

Award-Winning Coverage of Sustainable Construction, Products and Lifestyles

GREEN BUILDER[®]

September/October 2025 / www.greenbuildermedia.com

The Next New Thing:

As energy costs surge, long-term ROI depends more than ever on good building science.





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RETHINKING OUTDOOR LIVING: INNOVATION AND SUSTAINABILITY WITH TREX



Traditional wood decks may be charming, but they also come with challenges: warping, cracking, splinters, insect damage, and the need for regular repairs. Many homeowners want the look of real wood without the headaches.

Composite decking has emerged as the industry's answer, delivering strength, comfort, and minimal upkeep. Yet consumers continue to ask: can these products also be sustainable?



As the inventor of composite decking and the category's leader for more than 30 years, Trex has consistently shown that durability and sustainability can go hand in hand.

Its boards, crafted from a proprietary blend of up to 95 percent recycled plastic film and reclaimed sawdust, demonstrate how thoughtful design can deliver both strength and sustainability.

Innovation remains central to Trex's approach. In 2025, the company expanded its SunComfortable™ heat-mitigation technology into its more affordable Enhance line, helping deck surfaces stay cooler and more comfortable in hot weather. The technology can reduce heat buildup by up to 35 degrees compared to Trex's original boards.

Plus, homeowners don't have to worry about sanding, sealing, or painting at all. The boards are also resistant to rot, fading, staining, mold, and splintering, making it the ideal choice for homeowners that want a durable, low-maintenance, eco-friendly deck.

Applications are nearly limitless, from patios and pool decks to marinas and beyond. With the addition of Trex's innovative railing products, homeowners can create streamlined, cohesive outdoor living spaces built on the same foundation of durability, comfort, and sustainability.

The result is a complete outdoor living system where performance, design, and sustainability come together. Trex shows what the future of decking can look like.

**Based on laboratory testing simulating full summer sun exposure at noon over an extended period. Colors used are Lava Rock (without SunComfortable) and Salt Flat (with SunComfortable). Actual temperature reduction may vary depending on environmental conditions, color and usage. Trex decking with SunComfortable technology will still get hot when high temperatures and sun converge. Care should be taken on such days to avoid extended contact between exposed skin and the deck surface.*



Local angels? Imagine presenting a rapid response team of skilled pros that could help low-income families by offering volunteer building repairs and advice in times of heat crises. IMAGE: AI VISUALIZATION

The Heat is Inescapable, But We're Not Powerless

I read a shocking article yesterday in the [Guardian](#) about the impacts of extreme heat on families in the U.S. More people than ever are dying in their homes, unable to afford utility bills or repair their air conditioning. What's happening is a perfect storm of economic inflation, rising electric costs, and greater need than ever for mechanical cooling. The result has been more tragic deaths. Adding \$270 a year to utility costs might not seem significant to some homeowners, but for the 60 percent of Americans who live paycheck to paycheck, it means the air conditioner stays broken.

The article spells it out well: "Amid soaring energy costs, shrinking federal aid, hotter summers and a ZIP Code lottery when it comes to utility disconnection rules, health experts warn that households on fixed incomes and those with medical issues such as diabetes, heart disease, obesity and addictions will be most vulnerable."

I chose this topic because at *Green Builder*, part of our mission is to make better building science accessible to everyone. New homes, by and large, can absorb the shock of hotter, longer summers. They tend to be better insulated, more efficiently cooled and less leaky than older shelters. But they represent just a small sliver of the overall housing stock. Fewer than 10 percent of U.S. homes have been built in the last 10 years.

Many of the deaths, I should add, occur in mobile homes or RVs, which are not built to the same standards as conventional housing. About 30 percent of them rely solely on window air conditioners. Among heat deaths in Maricopa County, Arizona, last year, most had window units, but the unit was broken in 70 percent of cases.

What this story highlights is the fact that many Americans are facing an existential crisis—at least part of which is manmade. For example, the [New York Times](#) reports that AI data centers will likely increase utility costs by an average of eight percent nationwide by 2030 and as much as 25 percent in places like Virginia because of massive power demands. Ironically, lower-skill

workers are also the ones most likely to lose their jobs to AI. [McKinsey Global](#) estimates that up to 30 percent of tasks in 60 percent of occupations could be automated with current technologies, disproportionately affecting low-skill jobs.

That's a lot of change and potential suffering to parse over the next few years. But I believe the housing industry has potential to mitigate some of this pain. If you agree that our quality of life begins with safe, comfortable shelter, then our path is clear.

1. **Get the price of housing down.** Clear regulatory and zoning hurdles to allow for fast-track construction of high-performance multifamily units. It's an issue that crosses the political divide. This is where AI could earn its keep, evaluating the performance and safety of every new project in seconds, rather than weeks.
2. **Redirect AI development costs back on the billionaires.** Let the people raking in money from AI investors subsidize the utility upgrades necessary to support AI data centers, rather than externalizing them to American families.
3. **Share your skills—and your time.**

As building experts, we all have skills and knowledge (and even materials) to share. Let's volunteer our time and expertise to improve living situations for local citizens. Work with your A/C guy to offer a free "fix your A/C" workshop on a Saturday. Teach your local manufactured home HOA how to install radiant foil barriers or small solar arrays. Form a team of volunteers to swoop in and assist low-income families when they have nowhere else to turn. Your kindness will never be forgotten. **GB**



Matt Power
Editor-in-Chief

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Orlando Eyes Clean Energy Future

Despite DOGE efforts, the city government plans to be all-solar by 2027.

Orlando, Florida will power its municipal buildings entirely by renewable energy by 2027, bringing in environmental and economic benefits, including fighting climate change, cleaning up the atmosphere, and creating numerous jobs before the end of the decade.

The city also has 10 new photovoltaic systems expected to be online by the end of 2026 on buildings such as community centers, fire stations and the city's fleet and facilities headquarters. In a report in the Orlando Sentinel, Mayor Buddy Dyer said he wants to make the city "the most sustainable one in the southeast," joining others such as Burlington, Vermont and Aspen, Colorado, which have entirely renewable electrical grids.

Solar is considered a good investment for cities like Orlando because city workers will occupy the buildings for a long time, according to Mike Hess, the city's director of sustainability and resilience. New solar systems are expected to last about 25 years and should be paid off in 10, meaning taxpayers would reap savings for 15 years.

Orlando's green goals have drawn a critical eye from Florida's Department of Governmental Efficiency (DOGE), which is auditing the city alongside



A shining example. Orlando plans for all municipal buildings to be solar powered within two years, as it strives to become one of the nation's leading cities in renewable energy.

CREDIT: ISTOCK/PAULO ALMEIDA

several other local governments across the state. DOGE asked the city to turn over documents and data about any policies related to climate change, as well as capital and operating expenses of any such programs. **GB**

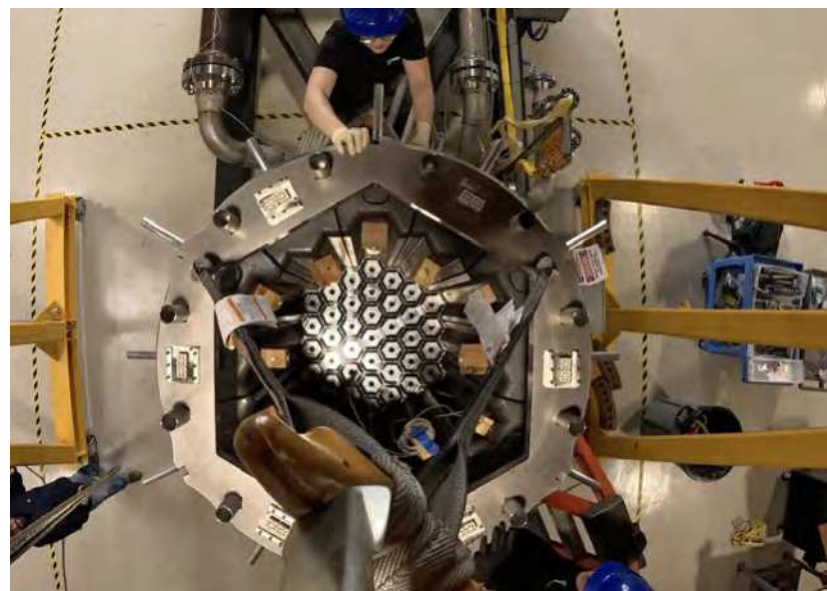
Make Way for the 'Mini Nuke'

New microreactors could bring onsite nuclear energy to every residence and business.

At least a half dozen companies are developing ultra-tiny nuclear reactors that can be used to cleanly power vehicles, machinery, a manufacturing plant and about 1,000 homes. The microreactors, which are roughly small enough to be packed in a shipping container and loaded onto a flatbed, can generate as little as 1 megawatt of power—about 1 thousandth the amount of a full-sized model, according to a report in the Washington Post.

According to the Department of Energy (DOE), these mini reactors do not require water for coolant. Instead, they rely on helium gas, molten salt or air-cooled alkali metal pipes to carry heat away from the core. For fuel, they rely on a novel type of uranium pellet that DOE has declared meltdown-proof. If one or more designs emerge as successful, it could be the first new style of commercial nuclear reactor used in the U.S. since the early years of the Cold War, the Washington Post report notes.

Developers of the "mini nukes" technology hope to get the first of them running as soon as 2028 and envision installing them widely by the early



Puny yet powerful. Nuclear microreactors, such as this unit under development by Radiant, may soon be the next option in portable clean energy for businesses and residential homes. CREDIT: COURTESY OF RADIANT

2030s. Some scientists say the tiny devices could still be dangerous; an explosion or technical malfunction could rupture the reactor and trigger a radiological release. And there still is no way to permanently dispose of radioactive nuclear waste. **GB**

Study: Teens Have a Distorted View of Climate Cause and Effect

What's making the world warmer? A new report says that today's teenagers don't have a clue.

Less than 1 in 8 teenagers believe they know “a lot” about the causes of climate change, and only 1 in 10 believe they know about ways to solve it, according to a new report from the Aspen Institute. And even though 85 percent of survey respondents say they are, to some degree, worried about climate change, nearly half have misconceptions about its existence. For example, 51 percent believe a shrinking ozone layer is to blame, and 28 percent think it is being caused by an increase in solar flares. Fifteen percent believe that nothing can be done to stop it, or that it's a myth.

The report, “[Youth Climate Literacy 2025](#),” attributes the lack of knowledge to non-exposure to credible information—by choice or otherwise—from parents, the media, and educators. Eighty percent of Americans believe more must be done to “help young people develop knowledge and skills to address climate change and build a sustainable world.”



Lessons not learned. In school, teenagers discuss a lot—but they appear to be scrambling their science education with misinformation. CREDIT: ISTOCK/MONKEYBUSINESSIMAGES

Among teenagers that understand the effects and causes of climate change, 71 percent say that they learned about it from teachers. Parents and family also educated them 67 percent of the time, and 63 percent read about it on social media. More than 1,000 teenagers aged 13-19 were surveyed; there are 74 million teenagers nationwide. **GB**

Construction Spending Expected to Soar by 2030

Forecast suggests that residential projects will play a major role.

Construction industry spending is projected to grow by 4 percent annually over the next several years, rising from \$1.553 trillion in 2025 to \$1.889 trillion by 2030, according to a new report by telehandler technology and design firm [Merlo America](#). Nearly 40 percent of that spending growth—\$756 billion—will come from the residential housing sector.

Thirty-five metropolitan areas will account for 64 percent of total construction spending in 2030—with the top 10 Metropolitan Statistical Areas (MSAs) alone representing more than one-third of the market. Expected to lead the charge is the New York-Newark-Jersey City region, projected to hit \$162 billion in spending by 2030, followed by Los Angeles, Chicago, Dallas-Fort Worth and Houston. Five states—California, Texas, Florida, New York and New Jersey—will carry 42 percent of spending growth. Each state's unique strengths—tech innovation, population growth, and infrastructure needs—position them as key players in the construction and data center boom, according to Merlo America. **GB**

MSA Total Spend Over Time



Construction boom ahead? Ten metropolitan service areas (MSAs) are expected to account for almost two-thirds of the construction industry's spending by 2030.

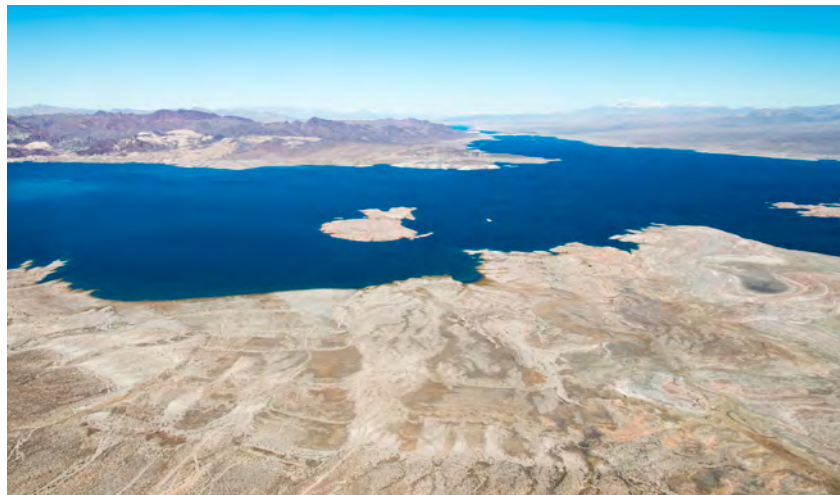
Climate Change Making Things Hot, Then Hotter in Colorado

Scientists say the state's water woes are a sign of things to come nationwide.

Eastern Colorado is drying out faster than western parts of the state due to climate change, potentially accelerating an imbalance in statewide water resources. It's an example of what will likely happen in other parts of the nation, according to the National Center for Atmospheric Research (NCAR) in Boulder, Colorado.

Eighty percent of the state's water comes from west of the Continental Divide, while 90 percent of Colorado's population lives on the eastern side, in rapidly growing cities such as Fort Collins, Colorado Springs and Denver. Also, a 25-year megadrought in the Southwestern U.S. has generated the region's driest conditions in 1,200 years, according to NCAR.

With water resources such as the Colorado River, Lake Mead and Lake Powell having dropped to record lows, expect the same situations in other Southwestern



Drying out. Lake Mead, the nation's largest reservoir of water in terms of capacity, is at a record low due to a 25-year-long megadrought across the Southwest.

CREDIT: ISTOCK/TOBAISJO

cities such as Las Vegas and Phoenix, NCAR adds.

Anthropogenic (human)-caused global warming is exacerbating the problem, NCAR notes. Rising levels of greenhouse gas emissions, mostly the result of fossil-fuel combustion, have warmed much of western Colorado and neighboring states by an average of more than 4 degrees Fahrenheit above preindustrial levels, according to National Oceanic and Atmospheric Administration (NOAA) data.

More information can be found in "[Climate models show Colorado drying sooner and with greater certainty east of the continental divide](#)," published by [Environmental Research Communications](#). **GB**

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AI to Drive Up Energy Prices?

As interest in artificial intelligence grows, so will the cost of electricity needed to make everything go.

Demand for electricity continues to climb—and so do utility bills, courtesy of the emergence of artificial intelligence (AI). AI is powered by enormous data centers, which can use as much electricity as a small city. The number of U.S. data centers has doubled in only three years, and these locations could amount to almost 10 percent of all energy produced by 2030. All of this translates into more money from wallets belonging to homeowners, builders and manufacturers.

According to an analysis by Carnegie Mellon University and North Carolina State University, the average household electricity bill will rise by about 8 percent nationwide by 2030. But in data center-heavy areas, the increase could top 25 percent. “Data centers are the essential digital infrastructure behind every online purchase, every telehealth appointment, every online news article and every digital classroom,” said the Data Center Coalition’s vice president of energy, Aaron Tinjum, in a report in the Washington Post.

For years, the existing power grids have supported an array of e-commerce



Growing demand. Data centers are the driving force behind AI, but their need for electricity is straining an already overworked grid. CREDIT: ISTOCK/GERVILLE

sites, social media and online video platforms. AI applications are now adding to the load. “These data centers could overwhelm the grid,” says market researcher Joseph Bowring. “The system cannot go on this way.” **GB**

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ZERH HOUSING INNOVATORS ROUNDUP 2025: SUSTAINABILITY SELLS

For these U.S. Department of Energy (DOE) Zero Energy Ready Home (ZERH) Housing Innovation Award winners, creativity and energy efficiency are the keys to successful green home construction.

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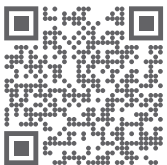
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ZERH Housing Innovators Roundup 2025

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**BY U.S. DEPARTMENT OF ENERGY
EDITED BY GREEN BUILDER STAFF**

Innovation breeds success. The six grand winners in the U.S. Department of Energy (DOE)'s annual Zero Energy Ready Home (ZERH) Housing Innovation Awards have found ways to promote the benefits of affordability, geothermal energy, passive construction and recycled products—all key elements of sustainable thinking.

Meeting the requirements of the DOE ZERH means that the home has been certified to the criteria of ENERGY STAR Certified Homes Version 3.0, 3.1, or 3.2, and the U.S. Environmental Protection Agency (EPA)'s Indoor AirPlus program.

Builders must also meet other efficiency requirements, such as those of EPA's WaterSense program toward hot water distribution; the International Energy Conservation Code (IECC)'s insulation mandates; HVAC and water heating efficiencies; third-party verified air sealing targets; installation of Energy Star appliances, windows, and lighting; and ducts in conditioned space. While homes aren't required to have solar electric panels, the ZERH program specifies installation of the electrical infrastructure and space in the home for future installation of PV, as well as electric vehicle chargers, heat pumps, and heat pump water heaters, in case the owners want them one day.

Here's a look at the winning projects, and where the builders plan to go from here.

Compact package. The energy-efficient Westbrooke Infill by Addison Homes was based on a narrow floorplan with two full stories, a partial third floor to house a fourth bedroom, bath and playroom, and a basement with the garage, mechanicals, rec room, and storage.



PHOTOS COURTESY OF ADDISON HOMES

Project Info

PROJECT NAME: Westbrooke Infill, Powdersville, South Carolina

BUILDER: Addison Homes, Greer, South Carolina, www.addison-homes.com

COMPLETED: August 2022

What makes a home a DOE ZERO ENERGY READY HOME?

- 1 BASELINE**
ENERGY STAR
Certified Homes
Version 3.0/3.1
- 2 ENVELOPE**
meets or exceeds
2012 IECC levels
- 3 DUCT SYSTEM**
located within the
home's thermal
boundary
- 4 WATER
EFFICIENCY**
meets or
exceeds the EPA
WaterSense
Section 3.3 specs
- 5 LIGHTING AND
APPLIANCES**
ENERGY STAR
qualified
- 6 INDOOR AIR
QUALITY**
meets or exceeds
the EPA Indoor
AirPlus Verification Checklist
- 7 RENEWABLE READY**
meets EPA Renewable Energy-
Ready Home.



On the Rise

When there's not enough room to build a home outside, think up—way up.

Todd Usher, president of Addison Homes in Greenville, South Carolina, considers himself a semi-custom home builder, offering his home buyers a curated suite of house plans, interior, and exterior finish options. However, for the benefit of his customers, there is one standard upgrade on his homes: Each one is constructed to the high performance criteria of the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) program.

Usher is unique in focusing on DOE ZERH construction. Addison Homes completed its—and one of South Carolina's—first such home in 2015. Addison is currently the only South Carolina builder certifying homes to the requirements of the program. It has constructed 11 homes to the ZERH standards, including six that have won DOE Housing Innovation Awards. In 2024, Addison was recognized with its second DOE Zero Energy Grand Award.

The four-level Westbrooke Infill home in Powdersville, S.C., is proof that DOE's ZERH requirements may be a recipe. A recipe, yes, but no cookie cutter. This home is unique for Usher in terms of its layout and some of the technologies incorporated into the home.

The narrow, sloping, wedge-shaped lot was the last one available in a 30-year-old suburban neighborhood. The lot dimensions left little room to spread out, so Usher worked with the owners on a floorplan that instead went up, with two full stories plus a partial third floor to house the fourth bedroom, fourth bath, and playroom. A walk-out basement below contains the garage, mechanicals, rec room and storage.

INSIDE INFORMATION

While many past Addison homes had an insulated crawlspace, the sloped lot of this home was ideal for a daylight basement, providing more living space within its compact 38.5-by-25.6-foot footprint. Basement walls were constructed of pre-cast concrete panels engineered specifically for the home. The concrete walls have waterproofing on the exterior, while an integrated rigid foam layer wraps the inside surface of the walls and molded concrete studs. The foam-wrapped studs are faced with metal to provide an interior drywall nailing surface.

The panels are made offsite in a factory in North Carolina and trucked to the home site, where they can be set in place with a crane in less than a day. "Construction can begin immediately and we don't have to do anything other than run electrical through them and hang drywall," says Usher. "For us, this is more cost effective than doing a poured concrete wall that then has to be cured, waterproofed, insulated and framed."

The home's stick-framed walls were constructed with several advanced framing techniques, including 2-by-6 studs at 24-inches on-center spacing, two-stud (not three-stud) corners with drywall clips, open and insulated headers, and ladder blocking rather than solid blocking at interior wall intersections. All of these steps reduce the amount of lumber needed for framing while increasing the amount of space in the walls for insulation.

The walls were packed with R-19 unfaced fiberglass batts, then sheathed with a coated OSB with a one-inch layer of polyisocyanurate

foam glued to the inside surface. "This is the first home we built using a wall assembly construction of 2-by-6s at 24 inches on center and the R-6 coated sheathing," says Usher. "Moving from R-13 cavity insulation to R-19 makes the house far more energy efficient, with thicker, quieter walls, and did not add significant overall cost."

Usher credited the coated insulated sheathing with helping them achieve exceptional air tightness. "[The sheathing] did not require the special nails and tape of other exterior insulation products," he says. "It saved us multiple labor steps since it includes sheathing, continuous insulation, and weather barrier in one product," says Usher.

For the gable roof assembly, Usher used locally made engineered roof trusses and, as with previous homes, insulated along the underside of the attic with 8 inches of open-cell spray foam that covered all truss top chords, providing an attic insulation value of R-31 and an unvented conditioned attic space for ducting and living space.

Addison incorporated a "vapor vent" along the ridge of the roof by using a vapor-open house wrap beneath roof ridge venting to avoid potential condensation issues.

All seams in the OSB roof sheathing were taped per the Insurance Institute for Building and Home Safety (IBHS) Fortified Roof standard to increase the home's hurricane resistance. The roof was topped with synthetic underlayment and asphalt architectural shingles.

"Offsite-manufactured components like roof trusses, floor trusses, and basement wall panels, and the accompanying engineering

Annual Energy
Costs

\$1,600
(without PV)

N/A
(with PV)

Annual Energy
Cost Savings*

\$2,300
(without PV)

N/A
(with PV)

Annual Energy
Savings

19,970 kWh
(without PV)

N/A
(with PV)

Savings in the
first 30 years

\$95,800
(without PV)

N/A
(with PV)

* vs typical new homes

Key Features

AIR SEALING: 0.70 ACH50; insulated sheathing sealed with tape; airtight precast foundation.

APPLIANCES AND LIGHTING: ENERGY STAR appliances; LED lighting.

ATTIC: Unvented attic, 8-inch R-31 open-cell spray foam on underside of roof deck. 10-inch raised-heel trusses.

ENERGY MANAGEMENT SYSTEM: Electricity consumption and IAQ of whole house and specific circuits monitored and tracked.

FOUNDATION: Insulated basement. Precast concrete wall system with adhered 2.5-inch rigid polyiso on interior with metal facing over insulation-wrapped concrete studs; 0.5 inch drywall.

HOT WATER: Heat pump water heater, 80-gallon, 3.45 COP; internet-tied auto leak detection and shutoff. Adaptive recirculation loop.

HVAC: Central variable-speed heat pump, 9.2 HSPF, 18.7 SEER; small-diameter compact ducts; MERV 16 filters; transfer grilles.

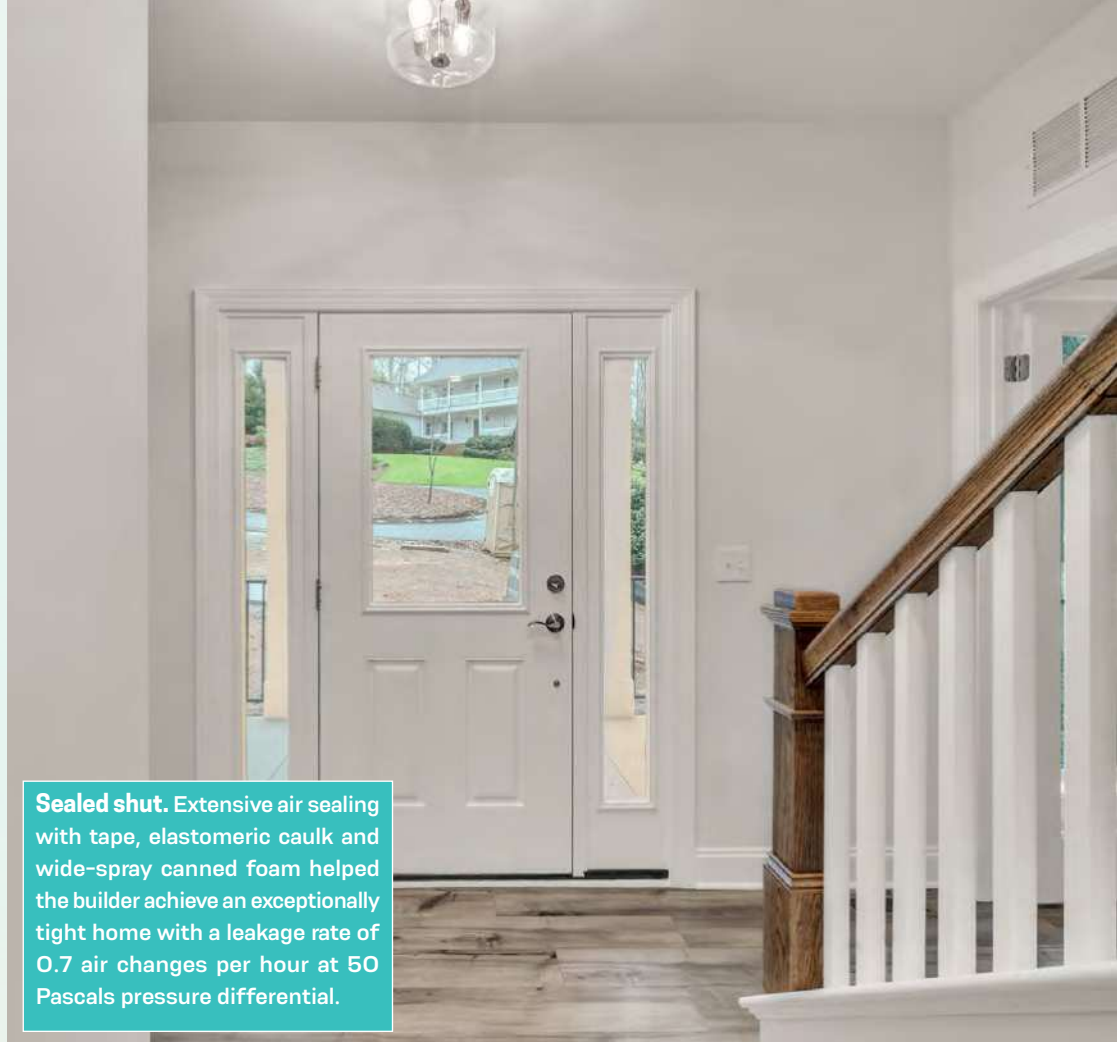
ROOF: Gable truss roof, 7/16-inch OSB roof sheathing, synthetic roof underlayment, asphalt architectural shingles.

VENTILATION: Bath exhaust fans with humidity and timer controls. Ventilating dehumidifier with humidity controls and MERV 13 filters, tied to HVAC air handler. Fresh air intake tied TO RANGE HOOD.

WALLS: 2-by-6 24-inch o.c. + 1-inch Polyiso, R-25 total: advanced framed, R-19 unfaced fiberglass batt in cavity, 7/16-inch coated OSB with taped seams; 1-inch rigid polyiso; composite polymer siding.

WINDOWS: Double-pane windows, U=0.26, SHGC=0.19.

OTHER: Wired for an electric vehicle charger.



Sealed shut. Extensive air sealing with tape, elastomeric caulk and wide-spray canned foam helped the builder achieve an exceptionally tight home with a leakage rate of 0.7 air changes per hour at 50 Pascals pressure differential.

plans that specify the location for each component, are integral to our approach to quality construction, as they avoid framers having to make a lot of ad hoc decisions in the field,” Usher says. “They also reduce labor time and waste for cost savings.”

ENVIRONMENTAL ASPECTS

The ventilation system for the home consists of fresh air intakes on the ventilating dehumidifier and exhaust fans (not balanced). The central thermostats control the HVAC setpoint for heating and cooling, a humidistat for control of the dehumidifiers, and ventilation control based on ASHRAE 62.2. The bath exhaust fans are controlled by a humidity sensor, a timer, and a manual switch.

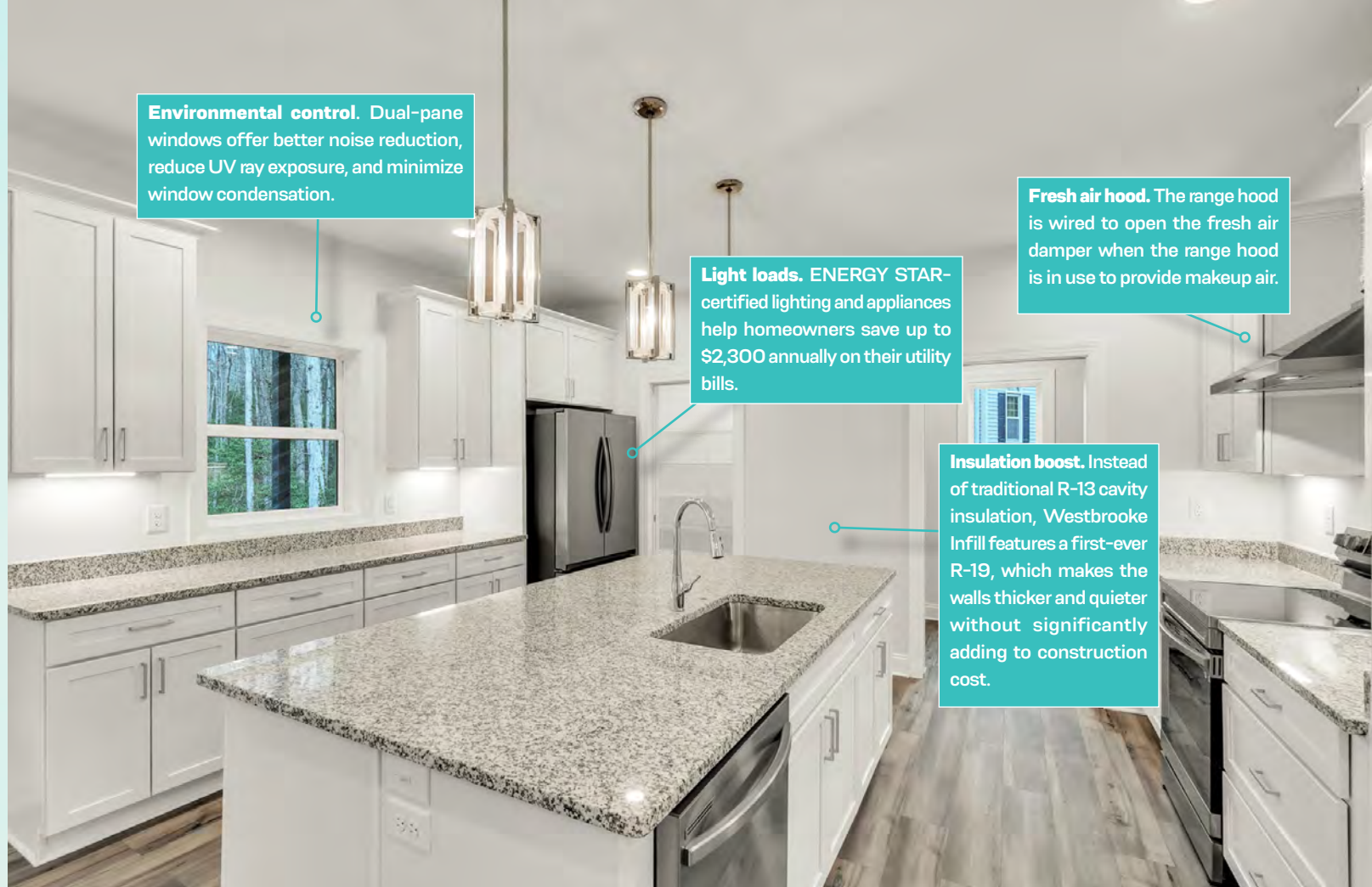
The range hood is wired to open the fresh air damper when the range hood is in use to provide makeup air, although this is not required by code or the DOE ERH standard. Space heating is provided by two high-efficiency (9.2 HSPF2, 18.7 SEER2) variable-speed heat pumps: 1.5 ton for the basement and main level, and 1 ton for the two upper floors. “That’s just 2.5 tons for all 3,682 square

feet,” Usher says.

Both systems were sized using ACCA Manual S based on a Manual J load calculation. Transfer grilles were used to balance air pressures between rooms and return ducts. Usher selected a compact duct system using 3-inch- and 4-inch-diameter uninsulated ducts that run through the floor cavities of the home. Each heat pump was paired with a ventilating dehumidifier to manage the latent load in the home and to provide fresh air ventilation.

“This is the first time we used thermostats with integrated controls for temperature, dehumidification, and ventilation of fresh air,” Usher notes. The thermostats are connected to the internet where the homeowner can control the home’s systems and monitor electrical usage of the whole house and individual circuits.

To get the desired HVAC performance, Usher has taken the unusual step of bringing all of his HVAC design in house. “We currently do the HVAC system design, procure the equipment and ductwork materials, then hire installers and provide them with step-by-step installation instructions,” says Usher.



Environmental control. Dual-pane windows offer better noise reduction, reduce UV ray exposure, and minimize window condensation.

Light loads. ENERGY STAR-certified lighting and appliances help homeowners save up to \$2,300 annually on their utility bills.

Fresh air hood. The range hood is wired to open the fresh air damper when the range hood is in use to provide makeup air.

Insulation boost. Instead of traditional R-13 cavity insulation, Westbrook Infill features a first-ever R-19, which makes the walls thicker and quieter without significantly adding to construction cost.



Smarter systems. An 80-gallon heat pump water heater is internet connected and has leak detection with an automatic shut off valve. A smart recirculation pump speeds hot water to faucets for shorter wait times and less water loss.



Foam buffer. The attic is insulated on the underside of the roof deck with 8 inches of open-cell spray foam, providing an insulated space for the small-diameter HVAC ducts.

SERVING THE CLIENT

Usher, a recent PhD graduate and current professor in Clemson's Department of Construction Science and Management, has put his educator skills to use—not just with subcontractors but also with college students, code officials and fellow builders.

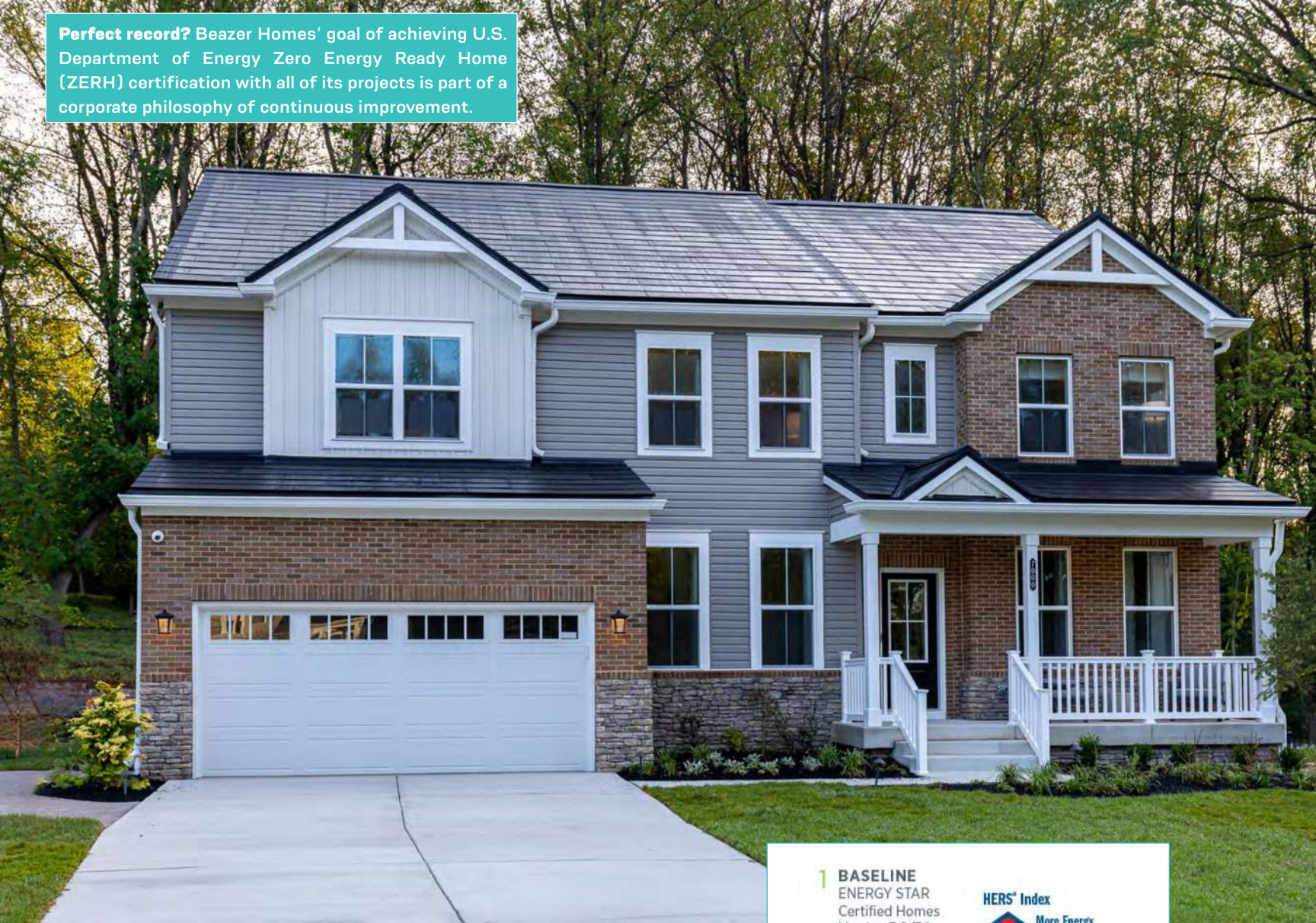
Usher is also a frequent speaker at conferences, a prolific blogger on LinkedIn, and recently a developer of building science YouTube videos.

One of his most appreciative audiences may be Addison Homes' clients. For every home buyer, Usher prepares a 75- to 100-page

homeowners manual that includes explanations of all systems in the home with warranty and maintenance information.

He also makes house calls. "We are always available to past clients for questions and consultation. We have also started to offer home maintenance services, where we monitor and maintain the systems in our past clients' homes on service agreements," Usher says. "We firmly believe that continuing relationships and service after the sale is absolutely critical for zero energy homes because of the lack of understanding of high-performance homes in the market among contractors."

Perfect record? Beazer Homes' goal of achieving U.S. Department of Energy Zero Energy Ready Home (ZERH) certification with all of its projects is part of a corporate philosophy of continuous improvement.



PHOTOS COURTESY OF BEAZER HOMES

Project Info

PROJECT NAME: Hampton Hills, Ellicott City, Maryland

BUILDERS: Beazer Homes, Atlanta, Georgia, www.beazer.com

COMPLETED: August 2023

1 BASELINE
ENERGY STAR
Certified Homes
Version 3.0/3.1

2 ENVELOPE
meets or exceeds
2012 IECC levels

3 DUCT SYSTEM
located within the
home's thermal
boundary

**4 WATER
EFFICIENCY**
meets or exceeds
the EPA WaterSense
Section 3.3 specs

**5 LIGHTING AND
APPLIANCES**
ENERGY STAR
qualified

**6 INDOOR AIR
QUALITY**
meets or exceeds
the EPA Indoor
AirPlus Verification
Checklist

7 RENEWABLE READY
meets EPA Renewable Energy-
Ready Home.





Comfort Zone

Beazer Homes' ZERH winner makes it easy to live an easy life.

Beazer Homes is steadily developing a reputation as an industry-leading home builder in the United States, and it has come into the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) program in a big way. After building its first DOE Zero Energy Ready-certified home in September 2022, Beazer now constructs 98 percent of its new home starts to ZERH program requirements. More than 3,200 homes have been certified as of December 2024.

The builder is on track to certify 100 percent of its new homes by the end of 2025. DOE recognized Beazer's efforts with a Housing Innovation Grand Award for most homes certified in 2024.

According to the company, Beazer's participation in the ZERH program has been a win-win: A win for Beazer, with the record-breaking number of certifications providing national recognition and third-party verification of its truly high-performance homes, and a win for DOE, confirming the feasibility of the program for large production builders. Beazer has a commitment "to provide homeowners with extraordinary value at an affordable price," but the American home buyer might be the biggest winner of all.

TRADITION OF EXCELLENCE

The builder, who constructs about 5,000 homes annually and is active in 13 states and 17 submarkets, is no stranger to above-code, high-performance construction. Beazer built its first ENERGY STAR-certified home in 1998 and made a national commitment to build 100 percent Energy Star dwellings

starting in 2011. As soon as the ZERH Version 2 program requirements were released in 2020, Beazer voluntarily began certifying homes at that more-stringent level.

The Hampton Hills project in Ellicott City, Maryland, is a prime example of how well that program works. "We've always been focused on doing more and offering a better product for our homebuyers," says Brian Shanks, Beazer's manager of governmental affairs. "Comfort's got to be No. 1, so we've focused on the building envelope first.

The next step was determining how to deliver a zero-energy home. That includes looking toward renewables and battery storage opportunities."

Although installation of photovoltaic panels is not required by the DOE program, on this home Beazer chose to install a 10-kW PV array and two batteries providing 27 kWh of storage capacity, for 12 hours of resiliency running entirely off the battery. This home also has an electric vehicle (EV) charger.

Beazer worked with building scientists to develop a housing assembly that uses common construction materials combined in uncommon ways to provide the highest performance possible. The 2-by-6, 24-inch on-center wall panels are first sprayed with 2.5 inches (R-18.5) of closed-cell spray foam that helps to insulate the walls and improve the air infiltration barrier for an airtight outer layer. The wall cavities are further filled with R-12.5 of blown fiberglass and topped with half-inch drywall.

"Combining spray polyurethane foam with the loose fiberglass enabled us to

achieve a more-robust wall assembly without increasing the wall cavity depth," says Shanks.

In addition, taped house wrap provides a weather-resistant barrier under the vinyl siding and masonry accents. Tape flashing around windows and doors and rubber flashing gaskets around piping provide air sealing and water control around any holes in the exterior walls.

The simple gable truss roof tops a vented attic insulated with 20 inches (R-60) of blown fiberglass. Raised heels lift the trusses 16 inches to provide more room for insulation above the top plates at the exterior walls. A synthetic underlayment protects the OSB roof sheathing. The entire roof is covered with inconspicuous photovoltaic tiles.

The 2-by-4 walls in the home's finished basement are filled with R-19 faced fiberglass batts. The 14-inch I-joist ceiling above the garage is densely packed with R-47 of blown fiberglass.

POSITIVE VENTILATION

In addition to traditional air sealing measures, Beazer used a whole-house aerosolized air sealing process to help reduce air leakage to 1.09 air changes per hour at 50 Pascals pressure differential (ACH50), well below the 3.0 ACH 50 air leakage maximum required by the program.

To provide ventilation to the home, Beazer installed an energy recovery ventilator (ERV). "We put ERVs in our homes as a normal course of business," Shanks says. "The program doesn't require it, but the program validates it and gives us the acknowledgement."

Annual Energy
Costs

\$2,300
(without PV)

\$400
(with PV)

Annual Energy
Cost Savings*

\$3,500
(without PV)

\$5,450
(with PV)

Annual Energy
Savings

25,230 kWh
(without PV)

39,010 kWh
(with PV)

Savings in the
first 30 years

\$147,450
(without PV)

\$228,000
(with PV)

* vs typical new homes

Key Features

AIR SEALING: 1.09 ACH50; traditional air sealing practices and aerosolized acrylic whole house air sealant.

APPLIANCES: ENERGY STAR appliances.

ATTIC: Vented, 20-inch R-60 blown-in fiberglass; 16-inch raised-heel trusses.

ENERGY MANAGEMENT SYSTEM: Wi-Fi thermostat could control IAQ monitoring, HEPA filtration, UV purifier, and whole house dehumidifier.

FOUNDATION: Insulated basement, poured concrete walls, interior framed wall with R-19 faced fiberglass batts, half-inch sheetrock.

HOT WATER: Heat pump water heater, 80-gallon, 3.45 COP. Central hot water distribution design with the water heater centrally located.

HVAC: Central air-source heat pump, 8.1 HSPF, 16.7 SEER; compact duct design, variable speed compressor and inverter system.

ROOF: Gable truss roof, 24-inch o.c., 7/16-inch OSB roof sheathing, synthetic roofing underlayment, integrated solar roof tiles.

SOLAR: 10.08 kW PV, 27 kWh of batteries.

VENTILATION: ERV, integrated with HVAC system that monitors IAQ, ECM motors; MERV 8 filters.

WALLS: 2-by-6 24-inch o.c., R-31 total: Advanced framed, R-12.5 blown fiberglass, R-18.5 closed-cell spray foam, 7/16-inch OSB, house wrap, vinyl siding with masonry accents.

WINDOWS: Double-pane windows, U=0.28, SHGC=0.25.

OTHER: Electric vehicle charger.



The ERV brings in outdoor air through a dampered fresh air intake and pulls that air through a heat exchanger before distributing it in the home. The intake fan is operated simultaneously with an exhaust fan that pulls stale inside air from the home and passes it through the heat exchanger on its way out. The heat exchanger transfers heat—warming incoming air in the winter and cooling incoming air in the summer.

The ERV is equipped with an electronically commutated motor (ECM) for efficient operation. The incoming air passes through a MERV 8 filter capable of trapping dust, pollen, pet hair, and smoke particles.

After passing through the ERV, the tempered fresh air is supplied to the return side of the air handler for the home's central air-source heat pump. The heat pump is equipped with a variable-speed compressor and a true variable-speed inverter.

The system provides heating with an efficiency of 8.1 HSPF2 and cooling with an efficiency of 16.7 SEER2.

Beazer has invested in a commercially available but uncommon duct distribution system that uses small-diameter ducts to

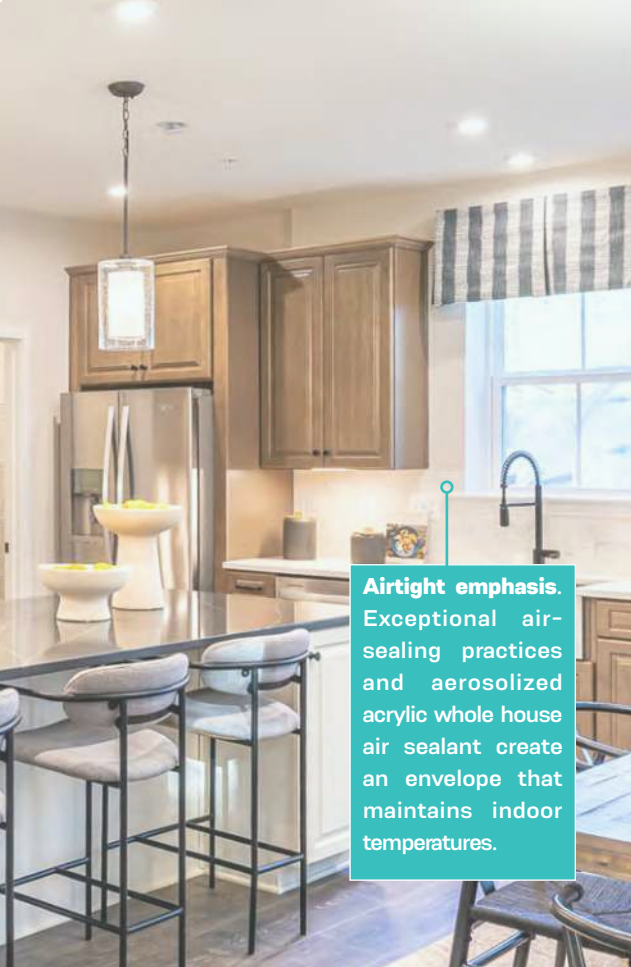
quickly and efficiently distribute hot and cold air throughout the two-story home plus basement, while keeping the ducts within the home's conditioned space.

“By pairing the efficient inverter heat pump system with the communicating Wi-Fi-enabled thermostat, the homeowner is provided with infrastructure capable of monitoring IAQ and an ecosystem that could include HEPA filtration, UV purification, and whole house dehumidification, should they choose to add it in the future,” Shanks says.

An 80-gallon heat pump water heater provides hot water with a coefficient of performance (COP) of 3.45, more than three times the efficiency of an electric resistance or gas water heater. The water heater is centrally located within the home to speed hot water to the kitchen, laundry, and bathrooms. The heat pump water heater's location in the basement in a utility closet off an unfinished storage area ensures that any noise or cold air will cause minimal discomfort to occupants.

TECHNOLOGY IS KEY

Many of the products and technologies



Airtight emphasis. Exceptional air-sealing practices and aerosolized acrylic whole house air sealant create an envelope that maintains indoor temperatures.



Roofing with a cause. The roof of the home has photovoltaic panels, which provide 10 kW of solar power and enable Hampton Hills to yield near net-zero energy bills over the course of a year.

Beazer used in Hampton Hills are featured in every home the company constructs. As a volume builder with a national scope, it was important to Beazer that those products be readily available through normal supply chain distribution partners. All construction techniques and methodologies Beazer utilizes during the build process are commonly known practices, although

not often associated with home building at scale. “In some cases,” says Shanks, “Beazer has worked with manufacturers to identify beneficial products for high-performance homes, helping to accelerate their development-to-delivery cycle.”

Shanks points to Beazer’s work with a leading ventilation product manufacturer as an instance where the company’s buying power has bolstered the supply of balanced ventilation products, improving their marketplace availability for all builders.

It hasn’t always been easy. “We had to take a deeper look at how our processes and components work together,” says Shanks. “We had to research which improvements to building materials or component specifications were impactful, and which weren’t.”

For Beazer, in some cases, it meant searching for manufacturing and trade partners with the same passion for delivering efficient homes, or working to improve training for staff and partners. Sometimes “we’ve had to train the local workforce, but ‘a rising tide lifts all boats,’” says Shanks, acknowledging that other builders have benefitted from Beazer’s innovations.

Shanks sees the move to 100 percent DOE ZERH certification as part of a corporate philosophy of continuous improvement. He credits Allan Merrill, Beazer’s chairperson and CEO, and Jim Moore, senior vice president of operations, with the vision to “keep doing better.”



Mathematical mastery. A centrally located heat pump water heater provides a coefficient of performance that is more than three times as efficient as an electric resistance or gas unit and speeds hot water to the kitchen, laundry and bathrooms.

Solar sited. The home is equipped with 13.2 kW of photovoltaic panels and 32 kWhs of battery storage—enough electricity to power the home and an electric vehicle or two.



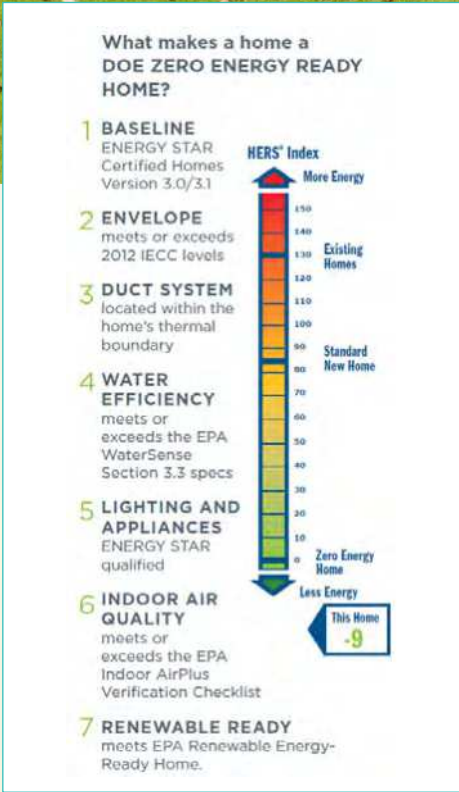
PHOTOS COURTESY OF DANIEL COLOMBINI

Project Info

PROJECT NAME: Spring Valley Passive House, Ossining, New York

BUILDERS: Daniel Colombini, Ossining, New York, www.goldmancopeland.com

COMPLETED: June 2023



The Three Rs

Construction of the Spring Valley Passive House is a classic case of researching, rebuilding and recycling.

"I'm a mechanical engineer and mechanical engineers love to engineer their way out of problems with mechanical engineering solutions," says homeowner and builder Daniel Colombini. But Colombini admits that better mechanicals alone were not going to be enough to turn the drafty old 1930s home he had bought in Ossining, New York, into a comfortable place for his family. Research into energy-efficient homes sparked an interest in Passive Houses and convinced him that, for a truly comfortable, long-lasting home, the best option was to start over with a highly insulated building envelope.

Colombini's research led him to the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) program. The end result was Spring Valley Passive House, a new 3,585-square-foot two-story home that achieved DOE ZERH certification and received a DOE Housing Innovation Grand Award. His home was also the first project to achieve both LEED Platinum and Passive House certification in Westchester County, and one of the first in New York state. The home achieved a HERS score of minus 9, providing enough electricity to power the home and an electric car, thanks to the 13.2 kW of roof-mounted photovoltaic panels and two 16 kWh batteries.

"We learned a lot about construction," says Colombini. "To do ZERH-level construction is not a big budget spend; these kinds of improvements should be done by everyone."

Colombini says total project costs were less than 10 percent over standard construction for a similar-sized home. Much of that added cost came from the Passive House qualifying windows and doors, which were

imported from Poland. To achieve DOE ZERH certification alone would have added less than 5 percent over standard construction, Colombini estimates.

SUSTAINABLY BUILT

To meet the Passive House criteria, Colombini went well beyond even the high insulation requirements of the 2021 IECC. The effort starts with a 2-by-4, 16-inch on-center exterior wall that is filled with R-12 mineral wool batts and wrapped with OSB that is sealed and taped at all seams. To the exterior of the sheathing, Larsen trusses were attached through to the studs. The Larsen trusses are factory-made I-joists or site-built trusses consisting of plywood and 2-by-4s salvaged from the demolition of the old home. The 12-inch-deep trusses were wrapped with a breathable air- and water-control membrane, then stuffed with R-42 of dense-packed cellulose. The membrane was held in place with vertical 1-by-4 furring strips that were topped with hemlock siding.

Lumber salvaged from the original house was used wherever possible on the new construction and 75 percent of demolition and construction debris was diverted from the landfill. Much of what couldn't be used on site was donated, given away, or sold for re-use on other projects.

The foundation included about 75 linear feet of existing concrete block wall that was retained from the original building and insulated for reuse as part of the basement walls. The basement and crawlspace walls were insulated with R-40 of XPS; 4 inches (R-20) of XPS was installed under the newly poured slabs.

The roof is a simple gable rafter roof constructed of 18-inch Larsen truss rafters at 16-inches on center. The rafters were topped with 5/8-inch OSB sheathing and a vapor-permeable water-resistant 3-ply membrane underlayment under the asphalt shingles. On the south-facing roof where the solar panels were to be installed, this underlayment was topped with 2-inch furring strips installed over the rafters. That was topped with another layer of sheathing to provide an attachment surface for the solar panels while avoiding holes in the primary weather and air barrier.

The home is heated and cooled by a variable refrigerant flow (VRF) heat pump system with a heating efficiency of 9.0 HSPF, a cooling efficiency of 16 SEER, and a capacity of 3 tons (36,000 Btu/hour). The heat pump serves three indoor evaporator units (one per floor), each equipped with a MERV 13 filter.

A separately ducted energy recovery ventilator (ERV) provides fresh tempered air throughout the home. The outside air intake is filtered with a MERV 13 filter. The ERV operates at three speeds, depending on air quality needs in the home. "Providing a ventilation system that is separate from the heating and cooling system allows for simpler ventilation operation that runs constantly, regardless of heating and cooling demand," says Colombini. "This works well for a Passive House, which often does not require heating or cooling, but always needs ventilation."

The HVAC was designed to be as simple as possible, using readily available high efficiency equipment. "Our experience shows that overly complex designs may indicate great efficiency on paper," Colombini notes. "But in practice, systems must be easy to operate and maintain by building occupants and service vendors."

Annual Energy Costs

\$2,200
(without PV)

\$200
(with PV)

Annual Energy Cost Savings*

\$6,300
(without PV)

\$8,950
(with PV)

Annual Energy Savings

28,550 kWh
(without PV)

44,360 kWh
(with PV)

Savings in the first 30 years

\$262,900
(without PV)

\$373,950
(with PV)

* vs typical new homes

Key Features

AIR SEALING: 0.64 ACH50; taped and sealed sheathing; blower door testing during construction.

APPLIANCES: ENERGY STAR appliances; induction cooktop.

ATTIC: Unvented attic. Dense-packed cellulose under roof deck.

ENERGY MANAGEMENT SYSTEM: Solar array monitored via an app.

FOUNDATION: Insulated basement and unvented crawlspace.

HOT WATER: Heat pump water heater, 50 gallon, 3.88 EEF. Adaptive recirculation.

HVAC: Central air-source heat pump, 9.0 HSPF, 16.0 SEER. Passive solar design.

ROOF: Gable Larsen truss and rafter roof, 16-inch o.c., 5/8-inch OSB, synthetic underlayment, architectural shingles.

SOLAR: 13.2 kW PV, 32 kWh batteries.

VENTILATION: ERV, MERV 13 filters, separate ducts.

WALLS: Larsen trusses and 2-by-4 16-inch o.c., R-57 total: R-12 mineral wool batt, 5/8-inch OSB, 12-inch Larsen trusses with R-42 dense pack cellulose, hemlock siding.

WINDOWS: Triple-pane windows, U=0.17, SHGC=0.49, low-e, argon-fill. Roofoverhangs.

OTHER: Passive House Zero certified; LEED Platinum.

Salvage right. Daniel Colombini's Spring Valley Passive House is a blend of repurposed materials, including its wooden structure and concrete foundation.



Reclamation project. Lumber salvaged from the original house was used wherever possible on the new construction.

Indoor air quality is king. Like all Department of Energy (DOE) Zero Energy Ready-certified homes, this house meets the air quality requirements of the Environmental Protection Agency (EPA)'s Indoor AirPlus program.

Premium glazing. For extra climate control and noise reduction, Spring Valley Passive House features triple-pane, low-emissivity coated windows.

Daylight intentions. Natural lighting is emphasized throughout the house to reduce electricity costs.





Second life. Much of the house is constructed from repurposed materials. For example, 75 linear feet of existing concrete block wall was retained from the original building and insulated for reuse as part of the basement walls.

“This project demonstrates that Zero Energy Ready Home construction can be attained with a modest cost increase given a properly trained design and construction team.”

—Daniel Colombini, principal and multidisciplinary design lead, Goldman Copeland

PROJECT CHALLENGES

Even though the project team sought simplicity on the design side, there were some implementation issues. Supplies were sometimes difficult to get due to the pandemic. Reuse of lumber helped to balance some material cost spikes and shortages, as did some creative switching of materials such as using siding made of hemlock instead of cedar.

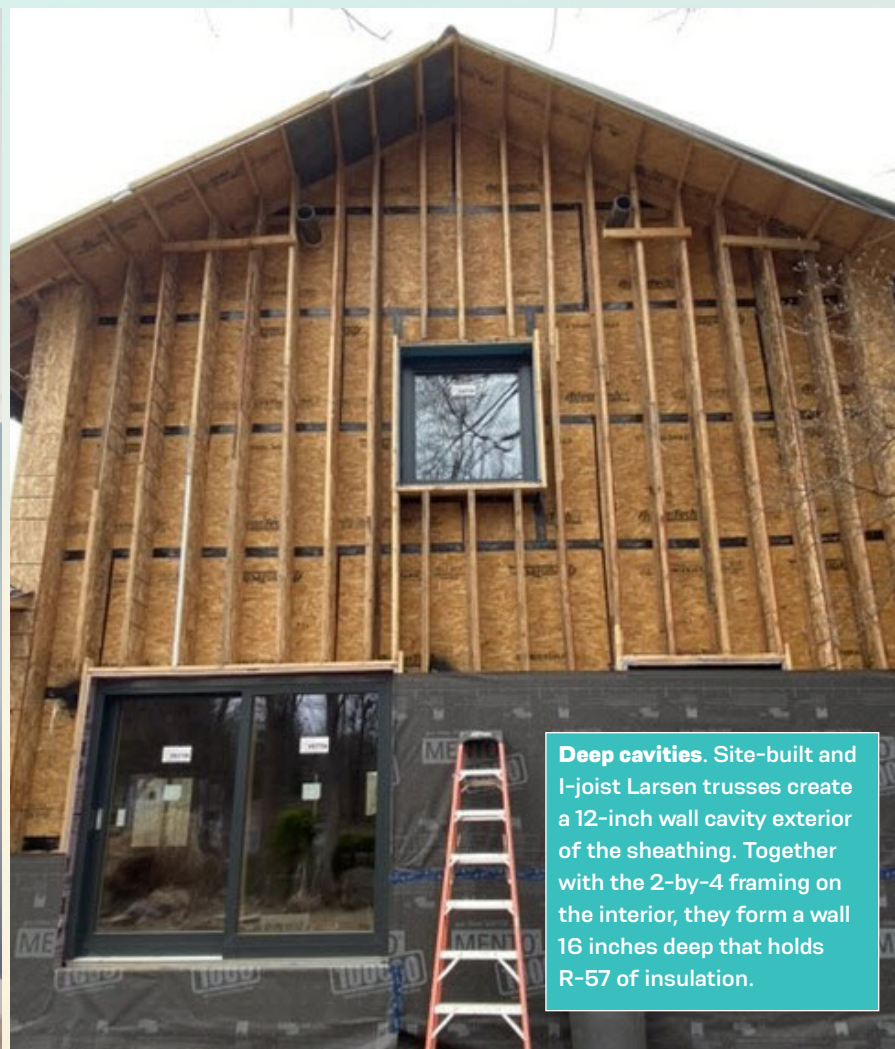
Another challenge was finding skilled labor that understood what needed to be done to meet the objectives of the project. “Finding contractors who were able to do this was nearly impossible,” Colombini remarks. “Everyone learned a lot on the job.”

Several training sessions took place on site to teach the subcontractors various envelope assembly details. For example, extreme care was taken to provide a sealed envelope. This required constant supervision and quality control, Colombini says.

Still, Colombini is optimistic. “Many of these strategies could be easily implemented by any design and construction team that is educated on their implementation,” he says.

Colombini says there is one huge point that the development team must keep in mind. “What are the fastest, most cost-effective ways to meet the design criteria that we’re trying to hit?” he notes. “That’s the question we have to keep asking.”

That perspective has Colombini excited to take what he learned on this house and try another one. “I’d like to do one in Vermont,” says Colombini. “Going to a colder climate zone, with half the budget, is my challenge.”



Deep cavities. Site-built and I-joint Larsen trusses create a 12-inch wall cavity exterior of the sheathing. Together with the 2-by-4 framing on the interior, they form a wall 16 inches deep that holds R-57 of insulation.

Small home, big benefit. Duke Street Cottages make up a “pocket neighborhood”—a venue for sustainable workforce housing aimed at first-time and low- to middle-income buyers.



PHOTOS COURTESY OF HOWARD BUILDING SCIENCE

Project Info

PROJECT NAME: Duke Street Cottage Two Bedroom, Granite Falls, North Carolina

BUILDER: Howard Building Science, Granite Falls, North Carolina,
howardbuildingscience.com

COMPLETED: January 2023

What makes a home a DOE ZERO ENERGY READY HOME?



Housing for All

This ‘pocket neighborhood’ and others like it may become a big deal in housing development.

Builder Rob Howard first heard the term “pocket neighborhoods” in 2018. Now he’s close to realizing his dream of building one with completion of the ninth of 11 small homes on a 1.25-acre parcel he’s dubbed Duke Street Cottages in Granite Falls, North Carolina.

For Howard, pocket neighborhoods are the perfect venue for what he refers to as workforce housing—homes aimed at first-time and low- to middle-income buyers. “Our goal is to provide more housing choices with small homes that anyone can afford, including recent college graduates with student loan debt and retirees on a fixed income,” says Howard.

“We are building towards a sustainable future where everyone has a safe, healthy place to call home,” says Howard. “We believe that everyone deserves to live in the SHADE: a Sustainable, Healthy, Affordable, Durable, Efficient home.”

Howard’s roadmap for getting there is the U.S. Department of Energy (DOE)’s Zero Energy Ready Home (ZERH) program. Every one of the 11 Duke Street Cottages will be certified to the program’s criteria.

Howard achieved a DOE Housing Innovation Award in 2024 for one of the homes, an 800-square-foot, two-bedroom, one-bath, one-story home in one of two floor plans built to date at Duke Street. The compact home epitomizes Howard Building Science’s company motto: “Proving that Sustainable is Attainable.”

“Every decision we make about construction materials and processes has to pass a cost-effectiveness test,” says Howard. “This cost-benefit analysis was burned into my brain from 15 years with Habitat for Humanity. We cannot just throw money at

the problem of attainable housing. We have to optimize the material and labor resources to achieve the highest performance for the lowest cost.”

SMALL BUT MIGHTY

The Duke Street Cottages may be small in volume, but they are big on performance. The DOE program has ENERGY STAR and EPA Indoor AirPlus home certification and the latest energy codes as its baseline, so every certified home provides its home buyers with the health, resiliency, and utility bill savings these programs offer.

The DOE program offers multiple performance paths and builders are free to choose what building assembly methods and tradeoffs they will use to meet their performance targets.

For the first nine homes, Howard chose a panelized wall assembly. The panel product for this home consists of a 3.5-inch-thick closed-cell polyurethane foam core adhered to an inside-facing layer of OSB and an exterior layer of OSB with a coating that serves as a water-resistant air control layer.

The panels came to the site precision cut to the dimensions of the home’s design. This particular product uses inter-locking camlocks that ensure fast, foolproof connection of the panels. Spray foam was applied at the panel edges before connecting for airtight joints. Factory-formed corners provide for a complete air seal and continuous insulation at this otherwise hard-to-detail juncture. Pre-framed openings contribute to a fast assembly time, even with unskilled labor.

“With a small crew made up of two skilled carpenters and three college students, we were able to set the wall and roof panels in three days,” says Howard. Howard added

1-by-4 furring strips to the exterior of the SIPs to create a drainage plane and nail base for the engineered wood siding.

The same panel product was used to provide the roof, although the panels were thicker with a 5.5-inch core of closed-cell spray foam providing an R-40 roof in a simple gable design that was topped with asphalt shingles.

MORE FOR THE MONEY

Howard took many steps toward making the house as energy efficient—and cost effective—as possible.

The home sits on a crawlspace constructed of concrete masonry unit (CMU) blocks, insulated on the interior with R-10 rigid insulation; the ground is lined with a 10-mil vapor barrier. A dehumidifier is installed in the crawlspace to control relative humidity and prevent mold growth. Temperature and humidity sensors are also placed in the crawlspace to monitor conditions and send alerts remotely to homeowner’s mobile phones.

In the foundation, Howard has really been able to optimize costs. “We considered using precast insulated concrete wall panels or ICFs for the foundation walls but determined that we could achieve the same performance at a much lower cost by using a combination of CMU and rigid foam insulation,” he says. “We hired subcontractors to do our first crawlspace encapsulation but quickly realized that we could buy the materials and install them ourselves for a lot less money.”

The double-pane windows provide an insulation value of U-0.25 and have a low solar heat gain coefficient of 0.19 to minimize solar heat gain in this mixed-humid IECC 4A climate zone.

Annual Energy Costs

\$900

(without PV)

N/A

(with PV)

Annual Energy Cost Savings*

\$600

(without PV)

N/A

(with PV)

Annual Energy Savings

5,800 kWh

(without PV)

N/A

(with PV)

Savings in the first 30 years

\$25,650

(without PV)

N/A

(with PV)

* vs typical new homes

Key Features

AIR SEALING: 2.76 ACH50; closed-cell foam sill gasket; flashing tape on panel seams; stretch tape and liquid flashing around windows and doors; all penetrations sealed with spray foam and liquid flash.

ATTIC: Unvented, 5.5-inch R-40 panels with closed-cell spray foam core. 400-square-foot storage space.

FOUNDATION: Unvented crawlspace, concrete masonry unit walls insulated along interior with R-10 rigid foam. 10-mil vapor barrier on ground.

HOT WATER: Heat pump water heater, 50 gallon, 3.75 UEF. Core plumbing design.

HVAC: Ductless mini-split heat pump, 11.1 HSPF, 26.3 SEER. Dehumidifier in enclosed crawlspace.

ENERGY MANAGEMENT SYSTEM: Ventilation system controlled by sensors that monitor humidity, VOCs, smoke, carbon dioxide, and PM 2.5.

ROOF: Panels, gable roof: exterior face of panel is coated OSB.

VENTILATION: ERV, distributed system. Sensors to monitor humidity, VOCs, smoke, carbon dioxide, and PM 2.5.

WALLS: Panels, R-26 total: Closed-cell spray foam core, exterior face of panel has an integrated coating for rain screen and water control.

WINDOWS: Double-pane windows, $U=0.25$, SHGC=0.19.

OTHER: Electric vehicle charging station.



Howard took several steps to minimize drafts and air leakage in the building envelope, including taping the seams of the coated OSB, using a closed-cell foam sill gasket under the bottom plates, applying spray foam at the panel joints and around the windows and doors, installing stretch tape and liquid flash around the windows and doors, and sealing all penetrations in the building envelope with spray foam and liquid flash. Blower door testing is required on every ZERH-certified home and this home tested at 2.76 air changes per hour at 50 Pascals pressure differential.

An energy recovery ventilator (ERV) was installed to provide fresh air to the tight home while exhausting stale air. The ERV uses a heat exchanger to warm or cool the incoming air, which passes through a MERV 13 filter. Room sensors continually monitor humidity, VOCs, smoke, carbon dioxide, and PM2.5, and they can increase ventilation rates if sensors detect high levels of these air quality factors. A smart switch in the

bathroom monitors relative humidity and automatically controls the bath exhaust fan.

The ERV also helps distribute conditioned air from the home's single ductless mini-split heat pump which is installed in the living room/dining room. The high-performance heat pump has a cooling efficiency of 26.3 SEER2 and a heating efficiency of 11.1 HSPF2 and performs well even at cold outdoor temperatures.

The home's 50-gallon heat pump water heater provides domestic hot water with an efficiency of 3.75 UEF. A core plumbing design was used to keep hot water distribution as compact as possible. Energy Star-labeled appliances and lighting, and a heat pump clothes dryer and induction cooktop add to energy savings.

FROM THE POCKET

Howard has been interested in pocket neighborhoods since first hearing the term used by architect Ross Chapin, author of "Pocket Neighborhoods: Creating Small





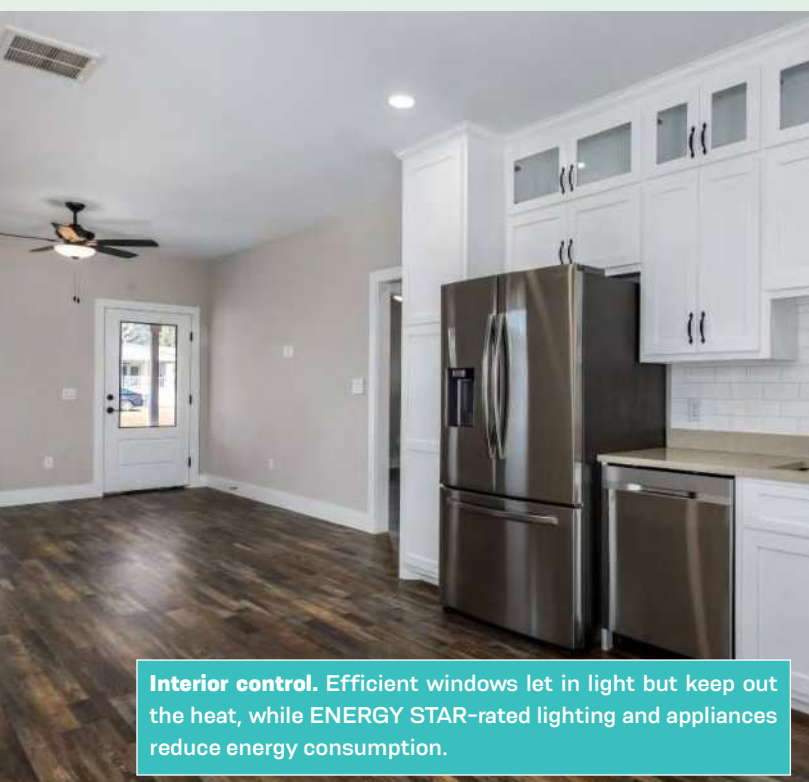
Superior simplicity. Interlocking panels—made with a 5.5-inch core of closed-cell spray foam—result in a highly efficient R-40 roof with a simple gable design topped with asphalt shingles.

Sun shield. Double-pane windows provide a high insulation value and have low solar heat gain coefficient to minimize solar heat gain.

On solid ground. The home's foundation, a combination of concrete masonry unit (CMU) and rigid foam insulation, improves thermal performance and energy efficiency.



Compact gear. Energy-saving appliances abound throughout Duke Street Cottages, such as this space-saving, stackable washer-dryer laundry hub with smart features.



Interior control. Efficient windows let in light but keep out the heat, while ENERGY STAR-rated lighting and appliances reduce energy consumption.

Scale Community in a Large Scale World,” at a conference in 2018. Howard already has plans for two more pocket neighborhoods in the works on property he has acquired.

But first he wants to finish Duke Street Cottages. Nine of the 11 homes have been built and sold so far; homes 10 and 11 will be modular construction. “That was not the original plan, but I ran into a right-of-way conflict with the railroad that backs up to our property,” Howard says. “I had to shrink the footprint of the last two homes from 24 feet wide to 16 feet wide. I realized you can only ship home modules up to that smaller size.” He also found a factory partner in South Carolina who would construct the modular homes to DOE ZERH standards.

Howard’s first foray into pocket neighborhoods has generated a lot of interest. Once he started building

the Duke Street Cottages, word got around. “Builders and developers just show up at the site to see what I’m up to—a lot of them are intrigued by this idea,” says Howard. “One morning I came out at 8 a.m. and there was someone walking the site. He was in town visiting family. He and his wife are now my business partners.”

Although the home does not have solar installed, it is roughed-in for a future solar array on the roof. “We are currently talking to LG about testing its new *Home 8 Energy Storage System* on one of the homes at Duke Street Cottages. With batteries and an 8-kW PV array, we can achieve net-zero energy with minimal dependence on the grid,” says Howard. “Our ultimate goal is for all of our homes to achieve net-zero energy.”

Price king. TC Legend Homes specializes in houses that are affordable and high performing in terms of affordable energy and HVAC usage. How does TCL do it? By using the same construction methods from home to home, which lowers construction costs.



PHOTOS COURTESY OF TC LEGEND HOMES

Project Info

PROJECT NAME: Lynden Powerhouse, Lynden, California

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

COMPLETED: September 2023

What makes a home a DOE ZERO ENERGY READY HOME?



A Certified Champion

Affordable, efficient and award winning. What's not to like?

It seems that the more innovative TC Legend Homes becomes, the more the company values simplicity. Simplicity of design has been a key to success for this 12-time winner and now 6-time grand winner in the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) Innovation Awards competition, according to company founder and president Ted Clifton. "It's what enables us to make homes that are affordable and incredibly high performing," he says.

While the going rate for custom homes in the Bellingham, Washington, market is \$350-\$550 per square foot, Clifton is building for \$300 per square foot. Clifton achieves this low cost with a tried-and-true building envelope and consistent HVAC package that also meets the criteria of the DOE ZERH certification. The criteria also provides homeowners with net zero power bills through a combination of solar panels and battery storage that can power the home and an electric vehicle or two.

The Bellingham custom home builder has been constructing houses in the northwest corner of Washington state since 1991, honing construction methods he learned from his father, Ted Clifton of Clifton View Homes in Coupeville, Washington. Like his father, Clifton has sought to achieve DOE ZERH certification on every home he builds since founding TC Legend Homes in 2015.

PIECING THINGS TOGETHER

One way Clifton simplifies construction is to use the same construction methods from home to home. Every house is constructed with a structural insulated panel (SIP) wall and roof assembly, and an

insulated concrete form (ICF) foundation.

The walls consist of 6.5-inch-thick SIP panels (two half-inch layers of OSB sandwiching a fully adhered 5.5-inch layer of graphite-enhanced expanded polystyrene [GPS]) that provides a wall with an R-29 insulation value, and exceptional wind and seismic resistance. Some builders use dimensional lumber to connect their SIP panels; Clifton uses insulated splines which, together with the continuous layer of GPS in the panels, provide a wall with almost no thermal bridging or transfer of heat between the inside and outside of the home.

Clifton did install a plastic mesh rainscreen product on this home at the homeowner's request. His preferred method of water management is a carefully applied draining house wrap with taped seams, and correctly installed siding over flanged, caulked windows with no window or corner trim. "With all that trim, you just have more seams to caulk," says Clifton. "We design in big eaves and keep it simple."

Thicker 10.25-inch R-48 SIPs are used to construct the roof. The panels are covered with a fully adhered membrane underlayment that prevents air and water leakage but is highly vapor permeable to reduce condensation in this otherwise unvented roof assembly. The locally made 24-gauge standing-seam metal roof has a lifetime warranty and allows for simple photovoltaic panel installation with very few roof penetrations.

Because of the structural strength of the walls and roof, no roof trusses are needed and all interior walls can be non-load bearing, providing for cathedral ceilings

and greater design flexibility for interior spaces.

BENEATH THE FEET: A SOLID PLAN

Clifton's signature house assembly also includes a slab-on-grade foundation with an exposed insulated concrete slab floor, wrapped in an ICF stem wall. This foundation assembly encompasses three components that serve multiple functions for simplicity, labor, and cost savings.

Under the 4-inch concrete floor slabs, four inches of high-density expanded polystyrene (EPS) provides R-20 of insulation value, as well as a vapor barrier, eliminating the need for a vapor retarder and capillary break under the slab. The EPS also provides a warm bed for the radiant heating coils that are covered with the poured concrete slab.

The slab is surrounded by 11.23-inch-thick ICFs consisting of two 2.625-inch layers of rigid foam providing an insulation value of R-24 and a stay-in-place form to hold the steel rebar and 6 inches of poured concrete. The foam separates the concrete slab from these concrete stem walls, virtually eliminating heat transfer through the slab edge. The concrete floor slabs themselves are usually sealed, stained, and polished to serve as durable, water-resistant flooring.

The exposed concrete slab also provides thermal mass that absorbs sun through large south-facing windows to provide a passive heating source. Extended roof eaves on the south side of the home allow in low winter sun while keeping out high summer sun.

Reasonably priced vinyl-framed triple-pane windows from a nearby British

Annual Energy
Costs

\$1,100
(without PV)

\$100
(with PV)

Annual Energy
Cost Savings*

\$1,850
(without PV)

\$3,700
(with PV)

Annual Energy
Savings

11,650 kWh
(without PV)

31,950
(with PV)

Savings in the
first 30 years

\$77,350
(without PV)

\$155,600
(with PV)

* vs typical new homes

Key Features

AIR SEALING: 0.45 ACH50. All SIP panel joints are double-bead mastic sealed. Interior panel seams are taped. Window and door rough openings are foamed. All penetrations are sealed with foam. The whole house is air sealed with aerosolized acrylic.

APPLIANCES AND LIGHTING: LED lighting, ENERGY STAR appliances.

ATTIC: Unvented vaulted ceilings: 10.25-inch R-48 graphite EPS SIP panels.

ENERGY MANAGEMENT SYSTEM: IAQ monitoring. Filter replacement alerts.

HOT WATER: Air-to-water heat pump for combined domestic hot water and space heating, 80 gallon, 4.62 COP. Adaptive recirculation. WaterSense-labeled fixtures.

HVAC: Air-to-water heat pump, radiant floor heating, 3 fan coils, 4.62 COP.

FOUNDATION: Slab on grade with 11.25-inch R-23.6 ICF stem wall. R-20 foam under slab.

ROOF: SIPs gable roof, self-adhering breathable vapor barrier. Metal roofing.

SOLAR: 17-kW PV, 30.7-kWh batteries.

VENTILATION: 3 HRVs, one for each living space, pull from baths and laundry, supply to bedrooms and living areas. HRVs are tied to a CO2 sensor for boost and motion sensors for auto turn off. Kitchen has separate fresh air intake fan balanced to range hood fan mounted outside for quiet operation. All air intakes have HEPA filters.

WALLS: SIPs, R-29 total. 6.5-inch graphite SIPs, self-adhered breathable weather resistant membrane, plastic mesh, fiber cement siding.

WINDOWS: Triple-pane windows, U=0.16, SHGC=0.45, Low e, argon-fill, vinyl-framed. Extended roof and eaves.

OTHER: Two EV chargers and an RV charger. 5,000-gallon rainwater cistern for irrigation.

Net zero accounting. The home's 17 kW of solar panels and 30 kWh of battery storage should provide the homeowner with \$0 electric bills and enough electricity to power the home, two cars, and an RV year round.



Columbia manufacturer complete the high-performance thermal envelope. “The window package only costs us about \$5,000 to \$10,000 more than double-pane windows but provides a lifetime of energy savings and internal thermal stability,” Clifton says. “This is going to make the home more comfortable and reduce mold issues around the window from condensation—a notorious problem in the Pacific Northwest.”

INDOOR INNOVATIONS

Three heat recovery ventilators (HRVs) were installed—one for each living area—to enable separate controls when one or more spaces are unoccupied, and to prevent the spread of viruses. Air quality and humidity sensors can boost air flow through the HEPA-filtered HRVs. The kitchen has its own exhaust fan, balanced with a HEPA-filtered fresh air intake powered by a fan located outside. It has a silencer for quiet operation “so it will get used,” notes Clifton.

The ventilation system also

supports the heating system. The main supply duct for each of the three HRVs contains a coil from the air-to-water heat pump that cools or heats the air before distributing it throughout the home, based on the temperature needs. The air-to-water heat pump is equipped with a variable-speed compressor and provides very efficient heating and cooling (at 4.62 COP) via radiant loops in the floor, fan coil units in each of the main living spaces, and HRV supply ducts to the living areas and bedrooms.

“When paired with the highly insulated envelope and thermal mass floors, the home stays remarkably consistent in temperature, both across the home and throughout the year. There is no need for daytime setbacks. Set your desired temperature once and the home will maintain it round the clock,” says Clifton. “This HVAC and envelope design work together to reduce overall energy demands and are easily replicated, creating efficient and comfortable buildings time and again.”





“We use the same mechanical closet in every house we build,” Clifton says. “I have a cut sheet (layout) so the electrician knows exactly where to put the electrical and the plumber knows exactly where to put the piping. I’ve gotten the cost down to \$35,000 for everything in the mechanical room. That’s the same price I paid for a much less efficient system in 2011. Equipment costs have gone up \$10,000, but our labor has gone down \$10,000. All of the equipment is in the same spot every time. I use the same materials list too. We can do it in a day. On other builders’ homes, you’ll sometimes see the HVAC guys there for a week.”

DONE BY DESIGN

For Clifton, the biggest energy and cost savings come from the design of the building itself. Most of his homes are a basic rectangle. The 2024 award-winning home was essentially three side-by-side rectangles. The homeowners wanted to get two families and their guests under one roof. The house and an ADU are on the main level and three bedrooms, a rec room, and two baths were added above the ADU for visiting family members. “The

Lynden house was a fun design challenge,” said Clifton. “We tried several designs starting at \$2.4 million for construction costs and got it down to \$1.2 million.”

Simplifying the design often means reducing the number of corners, which reduces costs and energy losses. “Adding a corner can easily add \$30,000 to the cost of construction,” said Clifton. “You have more air sealing and water management details, more thermal bridging, more exterior wall surface, and more risk of failures.”

Clifton also advocates simple roof lines with a monoplane shed roof, a symmetrical gable, or an asymmetrical gable, which enables clerestory windows to bring sunlight into the interior of the home. “You can add details to differentiate the house but add them outside of the thermal envelope, like decks and porches,” Clifton says. “I’d rather stick to the rectangle and put a cool timber-framed porch on the outside. Instead of putting our money into complicated wasteful shapes and expensive tricky details, we put our money into PV and EVs.”

Clifton is so passionate that he started his own design company, Powerhouse Designs, and now does all of the design work for his custom homes in-house. In typical custom construction, an architect draws up the plans, then hands them to an engineer who specifies materials to meet structural load and then hands the plans and specs to the builder. “The problem is the architect and engineer have no idea how much things cost,” Clifton explains. “When we used to build other people’s designs, it used to frustrate me so much. The architect or engineer might specify a \$2,000 glue-lam beam when \$600 worth of lumber could carry the load.”

The question: Could reducing the window size 10 percent save a lot without sacrificing view? “We went through one house that had been designed by someone else and specified it as drawn,” Clifton says. “We then started making changes and were able to save \$50,000 on construction costs by making tradeoffs.”

Cost cutting is key, Clifton notes. “We work with our homebuyers and show them the costs of different options so they can see where they can save and choose where they want to spend more money,” he says. “And they still get all the performance benefits of a DOE ZERH.”



Think thick. SIP walls and roof and ICF-wrapped slab-on-grade foundation provide exceptional insulation to the home.

Mono minded. A monoplane shed roof enables clerestory windows to bring sunlight into the interior of the home.

No bridging. Insulated splines and a continuous layer of GPS provide a wall with almost no thermal bridging or transfer of heat between the inside and outside of the home.

Enveloped. Taped seams, low-expansion foam around rough openings, and a whole house aerosolized air-sealing process also make the home exceptionally tight.



Hints of history. The townhome's modern aesthetic includes flat and pitched roofs, and composite wood lap siding along with patches of red brick—a nod to the former campus of historic 19th century Loretto Heights College.

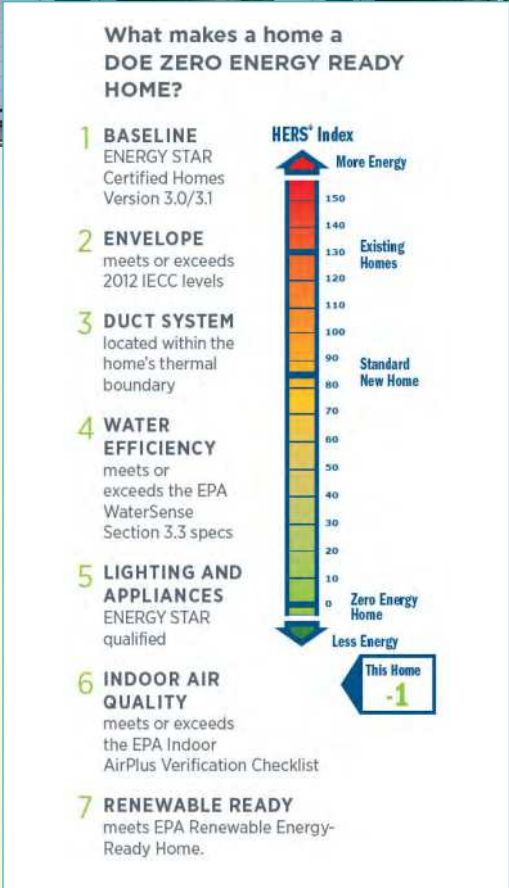
PHOTOS COURTESY OF THRIVE HOME BUILDERS

Project Info

PROJECT NAME: The E-PWR Volt Townhome at Loretto Heights, Denver, Colorado

BUILDER: Thrive Home Builders, Denver, Colorado, thrivehomebuilders.com

COMPLETED: April 2022



Resilient Trifecta

Thrive Home Builders' latest townhome tackles challenges such as affordability, growing families and disaster resistance

Thrive Home Builders of Colorado has reached new heights with its E-PWR Volt Townhomes at Loretto Heights, in Denver. Perched high on a hilltop southwest of downtown, the historic site is once again making history as the site of one of Thrive's most energy-efficient communities. The 148 townhomes and 140 single-family homes by Thrive meet all of the high performance criteria of the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) program. They offer a high level of energy efficiency, sustainability, health, and cost effectiveness for local home buyers.

The regional builder of single-family and multi-family market-rate and affordable homes also achieved a DOE ZERH Innovation Grand award on the townhomes. With a Home Energy Rating System (HERS) score of minus 1, the winning home should provide its first-time homebuyers with near-zero energy bills for years to come.

"Thrive's slogan is 'Homes that do more,'" says Bill Rectanus, Thrive's vice president for operations. "This 'do more' townhome shows how it can accommodate growing families, pay for its own energy, improve the health and comfort of its occupants, and play an important role in disaster resistance."

Thrive has achieved a home with an annual energy bill of \$7 using readily available materials and simple construction methods that any builder and any subcontractor can reliably execute, Rectanus adds. Through its groundbreaking performance and durability, "it can also be the best investment of its owners' lives."

Like all homes certified through the voluntary DOE program, the home has

ENERGY STAR Version 3.2 and EPA Indoor AirPlus home certifications, and the latest energy codes as its baseline, providing its home buyers with the health, resiliency, and utility bill savings these programs offer.

"This home serves as a template that will be replicated dozens of times in the future within Thrive's Loretto Heights community," says Rectanus. The townhome is one of 92 three-story townhomes, 56 two-story townhomes, and 140 single-family homes (288 total) that will circle the hilltop, which provides commanding panoramic views of downtown Denver and the surrounding mountains and prairies.

EASY ON THE EYES

The townhome's modern aesthetic includes flat and pitched roofs. There is also composite wood lap siding along with patches of red brick. This is a nod to the historic red brick buildings on the site, the former campus of Loretto Heights College, founded by the Catholic order of the Sisters of Loretto in the 1880s. While the site was sold to a local developer in 2018, many of the historic structures have been retained and repurposed as community buildings or affordable housing.

Beneath the modern façade of Thrive's townhomes, the builder showed how its focus on quality management yielded high performance results via mostly traditional methods. The builder achieved R-23 walls with 2-by-6, 16-inch on-center construction that incorporated advanced framing techniques such as three-stud insulated corners, open and insulated headers, and ladder blocking at interior wall intersections that allowed more room for the dense-packed

fiberglass.

Half-inch structural OSB sheathes the walls and, according to Rectanus, "expensive rain screen systems were replaced with low-cost corrugated draining housewrap." The builder followed a total UA performance path rather than prescriptive path, which enabled him to meet the overall insulation level specified by the 2021 International Energy Conservation Code (a program requirement) and avoid the need for exterior rigid insulation.

The wall's insulation performance was maximized through the use of extensive traditional air sealing methods, such as a top plate gasket at the ceiling-to-attic interface, foam sealant at electrical boxes and the bottom plate of exterior walls, taping of all house wrap seams, tape flashing around doors and windows, and gaskets around all exterior wall penetrations. For an extra measure of air sealing, the builder used a whole-house aerosolized acrylic air sealant process that helped bring the three-story home's overall air leakage down to 2.92 air changes per hour at 50 Pascals of pressure.

The home designs used a standard vented attic with R-60 of blown-in fiberglass insulation. The truss design incorporated 14-inch raised-heel trusses providing plenty of space for insulation over the exterior-wall top plates. Roofs were topped with ¾-inch OSB, a self-adhered membrane, and asphalt shingles.

The foam-wrapped slab-on-grade foundations reduce excavation costs and concerns about radon. Since the Denver area has high potential for radon, an active radon mitigation system was also installed. This includes a simple manometer indicator

Annual Energy
Costs

\$1,100
(without PV)

\$0
(with PV)

Annual Energy
Cost Savings*

\$2,150
(without PV)

\$3,200
(with PV)

Annual Energy
Savings

10,050 kWh
(without PV)

17,600 kWh
(with PV)

Savings in the
first 30 years

\$89,600
(without PV)

\$134,850
(with PV)

* vs typical new homes

Key Features

AIR SEALING: 2.92 ACH50; bottom plate and electrical boxes foam sealed; top plate gaskets; polypropylene gaskets for exterior wall penetrations; draining house wrap taped; windows tape flashed; whole house aerosolized acrylic sealant.

APPLIANCES AND LIGHTING: ENERGY STAR appliances and lighting.

ATTIC: Vented attic: 16-inch R-60 blown-in fiberglass; 14-inch raised-heel energy truss.

ENERGY MANAGEMENT SYSTEM: Indoor air quality and solar power monitoring.

FOUNDATION: Slab on grade; R-10 rigid foam along perimeter; R-68 blown fiberglass in first-floor joists.

HOT WATER: Heat pump water heater, 65 gallon, 3.55 UEF, in 9-square-foot closet with transfer grill and door undercut and ducted exhaust. Demand recirculation.

HVAC: Central air-source heat pump, 9.5 HSPF, 23 SEER2.

ROOF: Gable truss roof, 3/4-inch OSB, ice and water shield membrane, synthetic underlayment, composite shingles.

SOLAR: 5.2 kW, no battery.

VENTILATION: Fan-powered supply ventilation balanced to exhaust fans; humidity sensors; active radon mitigation system.

WALLS: 2-by-6 16-inch o.c., advanced framed, R-23 total: 5.5-inch R-23 blown fiberglass, 1/2-inch OSB, draining house wrap, composite wood siding.

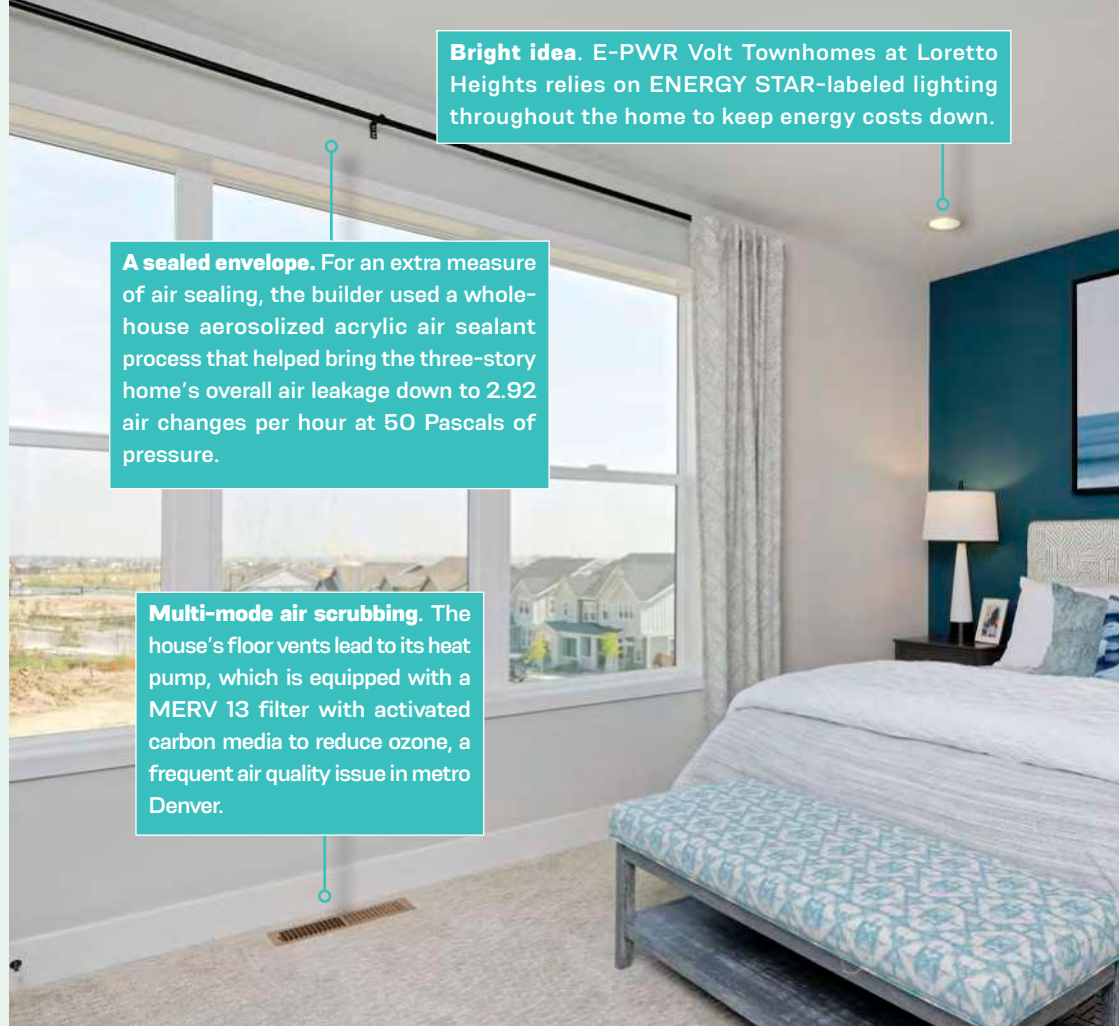
WINDOWS: Double-pane windows, U=0.25, SHGC=0.3.

OTHER: Electric vehicle charger. Extensive in-house quality management and training.

Bright idea. E-PWR Volt Townhomes at Loretto Heights relies on ENERGY STAR-labeled lighting throughout the home to keep energy costs down.

A sealed envelope. For an extra measure of air sealing, the builder used a whole-house aerosolized acrylic air sealant process that helped bring the three-story home's overall air leakage down to 2.92 air changes per hour at 50 Pascals of pressure.

Multi-mode air scrubbing. The house's floor vents lead to its heat pump, which is equipped with a MERV 13 filter with activated carbon media to reduce ozone, a frequent air quality issue in metro Denver.



to provide homeowners with easy verification of system performance.

Moderately priced vinyl-framed windows with a higher-performance glass unit and an insulation value of U-0.25 complete the building envelope.

SAFETY SEARCHES

In Denver's litigious housing market, Thrive took the unusual step of hiring a third-party inspector who is well known as an expert witness for homeowner associations that sue builders for construction defect claims.

Among the many extra steps of inspection, the reviewer subjected the townhome to water-resistance testing using the ASTM-E1105 test method, which involves putting the home in negative pressure while spraying high pressure water at the windows and wall penetrations after flashing and house wrap have been installed but before siding is put on to test for leaks.

"This rigorous testing is done in addition to normal building inspections, inspections by our energy rater partner, and Thrive's own quality assurance

system," says Rectanus. "It not only reduces Thrive's risk of construction defects slipping through our multi-step inspections, but also provides a 'belt and suspenders' approach to delivering a home of superior quality, durability, and performance to our homeowners."

The top two floors of the home are heated and cooled with a central ducted air source heat pump with a heating efficiency of 10.7 HSPF efficiency and a cooling efficiency of 22.4 SEER, with electric resistance for emergency backup. Thrive also installed a ductless heat pump in the ceiling of the lowest floor.

For hot water, Thrive installed an efficient heat pump water heater. With space at a premium in the townhome, Thrive worked with the manufacturer to plan adequate incoming air to the small utility closet housing the water heater through an air-transfer grill and undercut in the closet door. They also ducted the cold exhaust air outside through the exterior wall.

A 5.2-kW roof-mounted solar array helps to produce enough electricity to net the home owners near-zero



Above-and-beyond envelope. Thrive Home Builders' construction includes R-23 walls with 2-by-6, 16-inch on-center advanced framing techniques, and ladder blocking at interior wall intersections for dense-packed fiberglass.



energy bills over the course of the year. This moved the HERS rating for the home from a very efficient 41 to a stellar minus 1. A mobile application provided with the panels allows homeowners to track their energy consumption and production. The PV panels can also help power the homeowner's transportation via the 220-volt electric vehicle power charger installed in the garage.

"The path for achieving our purpose is and has been the path towards continuously improved DOE ZERHs. Beginning with our first DOE Grand Winner in 2013, we have focused on improving the energy performance of our homes, their indoor air quality, and their resilience—all at prices that everyday homeowners can afford," says Rectanus. "With high mortgage interest rates and a median new home price in Denver of \$650,000, Thrive must be focused on affordability. For us, building a better home does cost more, but this cost is offset by the lower monthly cost of ownership Thrive provides its homeowners thanks to \$0 utility bills."

The energy savings have a present value of almost \$40,000, which gives homeowners \$40,000 more in buying power, Rectanus

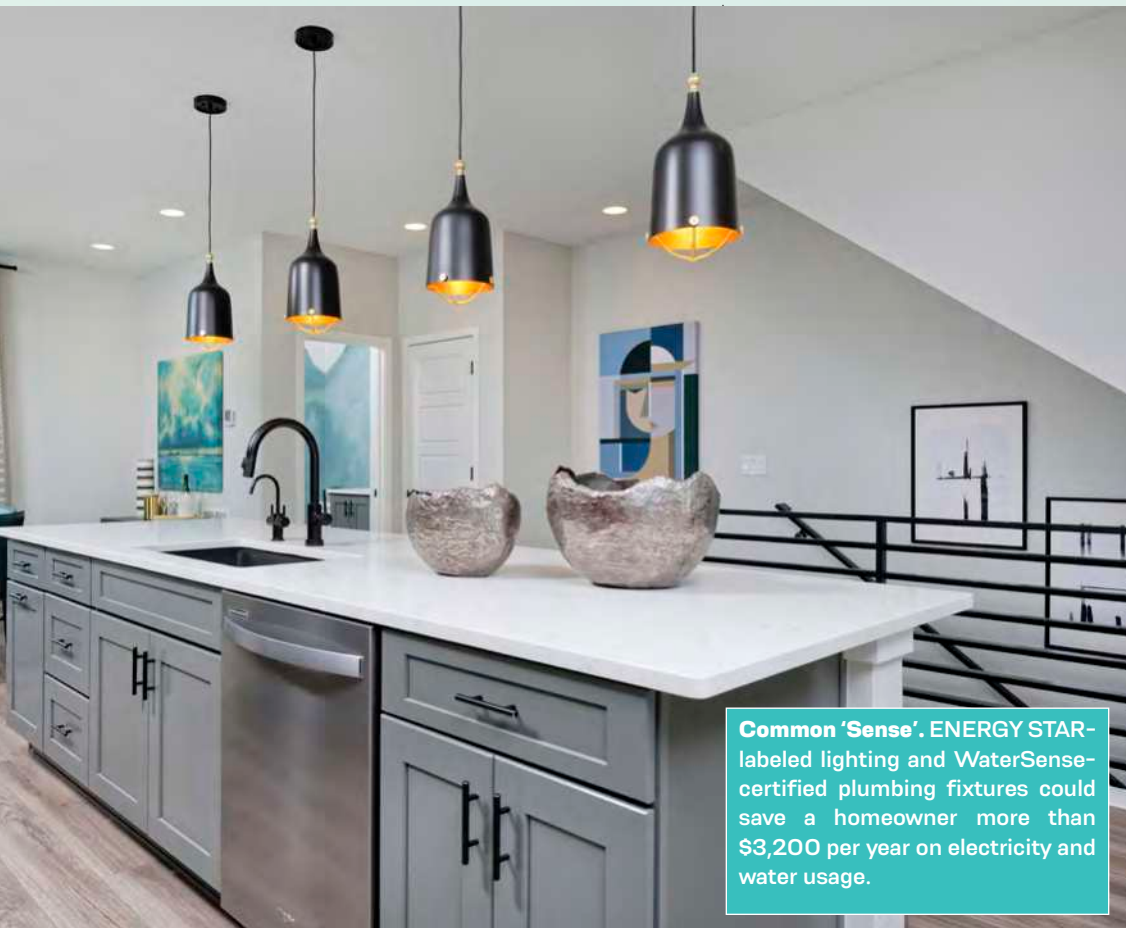
EDUCATING THE MASSES

Thrive has sought to assist other builders in achieving DOE ZERH standards by assisting in development of online and in person-training with the Energy and Environmental Building Alliance (EEBA); as a founding member of the EEBA Builder Benchmark Group; through seminars, presentations and trainings conducted at the National Renewable Energy Laboratory, the South by Southwest Conference, and the Home Builders Association of Metro Denver; through the RESNET and Zonda podcasts; and as a frequent contributor to construction industry trade publications.

Thrive is constructing its second ProBuilder Idea Home featuring DOE ZERH, Indoor AirPlus, ENERGY STAR Next Gen, and LEED certifications. It has collaborated with Xcel and the Colorado Public Utilities Commission in setting rebate and certification standards. Thrive currently is the Xcel Energy All-Electric and Mixed-Fuel Builder of the Year. The company is an active contributor to the education of future leaders, through its participation as the longest serving judge in the DOE Solar Decathlon Student Design Competition and as a frequent collaborator with the University of Denver Real Estate and Construction Management programs.

Thrive's efforts have been recognized with more DOE Housing Innovation Awards and Grand Awards than have been won by any other builder. It has also been recognized with the Pacific Coast Builders Conference Gold Nugget Award Home of the Year, the Best in American Living Platinum Award, the Best in Green Awards at the International Builders Show, and the RESNET Presidents Award and Cross Border Challenge twice as the most energy-efficient production builder in the U.S. and Canada, most recently in 2023.

Despite the successes, Rectanus notes that Thrive must still be cost competitive with national builders who construct just to code and who can spread losses across multiple markets when meeting the challenges of Denver's high prices and lagging sales. "If anything," says Rectanus, "the challenging market and competition have pushed Thrive to double-down on everything we do to make a better, healthier, more efficient, more comfortable, more resilient, and more cost-effective home." **GB**



Common 'Sense'. ENERGY STAR-labeled lighting and WaterSense-certified plumbing fixtures could save a homeowner more than \$3,200 per year on electricity and water usage.

TODAY'S HOMEOWNER

AN AI PRIMER WITHOUT THE HYPE

CREDIT: ISTOCK/HISPANOLISTIC

AI has both a light and dark side. Let's focus on the biggest potential upside: efficient planning, estimating and project management.

BY MICHELE LERNER

“**A**rtificial intelligence (AI),” the phrase that now seems to be on everyone’s lips in every conversation and in every industry, leaves some people hot with excitement and others cold or confused. The majority of builders don’t currently use AI in their business, according to a survey by the [National Association of Home Builders](#) (NAHB), but some are beginning to adopt AI tools, and it’s likely that adoption will accelerate in the industry in coming years.

Thus far, the most popular way builders use AI (20 percent) is to generate advertising and marketing, while 11 percent use it to help analyze markets and plan projects. For builders, remodelers and homeowners, AI tools can speed up estimates to bid on jobs, generate suggestions for remodeling projects, evaluate their return on investment and even track home equity. The benefits of using AI in a variety of ways are clear—even when most of us don’t always understand exactly how these tools work.

AI FOR HOMEOWNERS

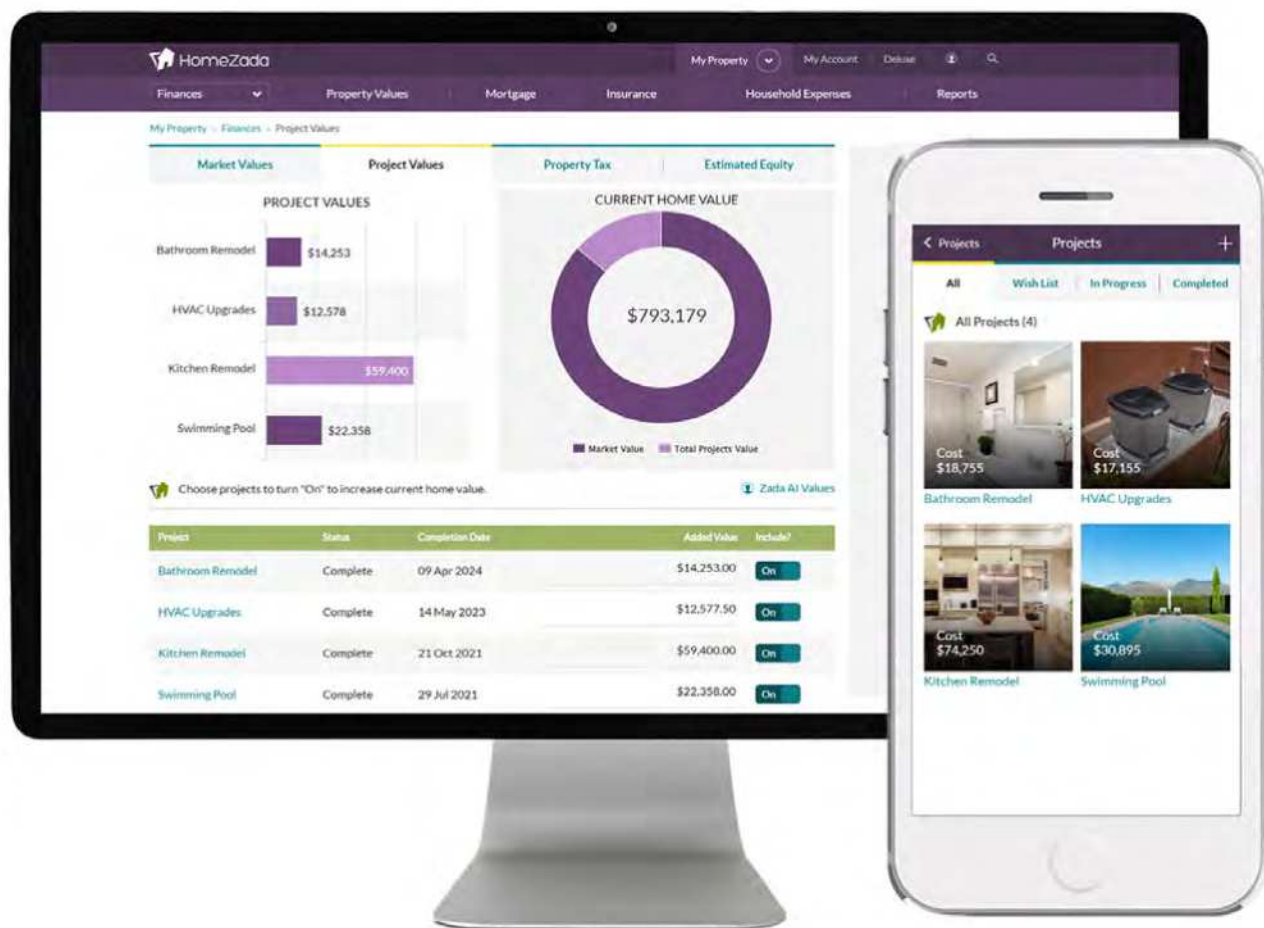
Whether you are new to homeownership or have owned multiple homes, it’s likely that you share the same dilemma: where to find the

information and data you need to manage your home. Maybe you need the serial number from your water heater to request a repair, you can’t remember when you last changed the filter on your heat pump, or you need a solid estimate of your home equity. AI technologies have the potential to help organize and streamline this information in the home building industry going forward.

“Most homeowners have data about their homes scattered everywhere from a Google spreadsheet to a paper folder with mortgage documents and a binder of appliance manuals their builder gave them,” says John Bodrozic, cofounder of [HomeZada](#), a digital home management platform based in El Dorado Hills, California. “We launched HomeZada in 2012 so that homeowners would have everything in one place, including a maintenance calendar, an inventory for their insurance company, data on their utility costs, property taxes, and more.”

For the past couple of years, Bodrozic and his cofounder, Elizabeth Dodson, have invested heavily in AI to create tools that help homeowners track and estimate their home’s value, and efficiently manage and improve their home.

“Our home inventory tool allows you to take a close-up photo for insurance of your equipment and appliances, which immediately



Staying up to date. HomeZada, a digital home management platform, provides buyers with the information needed to manage the house, such as product serial numbers, appliance maintenance dates, and an estimate of home equity. CREDIT: COURTESY OF HOMEZADA

uses AI to identify the brand and model of the item, its age and whether it's under warranty," Bodrozic says. "You can quickly create an insurance inventory this way, plus you can upload the manual. With AI, we can generate an estimate of how long the appliance or system will last and what it will cost to repair or replace it so homeowners can plan for that expense."

Builders can use HomeZada to generate a digital binder for their buyers that aggregates all the information they need to maintain their home. They can also pay for a one-year subscription for buyers.

For homeowners, HomeZada has a \$99 per year free version that provides additional support and information, plus a \$189 per year subscription to cover multiple homes.

"With the help of AI, we can even send a reminder to homeowners that their appliance is about to fall out of warranty after nine years or more," Bodrozic says. "The tool automatically generates a maintenance list that sends digital reminders to homeowners. There's a 'how to' button that provides instructions and a list of tools needed to perform basic maintenance tasks, plus an estimate of what it costs if someone wants to hire a contractor instead."

Homeowners considering a remodel can use HomeZada to generate estimated costs of a project and ROI based on their specific location and current market conditions.

"AI lets you have a conversation, so the results are based on whether you want a basic new bathroom or want a high-end remodel

with specific fixtures," Bodrozic says. "You can save the estimate to create a budget for your project."

ROI estimates are based on searches of comparable homes by photos and property data.

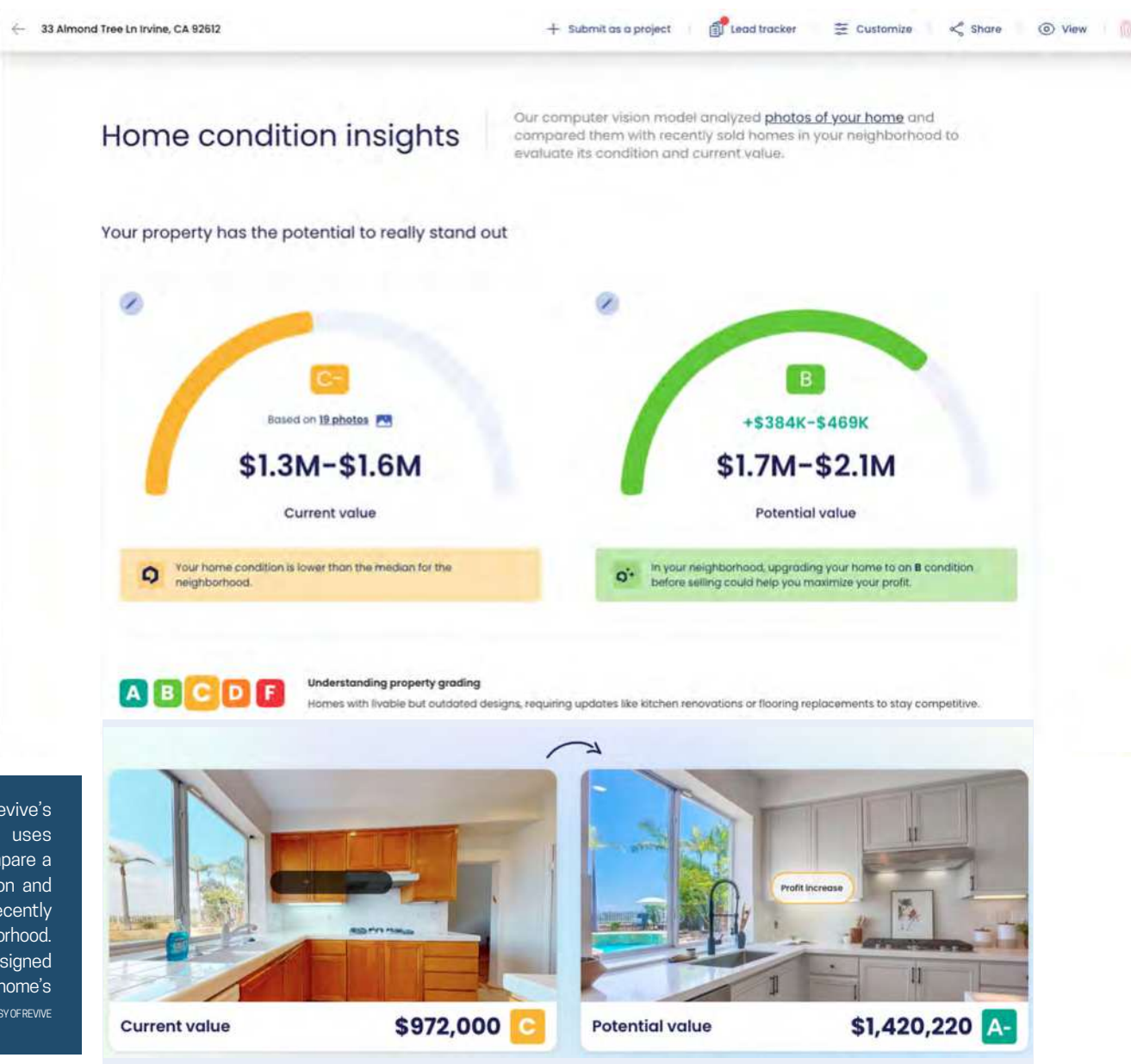
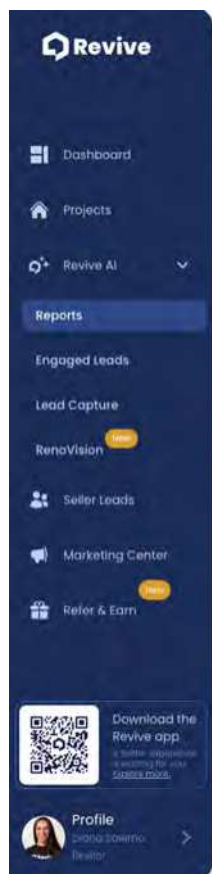
"We can also generate a high-level analysis of energy and water saving projects to see how much you might save by investing in different projects such as solar panels, energy efficient windows, new insulation or a tankless water heater," Bodrozic says.

Homebuyers can also use HomeZada before purchasing to get a forecast of future renovation costs to compare properties or prepare financially for homeownership.

COST PREDICTOR

For homeowners considering renovating to sell faster or for a higher price, or who just want to improve their home for their own enjoyment and to build home equity, [Revive](#), a home renovation platform, offers AI-empowered tools.

"Our sales team analyzes projects all day long, but we also rely on comparable properties to see what sells, in what condition and at what price," says Dalip Jaggi, cofounder and chief operating officer of Revive based in Irvine, California. "The key is to understand what the sales price would be if you bring a property up to the neighborhood standard and then to decide which improvements make sense at what cost."



Insight information. Revive's computer vision model uses uploaded photos to compare a home's physical condition and sales price to that of recently sold models in the neighborhood. A letter grade is then assigned to determine the current home's upgrade potential. CREDIT: COURTESY OF REVIVE

In addition to providing renovation insights and financing, Revive has a cash offer option for homeowners who want to sell without renovating.

"When you put in an address, our machine learning model uses computer vision to upload photos and look at 586 characteristics to check on the home's condition," Jaggi says. "When we match that with all the data about comparable home sales and their condition, we can generate a letter grade that shows whether something is a B or a C minus house."

Within 6.5 seconds, Revive's tool can estimate the cost of potential home improvements according to local material and labor costs. That tool is currently only available to real estate agents, but it will eventually be available to homeowners.

"Our vision is that homeowners will make smart decisions with the help of their real estate agent," Jaggi says.

Revive recently launched a "RenoVision" tool that allows users to upload a photo, and a style such as "coastal" or "farmhouse" to generate images and cost estimates for each project. Later in 2025,

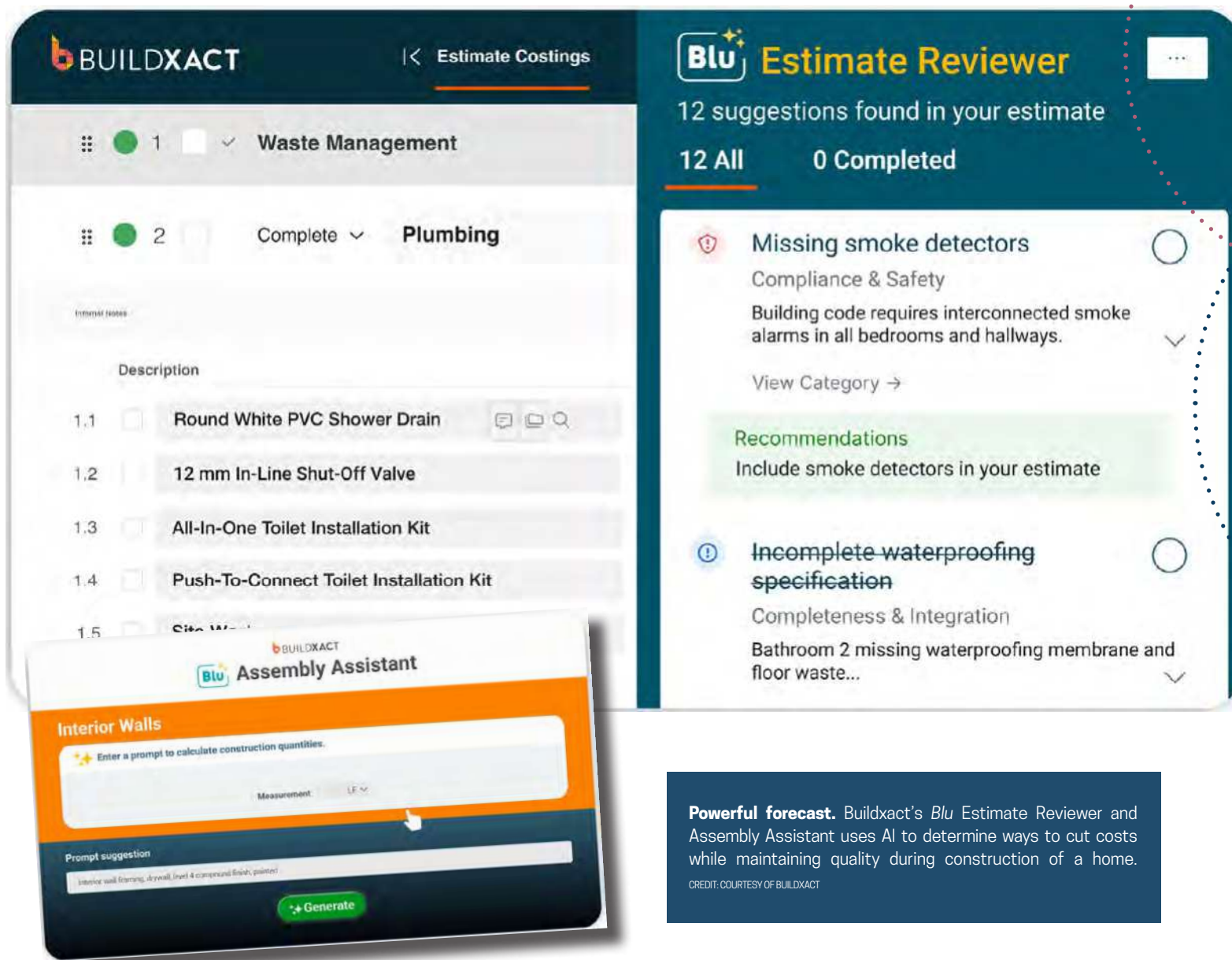
that tool will connect with a catalog of products for greater accuracy.

"The idea is to help homeowners visually see options of improvements that would likely appeal to buyers to generate a higher offer, plus estimate the cost," Jaggi says.

AI FOR BUILDERS AND REMODELERS

While large national and regional builders have the funds and expertise to invest in AI to streamline their projects, small- and medium-size builders don't have that same capacity, says Marissa Wagner, chief marketing officer of **Buildxact**, an estimating and project management software company with U.S. headquarters in Austin.

"At Buildxact, we've created a digital toolkit that smaller builders can use to control and scale their business," Wagner says. "Small- and mid-size builders aren't just builders—they are small business owners that don't have the sales and marketing team, and administrative staff that larger builders have. They're general contractors and project managers and sales professionals



Powerful forecast. Buildxact's *Blu* Estimate Reviewer and Assembly Assistant uses AI to determine ways to cut costs while maintaining quality during construction of a home.

CREDIT: COURTESY OF BUILDXACT

all in one person.”

Buildxact, which operates in the U.S., Australia, New Zealand, the United Kingdom and Canada, was founded 15 years ago. It has been in the U.S. since 2020. Its tools serve 7,000 construction companies, including remodelers, home builders and contractors.

In June 2025, Buildxact introduced “Blu,” a digital AI platform with four tools available now and more to be introduced in the future, Wagner says.

“The ‘takeoff assistant’ is an evolution of our core feature,” she says. “Builders can upload plans and measurements, and within 90 seconds *Blu* generates a complete takeoff list. Normally that process can take three or four days.”

The *Blu* estimate generator uses AI to create an estimate for a project based on basic information such as the size of the project, and some high-level information along with local material and labor costs, Wagner says. The tool can be connected with a builder or remodeler’s supplier. It can be used for everything from a single room, such as a kitchen remodel, an addition or an entire house.

“The *Blu* assembly assistant can be linked to the takeoff tool when builders provide specific measurements for their projects,” Wagner says. “It can quickly generate a materials list and estimated labor costs for an assembly for a specific project.”

The *Blu* estimate reviewer is particularly valuable to small and medium-sized companies who need to send a quote to a prospective client, she says.

“The reviewer tool provides an audit to make sure the builder isn’t missing any key elements,” Wagner says. “Labor costs are integrated into the estimate on a ZIP Code level with this software. For material costs, we can integrate with Home Depot’s live price lists in the U.S. for updated prices. The builders can choose what they do and don’t want to share with their clients and get updates throughout the project.”

Eventually, the Buildxact tool will allow builders to check availability and order materials directly. Wagner anticipates availability later in 2025.

Builders can choose between three levels of plans priced from



Guided right. Builders using Reframe Systems' software and algorithms can simplify and systematize the construction process for climate-resistant microhome modules, which are designed to match an area's zoning requirements. CREDIT: COURTESY OF REFRAME SYSTEMS

\$199 per month for the base plan to \$599 per month for builders with a higher volume of work.

"We're not looking to replace builders in any capacity—we just want to restore their time to them," Wagner says. "These tools optimize their time by finding efficiencies in their workflow."

TRANSFORMING HOMEBUILDING WITH AI

Modular homes built offsite and finished onsite are not new. But a trio of former Amazon Robotics leaders aims to use AI and lessons learned from Amazon warehouse solutions to build resilient Zero Energy Ready Homes (ZERHs) that are attainably priced. The three cofounders—Aaron Small, head of operations, Felipe Polido, head of technology, and Vikas Enti, CEO—created [Reframe Systems](#), based in Andover, Massachusetts, a little more than two years ago. Their strategy is to develop micro factories in multiple markets to build climate-resilient homes that match the zoning requirements in each location.

"Eighty-five percent of each home we build is completed in the micro factory," Enti says. "They're like giant Legos or shoeboxes that we can stack, so we can design and build single-family homes, [accessory dwelling units] and triple-decker buildings for multiple families."

But despite their small size, the homes can't be mass produced because there are 30,000 zoning areas that have various requirements, Enti adds. "Plus, you have different climates, different building codes and lots in different sizes and shapes," he says. "Each factory will have local architects and engineers for local context."

Enti and his partners created software and algorithms to simplify and systematize the construction process for each module, and introduced robots into their first factory.

"The idea is that we want to be able to hire someone inexperienced in the morning and have them build modules in our factory that afternoon," Enti says. "Framing a house is a pretty repetitive task,



so we developed a system to print the instructions on the lumber itself like an IKEA furniture manual.”

Sixty percent of our workers are apprentices, some of them in high school or trade school, Enti adds. “They can do this work because it’s intuitive like other manufacturing processes.”

Currently, robots build about 60 percent of the walls, sheathing and insulation for each home. Enti anticipates robots will build about 80 percent of those parts in 2025.

Each module is typically 14 feet wide, 16 feet long and 10.5 feet high.

To keep costs down, Reframe offers precut parts that can be assembled 30 percent faster than parts that haven’t been precut. The roofs are predesigned and ready for solar panels. In addition, Enti says the use of robots and apprentices saves 20 percent on labor costs.

“We use light wood framing from a local lumber yard in Massachusetts, high performance triple-pane windows, and MDF composite flooring,” Enti says. “We’re trying to get away from using vinyl and nonbiodegradable materials, plus we’re continually looking

for local sources for every product. We’re building foundations with as little concrete as possible—at least 50 percent less than a traditional foundation.”

In 2024, Reframe built a house in 48 days. Eventually, Enti hopes to get the build time from foundation to final finishes down to 30 days.

“We’re not a design-build firm, so we focus on partnering with developers who own land and want to build resilient missing middle housing,” Enti says.

Reframe Systems has roughly 20 homes in the process of design or construction in Massachusetts this year and it is shipping modular homes to Los Angeles to help rebuild ones destroyed by the January 2025 wildfires.

“We plan to open our next micro-factory in Los Angeles in 2026 and then hope to be in five markets by 2030,” Enti says. “We want to develop these micro factories to be the size of a garden center in a Home Depot and in similar locations. Our goal is to develop the largest home manufacturing network throughout the country.” **GB**



Another First

Our newest exhibition partner project showcases affordable, comfortable duplex living in North Carolina.

BY SARA GUTTERMAN



Courtyard living. This draft rendering of VISION House Hickory Grove shows the approximate layout and style of the project, although details may change.

“This isn’t just a development project. It’s a housing solution.”

—Rob Howard, president, Howard Building Science

In today’s housing market, buzzwords like net zero, prefab, workforce housing, multifamily, and build-to-rent dominate the conversation—and for good reason. They reflect the urgent demand from consumers and the construction industry to deliver homes that are efficient, resilient and attainable.

Green Builder Media’s latest VISION House project, the VISION House Hickory Grove, in Hickory, North Carolina, checks every one of those boxes.

This project is a timely and necessary response to the moment we’re in: one defined by a growing affordability crisis, intensifying climate events, and surging demand for smarter, healthier homes.

A PARTNERSHIP THAT DELIVERS

We’re thrilled to partner with Rob Howard, president of [Howard Building Science](#). He’s a true trailblazer in sustainable construction who built North Carolina’s first net zero energy home nearly two decades ago. He brings a deep understanding of building science, community and smart development strategy.

“We’re taking the best of what we know about climate responsive design, building science, prefab, and sustainable building, and using it to create homes that people can actually afford to live in,” Howard says. “This isn’t just a development project. It’s a housing solution.”

VISION House Hickory Grove is a 12-unit prefab multifamily community nestled in the charming Viewmont neighborhood. The project includes two floor plans: one that is 1,150 square feet with 2 bedrooms and 2.5 baths, and the other that is 575 square feet with 1 bedroom and 1 bath.

These net zero carbon units, designed to meet the [U.S. Department of Energy \(DOE\)’s Zero Energy Ready Home](#) (ZERH) certification and the [FORTIFIED](#) Home certification for resilience, will be constructed offsite for enhanced precision and speed. They will be certified to use up to 50 percent less energy than code-built homes, and include solar plus storage for full energy independence.

Targeted toward workforce renters (think teachers, first responders, healthcare workers, recent graduates and retirees), the project redefines what attainable, sustainable housing looks like.

Community amenities include a shared green space, dog park, and community garden—all designed to foster interaction with nature and connection with neighbors. **GB**



Unassuming site. VISION House Hickory Grove, a planned prefab multifamily community, will consist of 12 net zero carbon units that meet the U.S. Department of Energy (DOE)’s Zero Energy Ready Home (ZERH) certification and the FORTIFIED Home certification for resilience.

CREDIT: COURTESY OF ROB HOWARD, HOWARD BUILDING SCIENCE



Coming soon. Floorplans are still being finalized, but they will reflect these model layouts, integrating sustainable features in multi-level, comfortable attached homes.

CREDIT: COURTESY OF ROB HOWARD, HOWARD BUILDING SCIENCE

RENTALS: THE LONG GAME

To help make the project possible, Howard reimagined how these homes can generate long-term value through rental income. By designing them from the start as build-to-rent, Rob found a way to make the project affordable and financially viable.

“Factoring in future rental revenue helped us with financing. And if we decide to sell them down the line, the homes will still be incredibly marketable,” he explains. “It’s a replicable model for other developers struggling to make workforce housing pencil out.”

MEETING A NATIONAL CHALLENGE

Communities across the U.S. are sounding the alarm on the disappearing “missing middle” of the housing market. According to a [Housing Forward Colorado](#) report (a [Southwest Energy Efficiency Project \[SWEET\]](#) project), states such as Colorado and cities like Portland, Oregon have taken bold steps to expand access to missing middle housing, including duplexes, townhomes and accessory dwelling units (ADUs), that fill the gap between single-family homes and high-rise apartments.

In Hickory, housing costs have surged, and local leaders are seeking ways to retain talent and support essential workers. The VISION House Hickory Grove directly addresses this growing challenge by offering homes that meet economic realities and a changing climate.

POWERED BY INNOVATION

The VISION House Hickory Grove will showcase products from companies that are committed to climate-smart housing, including:

- **Broan:** Ventilation and energy recovery ventilators (ERVs) for clean indoor air
- **Fabral:** Durable, beautiful metal roofing
- **JinkoSolar:** High-efficiency photovoltaics
- **Knauf:** Innovative, energy efficient insulating materials, and high performance drywall systems, and plaster and ceiling solutions
- **LP:** Carbon negative engineered siding
- **Opta:** Advanced low-carbon concrete using recycled glass
- **Schneider Electric:** Smart electrical panels, demand-side energy management systems, and battery storage solutions
- **LG:** Energy-efficient heat pump HVAC systems and water heaters, plus high-performance appliances
- **Huber Engineered Woods:** ZIP System sheathing for enhanced moisture resistance and air sealing

We’ll also measure and offset the full carbon footprint of each home through Green Builder Media’s COGNITION Carbon Offset Marketplace, ensuring net zero embodied and operational carbon.

We invite you to follow our progress. Subscribe to our weekly Vantage e-newsletter and keep an eye open for ongoing posts about the project.

TRANSCEND

HOME EVOLVED

ALL PHOTOS BY SAMANTHA CARLIN EXCEPT WHERE NOTED.

Focal point. Transcend sits atop the bank of the Lake Fork River in Lake City, Colorado, nestled in a Ponderosa forest, looking out into the expansive mountain landscape.



WILD AND FREE

With the completion of the VISION House Transcend, manufactured residences reach a new level of sustainability.

BY GREEN BUILDER STAFF

It all began with a simple mission: Build manufactured housing that was more than easy-to-assemble clone homes; residences that could be an affordable option for homebuyers, and help builders cope with a triple threat of labor shortages, soaring material costs and lingering supply chain issues.

In short, don't build your grandfather's prefab home.

Enter Transcend Communities, a collection of self-powered net zero energy homes with solar arrays, battery storage, all-electric systems, and resilient and durable appliances. A joint effort between California-based homebuilder Dvele and Green Builder Media, the first Transcend demonstration home—VISION House Transcend—has been unveiled in the San Juan Mountains near Lake City, Colorado.

According to Green Builder Media, it's the realization of a long-term goal. "With Transcend, we reimagined the future of housing," says Green Builder Media CEO Sara Gutterman. "This incorporated innovative sustainable design, building science best practices, and cutting-edge products to exceed the demands of today's homebuyer."

BRIGHT BENEFITS

The living area is bright and fresh, flooded with natural light. The light-toned hickory floors from CRAFT and the white quartz countertops from Caesarstone, which are nonporous, hygienic and stain, heat and scratch resistant, help reflect the daylight into the space. The addition of Sonos in-wall amp speakers brings the calming benefits of music into the home.

NOTHING BUT NET (ZERO)

JinkoSolar's ground-mounted solar array with *Eagle* PV modules, connected to the JinkoSolar *Eagle RS* DC-coupled battery storage system, provides the home with clean energy. The home is so efficient that it feeds energy back to the grid, which is operated by Gunnison County Electric Association, a member-owned electric cooperative that receives its wholesale power supply from Tri-State System Energy.

ALL-SEASON ENVIRONMENTAL CONTROL

The Arctic cold climate heat pump works in conjunction with Uponor super-efficient radiant ceiling panels to maintain a comfortable temperature in the house year-round. High-efficiency Grundfos pumps bring water from the well to power the Uponor hydronic heating and cooling system and fire protection system. *Rockwool Comfortboard 80* insulated sheathing and AFB evo insulation absorbs sound, mitigate wildfire risk, repel water, and ensure that the house remains comfortable and efficient in all weather conditions.





PERFECTLY REPURPOSED

The beautiful furniture by Lee Industries brings high design and comfort to this mountain home, from the couch, recliners, chairs, stools, and bed frames. Everything complements the home's modern mountain aesthetic. The pieces feature soy-based cushions, fibers made from recycled plastic, organic fabrics for upholstery, and springs made from 80 percent recycled metal for a healthier home and environment.



VISTA POINTS

The primary bedroom opens up to the front deck—the perfect view to start the day. Meanwhile, high-performance clerestory and slot windows pull in soft daylight. The *Sheetrock EcoSmart* drywall panels from USG are lightweight, low-VOC, and noncombustible, providing added fire safety.



NATURAL SURROUNDINGS

The premium quality, expansive windows and doors from Arq-Espacio further enhance the connection with the surrounding nature. The tilt and turn capabilities offer different levels of ventilation, making the most of small spaces and allowing a cool mountain breeze to flow through the home. The multi-chamber design of the window and door frames enhance thermal efficiency and serve as a fire retardant.



SOME FINE FIXTURES

The simple yet elegant faucets and showerheads from Grohe, sinks and elegant freestanding bathtub from American Standard, and wall-hung toilets from DXV, along with the Daltile *Rekindle* tile floors (with *StepWise* and *Microban* technology) and Caesarstone countertops, make the primary bathroom feel like a spa experience without sacrificing sustainability.



MASSIVE MATERIALS

Custom *TruStile* stacked-rail style doors were designed to let light transfer through slats of frosted glass, without compromising privacy. These beautiful interior medium density fiberboard (MDF) doors, certified to contain at least 69 percent pre-consumer recycled wood, have no added formaldehyde MDF material and low-VOC adhesives and primers, contributing to healthy indoor air quality.



INDOOR AIR AFFAIR

The Broan-NuTone *Overture* system, a whole-home ventilation system that includes exhaust fans, a range hood, and an ERV, detects poor air quality and automatically turns on the connected ventilation device, such as a bath fan or range hood.



STYLISH STOVE

The Dacor induction cooktop allows the owners to achieve exceptional cooking precision without heating the surrounding environment.



MULTIPURPOSE OVEN

A jack-of-all-trades, the *Dacor Combination Wall Oven* can sear, steam, air fry and microwave, and also has a speed-convection baking to level up every meal.





WASHING RIGHT

The Samsung front-load washer with *Super Speed* and the heat pump dryer with *Sensor Dry* technology enable owners to wash a full load in just 30 minutes without compromising cleaning performance. Meanwhile, the ventless dryer utilizes heat pump technology to dry clothes more efficiently, cost-effectively and gently.

A-PLUS H₂O

Grohe *Blue* provides filtered, fresh water from the kitchen faucet, with the ability to make sparkling water without the consumption of single-use plastic bottles.



VISUAL MAGIC

The views from the front porch of the home are unmatched. The Lake Fork River curves through the stand of pines and cottonwoods, with picturesque mountain ridges in the background.

CLIMATE CONNECTION

The *Lunawood ThermoWood* siding, provided by Delta Millworks, creates a seamless connection between the house and the surrounding Ponderosa pine forest. *Lunawood* is thermally modified with heat and steam to offer an easy-to-maintain, long-lasting and thoroughly sustainable option for all climates.



GOING FOR THE GRID

Rheem provided an electric *ProTerra* water heater that is four times as efficient as a standard electric water heater. It also features grid-enabled demand response, allowing it to respond to utility demand signals and take advantage of lower utility rates.



“SEAMING” PERFECT

Prosoco *Joint & Seam Filler*, *FastFlash*, and *AirDam* products prevent air and water from entering or escaping around windows, doors, openings, and gaps, increasing energy efficiency and reducing heating and cooling costs. **GB**

Product and support for Transcend is being provided by these partners.



Grid watch. Keeping up with a growing demand for electricity means relying on Electricity 4.0, which can help producers track energy usage in real time and optimize it. CREDIT: ISTOCK/METAMORWORKS

Smart Solutions, Strong Cities

The digital revolution in urban resilience starts with Electricity 4.0.

BY FRÉDÉRIC GODEMEL

As cities grow, they face an increasing number of challenges—from extreme weather and climate change to aging grids and uneven electrical availability. With the global population expected to reach approximately **10 billion** by 2050, and a significant majority (68 percent) of that figure living in urban environments, there is more pressure than ever for cities to implement stable, future-ready infrastructure.

Combine this urban development with the expansion of sectors like the data center industry, and you can begin to see how the growing demand for electricity poses an immense challenge. As this demand grows, there emerges an urgent need for optimized grid reliability. With the increased risk of energy disruptions, there are considerable

operational risks for businesses that require continuous power to operate.

These developments ultimately mean that we need infrastructure that's resilient, scalable, and flexible. The key to this lies in electrification and digitalization, what we have termed Electricity 4.0. Integrating these technologies into urban infrastructure can bolster sustainability, optimize resources, and build resilience in today's cities.

ADVANCING BUILDING PERFORMANCE

To see what electrification and digitalization look like in action, let's start with buildings. The technologies we need to achieve decarbonization in buildings already exist today, from AI-augmented

Outages are out at JFK. JFK International Airport's new *Terminal One* microgrid makes it the first airport transit hub that can function independently from the power grid, maintaining 100 percent of airport operations during power disruptions.

CREDIT: COURTESY OF THE PORT AUTHORITY OF NEW YORK AND NEW JERSEY



building management systems to rooftop solar panels, heat pumps, and microgrids. All that needs to happen now is wider adoption. In addition to reducing environmental impact, many of these technologies can generate payback within a short time—some in just **3-5 years**.

Take Schneider Electric's partnership with **Samwoh Corporation** in Singapore. By adopting an advanced building management system and connected products, Samwoh's headquarters managed to generate up to 50 percent of savings in utility costs and return 25 percent of its solar-generated electricity back to the grid—setting a national benchmark for innovation and sustainability.

This example demonstrates the impact of constructing new buildings with digital energy solutions. But with **50 percent of buildings** still standing in 2050, retrofitting existing buildings is just as important as building new, energy-efficient ones — and just as achievable. Last year, **we partnered with Capgemini** to launch an energy management platform that enables businesses to manage their energy performance across operations. The solution was deployed in

Capgemini's India operations, and it helped them achieve a **29 percent reduction** in energy consumption in 2023 (versus 2019) across eight main campuses.

This is just a glimpse of how energy-efficient technologies available today are shaping the cities of tomorrow. But buildings are only one piece of the puzzle.

THE NEW URBAN BLUEPRINT

Global electricity demand is poised to grow by **4 percent each year** through 2027. This surge poses a significant challenge for power grids and entails a huge financial cost. According to the Energy Transitions Commission, an estimated **\$22.5 trillion** in global grid investment is needed by 2050 to achieve a net-zero transition.

Considering the cost and scale of grid upgrades, microgrids are an

Shared interest. Schneider Electric's partnership with Capgemini led to an energy management platform that helped the technology services consultant cut its energy use by 29 percent in 2023.

CREDIT: COURTESY OF CAPGEMINI

Cautious interactions. As cities evolve into smarter, more connected ecosystems, the need for robust cybersecurity for connected devices and digital systems becomes essential.

CREDIT: ISTOCK/UEPONG



effective way to support electrification, ensure reliable local energy supply, and optimize electricity costs. This is particularly useful for critical facilities like hospitals or buildings in areas that frequently experience storms and other extreme weather. Designed to operate independently or connect to the main grid, they offer flexibility and reliability that cities need to stay resilient.

The latest advancements in battery energy storage system (BESS) technology have been transformative for microgrids, delivering greater capacity, efficiency, and longevity. Moreover, as these technologies become increasingly cost-effective, they not only reduce long-term energy costs but also enable the seamless integration of renewable energy sources.

A prime example of this shift is the new *Terminal One* microgrid at JFK International Airport. This helped transform the terminal into the first airport transit hub in the region that could function independently from the power grid, maintaining 100 percent of airport operations during power disruptions. The microgrid included rooftop solar and

battery-energy storage, utilizing re-claimed heat to cool and heat water. It helped to reduce the airport's greenhouse gas emissions by more than 38 percent, compared to the grid.

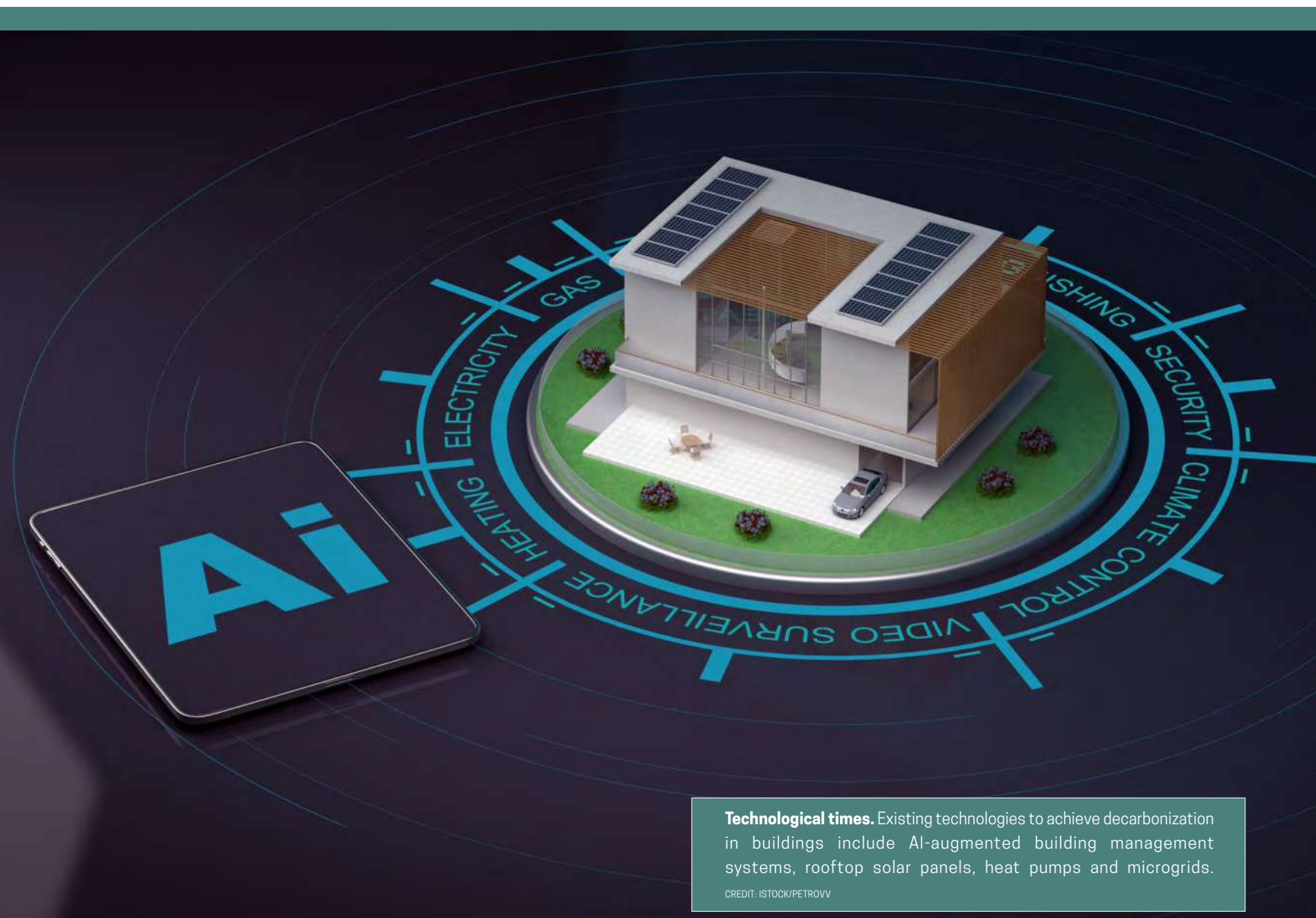
This demonstrates the potential for other major airports and facilities to follow suit. We saw the impact of the power outage that hit London's Heathrow Airport in March 2025, and the major blackouts that hit Spain and Portugal just a month after. These incidents show the growing importance of solutions like microgrids that enable airports, buildings, and factories to stay up and running during disruption.

At the heart of these technologies—enabling them to operate efficiently and respond to real-time changes—is one essential element: data.

PRECISION IN ACTION: DATA-LED OPTIMIZATION

Data is the lifeblood of Electricity 4.0. When it flows throughout the energy landscape, it makes the invisible visible, helping us to see the energy usage in real time and optimize it.

With IoT, AI and advanced analytics, cities can meet the demand for energy



Technological times. Existing technologies to achieve decarbonization in buildings include AI-augmented building management systems, rooftop solar panels, heat pumps and microgrids.

CREDIT: ISTOCK/PETROVV

in an efficient and sustainable way. How? By improving energy management, extending the lifespan of infrastructure through predictive maintenance and making smarter decisions in real time, based on data. These technologies not only enhance operational efficiency but also empower cities to respond swiftly to emergencies, reducing downtime and enhancing public safety.

The key to generating this precious data is digitally enabled devices. At Schneider Electric, we call this foundational level the “connected products” layer of our *EcoStruxure* architecture. This includes essential technology such as energy meters, **smart panels, switchgear and transformers**, which keep critical urban operations running smoothly. Once the data has been analyzed, insights can be used to support energy-saving initiatives. It can also enable automation to prevent equipment failures and improve efficiencies.

As cities evolve into smarter, more connected ecosystems, the need for robust cybersecurity becomes not just important, but essential. Every connected device and digital system creates a potential entry point for cyber threats. If these systems are not secured from the outset, the consequences of a data breach can be far-reaching and severe. To mitigate these risks, cybersecurity must be embedded into the design and development of

smart infrastructure, rather than added as an afterthought. Proactive, resilient digital security strategies are key to protecting not just data, but the trust and well-being of entire communities.

WORKING TOGETHER TO POWER PROGRESS

Electrification and digitalization are more than just technological developments—they are driving forces for a more resilient urban future. However, sustainable urbanization demands more than just innovation. Policymakers, corporations and global organizations must work together to accelerate the adoption of digital tools. This must be supported by the development of regulatory frameworks that facilitate sustainable energy transitions and invest in smart infrastructure solutions.

Cities are driving forces behind economic growth, as well as the cornerstone of nations and the blueprint of our shared future. We must invest in them now to ensure they remain vibrant, resilient, and livable for future generations.

Frédéric Godemel is executive vice president of energy management at Schneider Electric.



Little But Large



THIS FUTURISTIC HOME DEMONSTRATES THAT IT'S POSSIBLE TO BE **STYLISH**, **ECOFRIENDLY** AND **AFFORDABLE**.

BY AVI FRIEDMAN

Flexibility and affordability are the main focus of “Expandable House,” designed specifically in 2019 for the town of Batam, Indonesia, by Urban Rural Systems, a team at Future Cities Laboratory in Singapore, whose research and development focuses on solutions for growing cities. In the past half century, Batam increased in size and population from a small fishing village to a city of 1 million people—and growing. This raised issues of how to house the large numbers of incoming migrants, organize sewage systems, and provide transportation infrastructure. Expandable House tackles the housing problem through a flexible structure that can adapt to the homeowner’s needs.

Since every household differs in their needs, Expandable House is customizable to fulfill them. The Urban Rural Systems team studied patterns of household income generation, as well as the consumption of water, energy, and food, to develop a spatial layout that can flexibly and affordably meet these requirements.

The most basic form of the house consists of a one-story, open-plan layout. The height of the roof can be raised. The dwelling’s floor and foundations are structurally capable of supporting up to three additional floors, which would be added in between the foundation and the roof. The developer can sell the basic model of the house, allowing the homeowner to add infill levels according to their needs or their budget. They may also choose to use the home as a live/work unit by allocating the ground floor for commercial functions, generating income that can in turn pay for the house.

This form of housing curbs urban sprawl by encouraging densifying vertically instead. The basic model is inexpensive to construct, using local brick for walls and corrugated steel for the roof. Due to the adaptable nature of the house, it prevents unnecessary elements from being built, further cutting down costs.

Although the structure of the house is very minimal, it comes with all resources needed to live sustainably, including rainwater harvesting, solar power generation, and sewage/septic-tank systems. The house is also designed using passive cooling principles to avoid reliance on centralized energy infrastructure that is costly to build and disturbs the environment. A kitchen garden is included as an integral part of the house, encouraging self-sufficiency as part of the residents’ lifestyles. **GB**

This article was reprinted with permission from “Future Homes: Sustainable Innovative Designs” by Dr. Avi Friedman. He co-founded the Affordable Homes Program at the <https://www.mcgill.ca/mchg/> McGill School of Architecture in Montreal, and is the principal of Avi Friedman Consultants Inc., which focuses on affordable and sustainable residential environments. Friedman is the award-winning author and co-author of 36 books on sustainably designed housing.

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COMING NEXT ISSUE

GREEN BUILDER[®]

State of the Industry 2026

What's on the minds of homebuyers and renters? Where will they move? What kind of home will they find appealing? We'll take a deep dive into a year's worth of GBM research to find out.

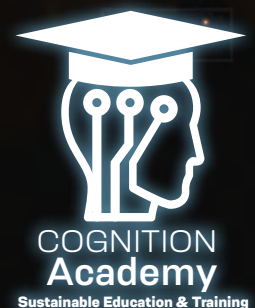
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THE POWER to be humble



Ron Jones
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S ometime between bedtime (around 10 o'clock) and midnight, the power shut down. I woke and realized that the nightlights and clock were no longer illuminated. The interior of the Aspen Cabin was so dark I literally could not see the proverbial "hand in front of my face."

Following several cloudy and rainy days, especially the two most recent, I should have monitored the solar system more closely, but I hadn't. As a result, I groped around until I found a flashlight and waited for the sun to come up, hoping I could reset the system in the morning before the food in the refrigerator spoiled.

At first light, I went to the workshop where the batteries and the rest of the inside components of the off-grid system are located. The readout was 46 volts, low enough to cause everything to shut down. I turned off all the non-essential circuits in the electrical panel and was trying to remember the reset sequence when it suddenly came to life on its own. The sun had broken through the clouds just enough to allow the solar panels to start generating watts. Soon, everything was back to normal.

We have an excellent whole-house generator standing by for such circumstances but the interface between it and the rest of the system has eluded us so far. There is an expert service technician scheduled to head our way later in the month, so hopefully that will result in a more-reliable solution. We need that, because the colder temperatures are already hinting that the season is changing rapidly here in the high country. This morning the low was 27 degrees, and it is still technically summer.

In retrospect, what we experienced was a relatively minor inconvenience, and a reminder to be more attentive. It also served to remind us that keeping the lights on, the heat working and the refrigerator keeping the food inside safe, is not really guaranteed, whether you're plugged into the grid or not.

Thousands of building occupants around the country find themselves with everything from temporary power

"In retrospect, what we experienced was a relatively minor inconvenience, and a reminder to be more attentive. It also served to remind us that keeping the lights on, the heat working and the refrigerator keeping the food inside safe, is not really guaranteed, whether you're plugged into the grid or not."

outages to total devastation when natural and man-made disasters occur. Entire communities are wiped off the map in a matter of days, even hours in some cases. It can be hard to put yourself in their situation unless you've experienced it yourself.

Shelter that provides basic safety and comfort is something we mostly take for granted, but when catastrophic events take place, we witness human misery and destruction that is hard to measure. As members of the building industry, we deliver security and sustainability to homeowners and renters everywhere. It is important work and we can't take our responsibilities lightly.

Where and how we build are essential to the prosperity of our neighbors and our communities. Too often, compromises in judgement and the focus on first costs result in situations of vulnerability for our customers. We can be profitable and responsible at the same time.

Having the power go down for a few hours was humbling and served to remind me just how fortunate we are to have all of the modern conveniences and technologies at our fingertips. But these good fortunes require our ongoing participation and attention. **GB**



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A modern kitchen featuring stainless steel appliances, including a refrigerator and a range with a cooktop and oven. The countertops are made of white marble with grey veining. The cabinets are dark wood. The background shows a view of a landscape with greenery and a blue sky.

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