildings is developing rapidly and will play a significant role in the future of green building. The ability to create and show 3D spaces and objects online, and walk around and through the house early in the design phase, is a step toward the development of the 3D internet.

As development of 3D internet technology continues, clients will be able to walk and look around and "see" the building in 3D—not as just a set of 2D drawings. Those won't be obsolete—the normal 2D drawings will continue to exist to show the plan, elevations, sections, details and any perspective renderings.

Many people have already commented that this process is "like being able to do a construction period walk-through or final walk around the building...but during the design phase, when changes can be made easily." Usually, this is not possible until much later, when the project is under construction and when any changes or adjustments would be considerably more expensive or impossible to do. This 3D experience will enable clients, during the design process and before construction begins, to easily make suggestions and recommendations that everyone agrees would improve the project.

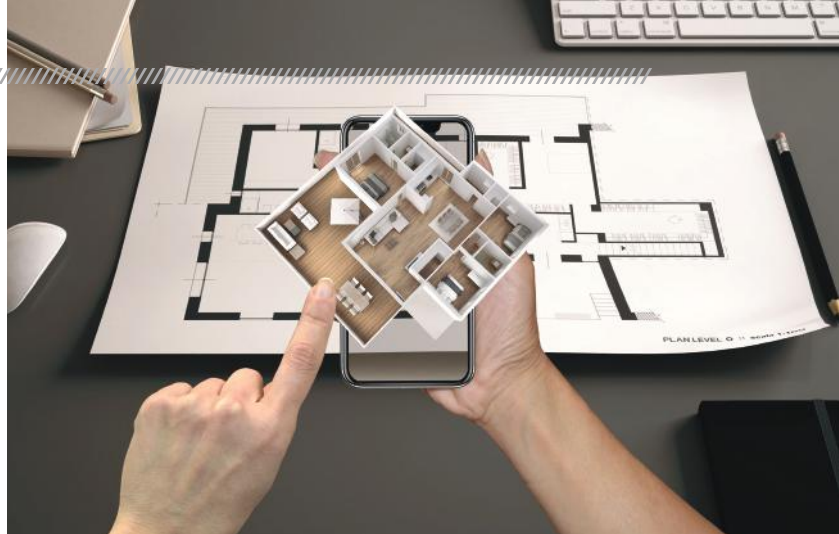
"We were able to design the house, coordinating with the clients in Maryland and the contractor in Montana, from my location in California."

BENEFITS OF 3D INTERNET

Because architecture, engineering and construction are, in fact, dealing with 3D objects and spaces, the 3D internet will be tremendously beneficial to all professions and trades in the AEC industry. It will also improve communication and selection of green building elements. Along with the 3D information of size and shape of any 3D object, there will be the ability to include additional, valuable information about that product or object.

The capabilities of 3D technology can include the ability to offer information about the 3D object's attributes, characteristics, qualities, installation instructions, needed clearances and connections, and eventually the ability to connect with a supplier to check on availability of the product. The end result will be increased efficiency and effectiveness of green building.

Providing information about their green building project can help product manufacturers feature and communicate the "green" aspects of their products as part of the 3D objects that represent their products. This will allow homeowners, contractors, architects, designers and green builders to more easily find and select green products that help them achieve their green building goals. Product manufacturers are currently exploring this capability. I had discussions with a number of



3D transformation. In the future, 3D internet will allow potential clients to visit and examine newly built green buildings, and also acquire information on related products.

them during this summer's Pacific Coast Builders Conference (PCBC) in San Francisco, and confirmed that they are already exploring 3D object technology and 3D internet capabilities that will lead to successful 3D internet participation. Home products and materials retail stores are also becoming involved with the 3D internet.

The development of the 3D internet is facilitated by the convergence of the computer technology of four major industries: the film and TV, computer gaming, automotive, and the AEC. Each has, for years, used software developed uniquely for each industry. Now, because of similar needs to show 3D environments, with people, buildings, cars, movement and interaction that are common to each of these industries, the technology that was unique to film and TV, and computer games, is becoming available to architects, engineers and contractors. Over the next decade, this technology will become a standard feature in industry.

THE 3D INTERNET OF THE FUTURE

Recently, the Metaverse Standards Forum (MSF) was formed and has quickly grown to more than 1,400 member companies. Standards will soon be developed for the 3D internet, similar to those for the existing internet, so that we can easily visit and explore the many 3D internet sites that will make up the Metaverse. Just like there is no "one internet" but a series of websites that share standards so that we can visit each of them, the 3D internet will be made up of many 3D internet sites, all sharing the same standards.

So, imagine in the future, having a 3D internet site of your own where you can allow potential clients to visit and walk around the green buildings that you have built. In addition, imagine product manufacturers having 3D internet showrooms that you and your clients can visit to see and acquire information on products for your green buildings; where you can easily download a 3D object of that product that can be incorporated into the drawings and product lists for your project. Those are just a few of the many promises that the 3D internet will bring to green builders. **GB**

Terry Beaubois is CEO of BKS: Building Knowledge Systems, in Palo Alto, California. His experience in computer technology related to construction goes back decades with NASA, and he has continued to research and apply the latest technology under development that is appropriate for consideration in the AEC/Building Industry. He can be contacted at tbeaubois@gmail.com.

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IT HAD BEEN A LONG WEEK ALREADY AS WE prepared for a much-anticipated photo shoot at our high-country project while continuing to push hard to wrap up all the construction tasks that demanded our attention. On the way home that Friday afternoon, we were looking forward to the weekend and a chance to relax a little and rest up.

A short while after arriving I happened to be in the vicinity of the laundry room where I detected the unmistakable aroma of raw fish. I hurried in to check on our old deep freeze unit located there, only to confirm the worst. At some point over the past few days, the aging appliance had given up the ghost. Worse still, we had been stocking up, so it was crammed full. Our weekend plans were about to change.

Almost everything in the freezer was just beginning to thaw or still cold enough to salvage, although we did discard a few items out of caution. We transferred all remaining contents into ice chests and covered each with bags of ice. Then we started cooking everything we could, a process that lasted through the next two days, and we contacted some young families in our little town who were more than happy to help us avoid wasting the rest.

By the time the last of the cooking, preserving and storing was completed on Sunday night, we were exhausted. Along the way, we had been forced to remove the empty freezer and clean up the unavoidable mess from all the defrosting. Now, we would need to start searching for a replacement unit.

I was feeling pretty sorry for myself when I was overtaken by an embarrassingly sheepish realization. What we had just experienced was definitely a first world problem, not a matter of life and death.

Over the course of our “lost weekend,” a hurricane had slammed into Puerto Rico, flooding thousands of structures, leaving the entire population in the dark as the power system

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was destroyed, and forcing many into the open to deal with the miserable elements. At the same time, at the extreme opposite end of the continent, a typhoon spawned in Asia and blasted parts of Alaska, where it literally swept homes right off their foundations and made travel next to impossible.

As I contemplated those disasters, there was no way to avoid thinking about similar recent news stories from around the world: floods of unimaginable proportions in Pakistan and elsewhere, brutal wildfires in Europe and North America, mass starvation and dislocation across many parts of Africa, just to mention a few.

Sometimes we are given the opportunity to reset the level. For someone who has spent his adult life in the shelter industry, it's hard to witness the vulnerability of people across the globe without being frustrated by the lack of commitment from so many to raise our standards. We can do better; we can help people make better choices and access the resources they need to live safer, more abundant lives.

It comes down to priorities. It is also good to occasionally be reminded that the first step toward sustainability is humility. **GB**



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