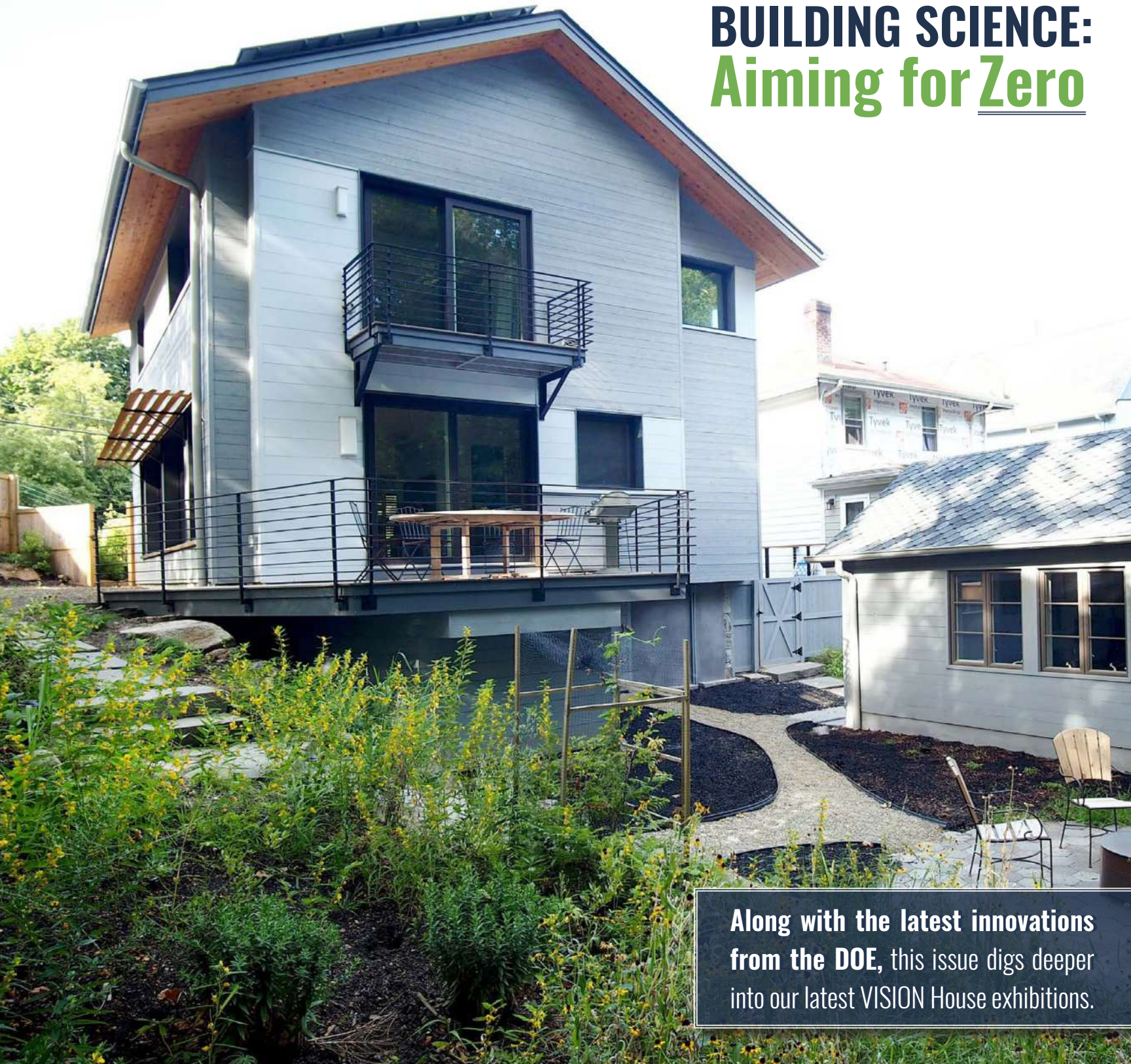


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BUILDING SCIENCE: *Aiming for Zero*



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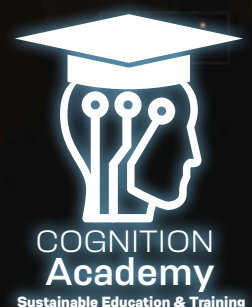
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- The upgraded home will show how home buyers can personalize their home to the lifestyle they lead.

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HOW MUCH HOME ENERGY CAN SMART DEVICES SAVE?

SMART DEVICE ENERGY SAVINGS (APPROXIMATE)

Device	Claimed Savings	Annual Savings (\$)	ROI
Aquanta Water Heater Timer	10% on water heating bills	\$30-\$40	4-5 years
Sense Energy Monitor	8-10% on electricity	\$96-\$120	2.5-3 years (user dependent)
Philips Hue Smart Lighting	Up to 10% additional savings	\$20-\$25	4-5 years
TP-Link Kasa Smart Plugs	1-4% on electricity	\$20-\$50	0.6-1.5 years. Saves on phantom devices
Rachio Smart Sprinkler Controller	20-50% water savings	\$130-\$260	0.9-1.8 years
Flume Smart Water Monitor	10-15% on water bills	\$50-\$100	2-4 years
ecobee Smart Thermostat	10-12% heating, 15% cooling	\$125-\$150	1.7-2 years
Lutron Caseta Wireless Dimmer	10-20% on lighting costs	\$30-\$60	1-2 years
Wyze Smart Bulbs	Up to 10% on lighting	\$10-\$20	2-4 years

Add up all the promised savings and you shave off one-fourth of the annual average for the whole house.

As you talk to homeowners about the many “smart” products now available for homes, they’re likely to have questions. If a smart thermostat will save 20 percent on heating and cooling, does that savings stack with an “intelligent” water heater timer and app-controlled lighting?

The short answer is “yes.” But how much? To estimate this, I crunched the numbers. Starting with energy costs of about \$2,300 per year for an “average” new home. I looked at some popular brands of smart devices, as shown in the table above.

BEHAVIOR MATTERS

Totaling the possible energy savings from installing all of these gadgets and using them well, I arrived at a total of \$427 to \$640 in potential savings per year, dependent upon the home’s location, region and occupant behavior.

- **Heating and Cooling:** \$131-\$145
- **Water Heating:** \$30-\$40
- **Electricity Monitoring:** \$96-\$120
- **Lighting:** \$20-\$25
- **Phantom Loads:** \$20-\$50
- **Water Use:** \$130-\$260

That total savings equals about 27 percent of the \$2,300 annual average energy cost for a home. The largest savings from smart tech happens in the Heating and Cooling and Water Use categories. Other applications such as Electricity Monitoring depend heavily on user behavior. Does the homeowner fix leaks quickly? Does the family reduce use/replace energy-guzzling items such as pool pumps and large-screen TVs?

A STACKABLE APPROACH

In “above code” or net zero homes, the energy saved with smart devices takes on greater significance, because they knock out a bigger piece of the overall pie. The combination of smart sensors and thermostats with high SEER heat pumps and upgraded insulation, for example, might create enough “slack” in the home’s energy budget to allow for an electric vehicle charger without upgrading electrical panels or wiring. **GB**



Matt Power
Editor-in-Chief

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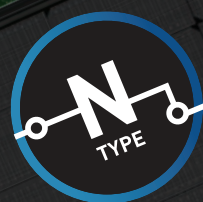
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Global Methane Emissions Rising at Record Pace

While CO₂ dominates headlines about the Climate Crisis, methane release should also be sounding alarms.

Global emissions of methane are rising at the fastest rate in decades, requiring immediate action to help avert a dangerous escalation in the climate crisis, according to “[The methane imperative](#),” a study by a coalition of researchers from 14 universities and research facilities worldwide.

According to the study, the world “quite rightly” has focused on carbon dioxide (CO₂) as the primary driver of rising global temperatures. But little has been done to address methane emissions, despite the fact that methane has 80 times the warming power of CO₂ in the first 20 years after it reaches the atmosphere. Methane emissions are responsible for half of the global heating already recorded, have been climbing significantly since 2006, and will continue to grow throughout the rest of this decade unless new steps are



Forbidden gas. Methane is far more dangerous to the environment than other greenhouse gasses, but is rarely talked about. CREDIT: ISTOCK/FRANCESCO SCATENA

taken to curb this pollution. So far in the 2020s, global methane emissions have typically been about 30 million tons higher each year than during the 2010s, with annual records in methane emissions broken in 2021 and again in 2022.

The new paper outlines a number of actions countries should take, including better linking CO₂ and methane reduction efforts and identifying the most effective methane cutting projects under certain circumstances. **GB**

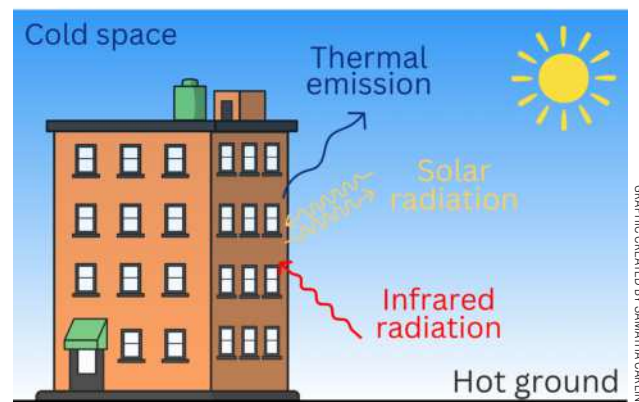
To Beat the Heat, Think Zigzagging Wall Assemblies

A small change in wall design could cut a home’s indoor temperature by more than 37 degrees Fahrenheit.

Incorporating zigzag patterns into walls could help cool overheated buildings, according to researchers at Columbia University. The patterns redirect the sun’s heat away from a building and can reduce its surface temperature by up to 3 degrees Celsius (37.4 degrees Fahrenheit) compared with flat walls, without consuming any energy.

The design consists of walls with a series of protrusions that create a zigzag shape when viewed from the side. This configuration utilizes radiative cooling—a passive strategy that reflects sunlight and emits long-wave infrared radiation through the Earth’s atmosphere into outer space. Better-known strategies, such as painting rooftops white to reflect sunlight, have been effective for horizontal surfaces but are less ideal for vertical, according to research team leader Qilong Cheng.

Flat emissive wall



The bounce effect. A revolutionary wall design could deflect enough heat to significantly lower a home’s indoor temperature and reduce dependency on air conditioning. CREDIT: NEXUS/QILONG CHENG

[Although it is still under research](#), the design could be a huge plus for the environment. Buildings are now responsible for approximately 40 percent of global energy consumption—much of which comes from air conditioning usage. Buildings also produce more than one-third of all global carbon dioxide emissions.

But this cooling method could increase heating demands in colder regions during winter. To address this, Cheng and his colleagues have proposed an adaptive design featuring hinged fins that can be raised in winter to increase heat absorption and lowered in summer to reduce it. **GB**

U.S. Homeowners Gain \$8 Billion in Tax Credits in 2023

Climate-friendly upgrades, new windows and more result in a financial boom for mostly middle-class families.

American taxpayers claimed more than \$8 billion in credits on their 2023 returns—more than twice government projections—for making climate-friendly upgrades to their homes under the Inflation Reduction Act, according to the Treasury Department. More than 3 million households claimed \$6 billion in credits for solar panel installation and related projects, as well as \$2 billion for other home improvements such as new windows and air-conditioning systems.

In most states, 2 to 3 percent of individual and family taxpayers claimed a tax credit for at least one form of climate-friendly home improvement in 2023. In addition, nearly half of the households that claimed the credits reported annual income below \$100,000, the credit uptake was more common higher up the income scale. More than 1 in every 20 households in income brackets



Cash cow. In 2023, U.S. taxpayers benefited from more than \$8 billion in tax credits for making climate-friendly upgrades to their homes. CREDIT: ISTOCK/MALERAPASO

higher than \$100,000 claimed the credit, although some of the credits limited eligibility for higher-income households.

Proponents say the better-than-expected numbers reflect an increasing desire by homeowners to adopt solar panels, heat pumps and electric vehicles. But other analysts say the figures include purchases from people who would have bought the products anyway, and others are units delayed by supply chain issues or a lack of qualified professionals to install them. **GB**

Study: Switching from Gas to Electric Stoves Cuts Indoor Air Pollution

A Columbia University project is the first to evaluate the effects of residential cooking electrification in public housing.

Switching from a gas stove to an electric induction stove can reduce indoor nitrogen dioxide (NO₂) air pollution, a known health hazard, by more than 50 percent, according to a study by scientists at Columbia University and the Columbia Climate School (CCS).

“Out of Gas, in With Justice” is the first study to evaluate the feasibility and benefits of transitioning from gas to induction stoves in affordable housing. It is also the first study to evaluate the effects of residential cooking electrification in a public housing setting in the U.S., according to a CCS release.

Twenty low-income households in a public housing building in the Bronx were recruited and randomized to have their gas stove replaced with an induction stove or serve as a control group. Results taken over a nine-month period



Down with NO₂. Indoor nitrogen dioxide levels are cut in half when an electric induction stove is used in place of a natural gas-based one, according to a Columbia University study. CREDIT: ISTOCK/BRIZMAKER

showed a 56 percent reduction in average daily NO₂ concentrations in the induction stove group compared with the control group using gas stoves.

Participants using the new stoves unanimously reported being pleased with the transition. None of them opted to switch back to gas cooking despite having the option to do so at zero cost, according to CCS. **GB**

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ZERH HOUSING INNOVATORS ROUNDUP 2024: UNLIMITED OPTIONS

The U.S. Department of Energy (DOE)'s annual Zero Energy Ready Home (ZERH) Housing Innovation Award winners promote the benefits of affordability, geothermal energy, passive construction and recycled products.

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"We think of it as our clients writing the next chapter of the book of their lives when they choose to build a custom home. Our job is to help them write it." **PAGE 50**

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Changing the Way Builders Do Closets

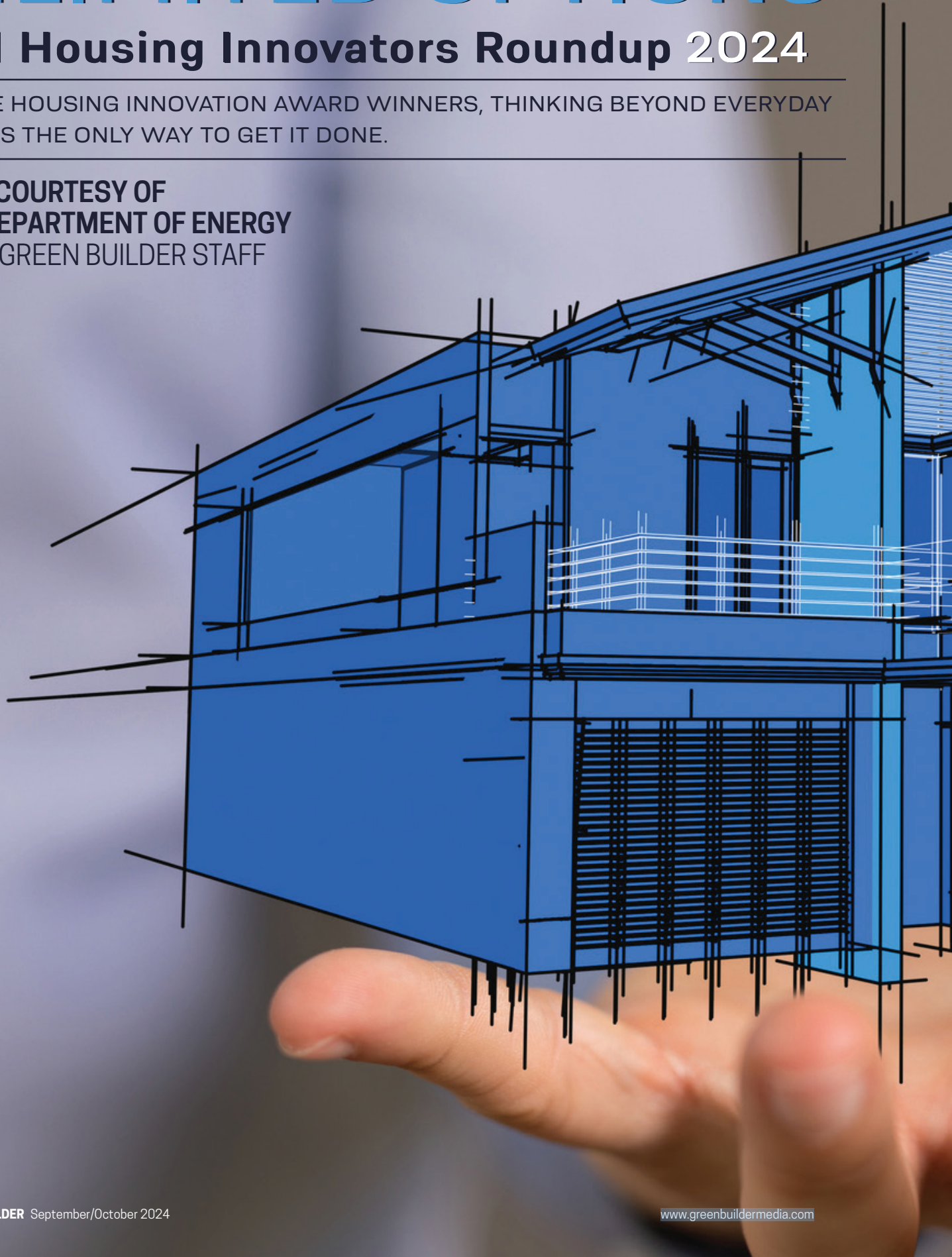
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UNLIMITED OPTIONS

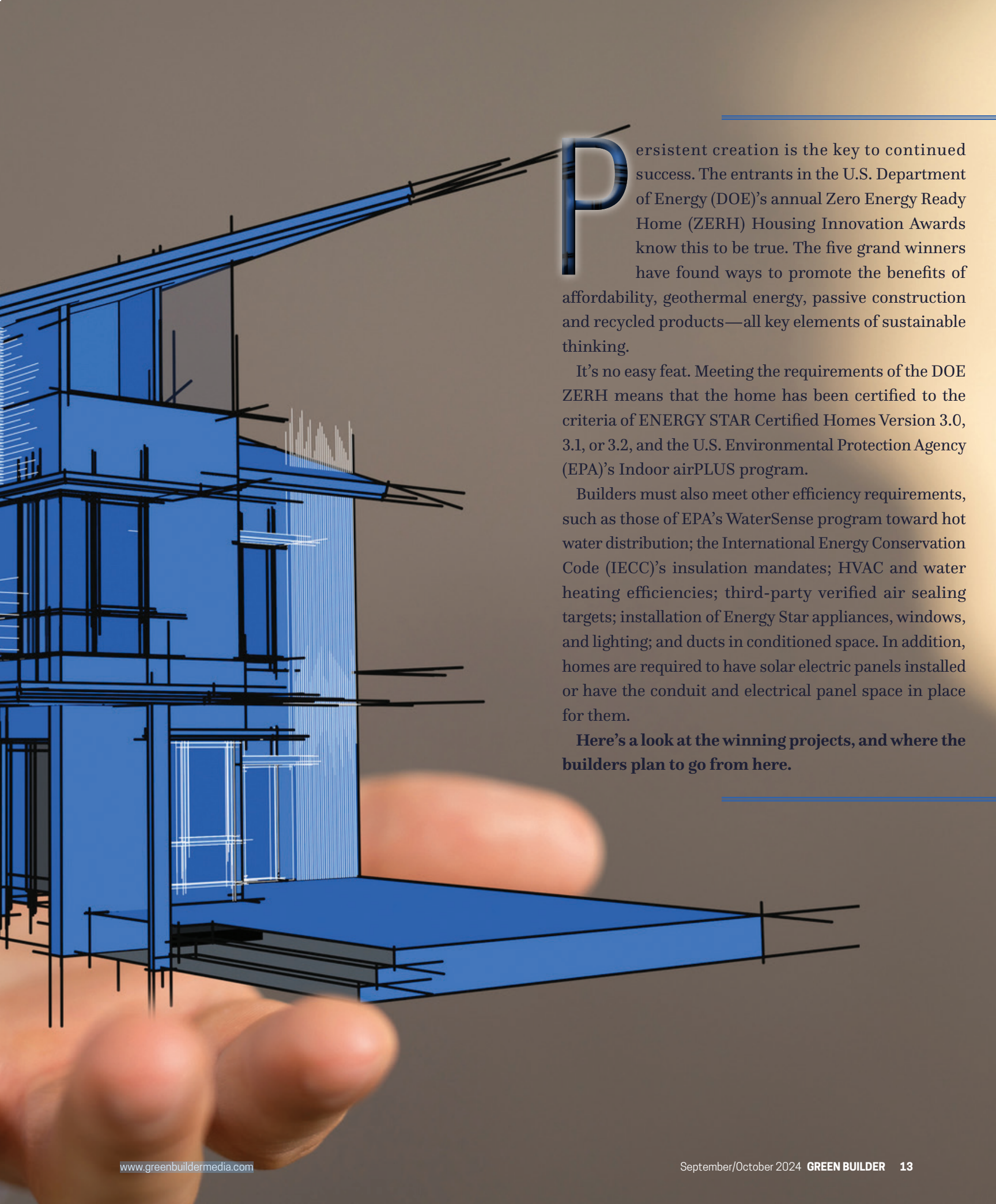
ZERH Housing Innovators Roundup 2024

FOR THESE HOUSING INNOVATION AWARD WINNERS, THINKING BEYOND EVERYDAY BUILDING IS THE ONLY WAY TO GET IT DONE.

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EDITED BY GREEN BUILDER STAFF



CREDIT: WIRESTOCK



Persistent creation is the key to continued success. The entrants in the U.S. Department of Energy (DOE)'s annual Zero Energy Ready Home (ZERH) Housing Innovation Awards know this to be true. The five grand winners have found ways to promote the benefits of affordability, geothermal energy, passive construction and recycled products—all key elements of sustainable thinking.

It's no easy feat. 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. In addition, homes are required to have solar electric panels installed or have the conduit and electrical panel space in place for them.

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

Hot topic. Affordable Housing Concepts' Zero Place apartment building in New Paltz, New York utilizes ground-source heat pumps to provide space and water heating for tenants.



PHOTOS COURTESY OF AFFORDABLE HOUSING CONCEPTS

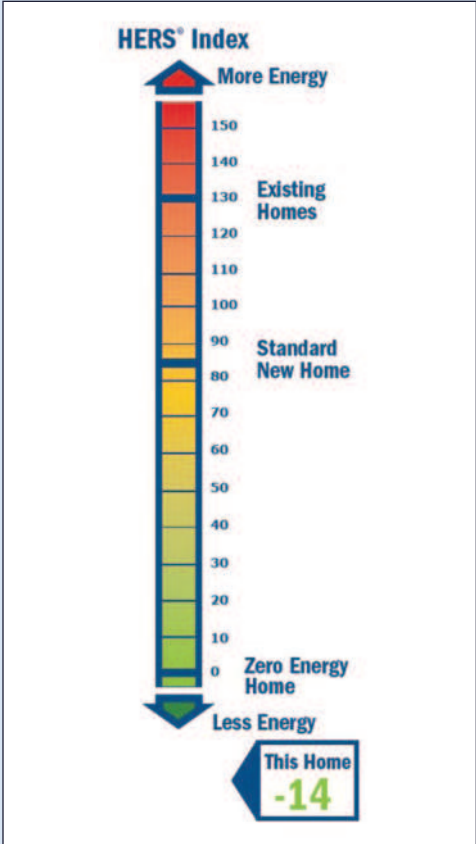
Project Info

PROJECT NAME: Zero Place, New Paltz, New York

CATEGORY: Multifamily

BUILDER: Affordable Housing Concepts, Gardiner, N.Y.

COMPLETED: March 2022



From the Ground Up

The Zero Place project showcases how to efficiently heat a multifamily home with geothermal energy.

A first glance at Zero Place, a four-story mixed-use apartment building in New Paltz, New York, reveals what appears to be eye candy. The 63,320-square-foot multifamily project sports a rooftop deck with seating and views, plus 688 photovoltaic (PV) panels on the roof and south-wall awnings capable of producing 270,000 kilowatt hours (kWh) of power per year.

What's underneath the building is even more impressive. Fifteen ground-source heat pump wells reach deep into the earth below the building to draw heat from the temperate ground. The ground-source heat pumps provide space and water heating for tenants in the building's 46 apartments and six commercial spaces.

This is the second ground source-heated multifamily building for developer Keith Libolt of Affordable Housing Concepts. It's the first structure that he has certified through the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) Program.

Ground-source heating was just one of several innovations convincing the judges for DOE's 2023 Housing Innovation Awards competition that Zero Place was worthy of Grand awards in the "Blazing the Trail" and "Total Package/Best All Around" categories.

The building, like every home certified through the DOE Zero Energy Ready program, met the criteria of *ENERGY STAR* Certified Homes Version 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 for hot water distribution through the EPA's WaterSense program; the insulation requirements of the 2015 International

Energy Conservation Code; HVAC and water heating efficiencies; third-party verified air sealing targets; installation of *ENERGY STAR* appliances, windows and lighting; and ducts in conditioned space. In addition, homes are required to have PV panels installed or have the conduit and electrical panel space in place for future installation.

To meet the envelope requirements of the DOE certification, Libolt chose a building material not often seen in multifamily construction, insulated concrete form (ICF) blocks. Rigid foam (2.625 inches thick) and plastic spacers create hollow blocks, which are stacked together to form walls. Steel rebar is laid horizontally and vertically through the spacers. The 6-inch-wide space is filled with concrete that hardens in place for an R-22 wall that is 11.25 inches wide and is resistant to hurricanes, fires, pests, and mold. The ICF blocks form the crawlspace and basement foundation walls where they are covered with a waterproofing membrane.

Above ground, the ICF blocks are covered with house wrap and brick veneer on the first three floors and engineered wood siding on the fourth floor. The ICF walls are inherently airtight but additional caulking or foaming was done at all rough openings around windows and doors, around plumbing and electrical holes, and at the edges of the drywall on party walls and wallboard behind showers and tubs. These measures yielded an airtightness of 1.9 air changes per hour at 50 Pascals pressure differential, better than the 2.5 ACH 50 required by *ENERGY STAR*.

The building's flat roof consists of open-web steel joists at 48 inches on center with corrugated metal and poured concrete decking

and adhered rubber roofing membrane.

The underside of the metal deck is covered with 4 inches (R-28) of closed-cell spray foam, which itself is covered by 12 inches (R-42) of open-cell spray foam.

The triple-pane windows, another unusual feature for multifamily housing, provide exceptional performance with a U-value of 0.17 and a solar heat gain coefficient of 0.27.

HEATING THINGS UP

While the building envelope is impressive, the mechanicals are the real story. Heating and hot water are provided by ground-source heat pumps. Builders often have difficulty siting these items because the piping used to extract heat from the ground is often installed as large loops of tubing buried 5 feet or deeper across several hundred feet of ground to the side of the building, thus requiring a site with a large amount of open space.

In this case, the builder dug the 15 wells straight down, 400 feet into the ground before starting the building. Each well contains a separate pipe loop that connects directly to a manifold in the equipment room, so if a well were to fail, it could be closed off with a valve without impacting the rest of the system. By digging the wells within the building's footprint, no additional yard space was needed. Excavation costs were reduced because excavation was already planned there for the building's footings and crawlspace.

For space heating, each of the 46 apartments has its own unitary ground-source water-to-air heat pump; nine more heat pumps provide heating and cooling for the corridors and common areas. The heat pumps have an average rated efficiency of

Annual Energy Costs

\$750
(without PV)

-\$250
(with PV)

Annual Energy Cost Savings*

\$1,200
(without PV)

\$2,250
(with PV)

Annual Energy Savings

8,050 kWh
(without PV)

14,900 kWh
(with PV)

* vs typical new homes

Key Features

AIR SEALING: 1.9 ACH50. All common wall connections spray foamed. Drywall sealed at top and bottom plates and corner studs of party walls.

ATTIC: 12-inch R-46 open-cell + 4-inch R-28 closed cell spray foam under roof deck.

ENERGY MANAGEMENT SYSTEM: Energy monitoring system measures energy usage of each load in each unit. Mobile apps let tenants track their energy and water use.

FOUNDATION: Insulated basement, 11.25-inch R-22 ICF walls, 4-inch R-26 cc spray foam under slab.

HOT WATER: Two central ground source heat pumps (3.2 COP) with four 162-gallon tanks provide space and water heating to all units. Risers with recirculation pumps distribute water to each line of apartments. Each apartment has a manifold to distribute hot water to each fixture.

HVAC: Ground source heat pumps, 3.4 COP. Variable speed pump.

LIGHTING AND APPLIANCES: LED lighting, ENERGY STAR appliances.

ROOF: Flat roof, 16-inch open-web steel joists at 48-inch on-center (OC) spacing; concrete deck, rubber membrane.

SOLAR: 248 kW of PV on roof and as window awnings.

VENTILATION: ERVs, one per apartment. Supplies fresh air thru ducted HVAC. Draws from bath, kitchen, laundry, mechanical room. Sensored and manual boost controls.

WALLS: ICF, R-22 total: 11.25-inch, house wrap, brick veneer or engineered wood.

WINDOWS: Triple-pane windows, U=0.17, SHGC=0.27, vinyl-framed, low-e, argon fill, casement style. Fixed solar panel awnings.

OTHER: Rooftop deck, handicapped-accessible units, walkable neighborhood. Several electric vehicle (EV) charging stations.

Power is up. The rooftop has space for half of the building's photovoltaic (PV) panels. The PVs provide occupants with free power over the course of the year.



3.4 coefficient of performance (COP), which means they are 3.4 times more efficient at heating air than a standard electric furnace.

The building's water loop employs variable speed pumping, which uses only as much power as needed. The system makes automated variable speed adjustments relative to the amount of heating and cooling needed and the number of heat pumps operating. Pump power has been measured at 3.6 kW/year (or approximately 3 percent of the annual total ground-source heat pump system energy use).

Ground wells also provide heat for domestic hot water for the building via two water-to-water ground-source heat pumps. These heat water in four 162-gallon storage tanks. The domestic hot water is distributed from these tanks via risers on each floor to each line of apartments. Each dwelling unit has its own manifold that distributes the hot water to each fixture. A recirculation pump and loop is installed to minimize wasted water while waiting for hot water to reach the faucet.

The domestic hot water system gets another boost in efficiency from excess heat

that is pulled from the apartments when their air handlers are operating in cooling mode.

This occurs more than one would expect for a building in IECC Climate Zone 6A; energy load calculations determined the building is cooling dominant.

Although heating and hot water are included in the monthly rent, tenants are encouraged to conserve and can track their usage on a mobile app. There is a surcharge for usage over a high threshold. While the thermostats are in each unit, the actual mechanical equipment for each apartment (including the heat pumps and energy recovery ventilators [ERVs]) is installed in common mechanical rooms accessible from the corridors. This allows easy access for building operations and maintenance staff to repair and maintain the equipment without needing access to the dwellings.

AIRFLOW ADVANTAGES

Each apartment has its own ERV. A dedicated fresh air supply is integrated into the return side of each unitary HVAC air handler so the ducted HVAC systems can distribute fresh air



GOOD AS GLASS. Triple-pane windows keep heat inside the apartments during winter and help control inside temperature during hot summer months.

BONUS BENEFITS. Solar panels on the roof provides occupants with free energy and produce enough electricity for several electric vehicle chargers.

SOLID STATE. The 11.25-inch-thick walls are constructed from insulated concrete forms (ICFs), providing continuous insulation along the building's interior and exterior.

SEALED UP TIGHT. All common wall connections are spray foamed to ensure a properly sealed environmental envelope.

to every room of the dwelling unit. Dedicated exhaust terminals are in each bathroom, the kitchen, laundry, and mechanical room.

Regular operation of the ERV provides an exhaust airflow of 20 to 30 cubic feet per minute (CFM) continuously per bathroom. A manual controller was installed in each bathroom to boost the ERV speed to 45 CFM for 20, 40 or 60 minutes. CO₂ sensors in each unit enable the system to adjust ventilation levels based on CO₂ levels. Occupants can also control the ERV to prevent excessive ventilation during periods of high exterior humidity, extreme temperatures, or wildfire smoke.

The kitchen exhaust terminal also operates continuously at 30 CFM constant speed, and air flow can be increased to 45 CFM at the push of a button when needed. A re-circulating fan in the range hood over the stove operates to remove grease and other cooking particles from the air.

Like all DOE Zero Energy Ready certified homes, this building meets the requirements of the EPA's Indoor airPLUS program, which include a whole-house ventilation system like

the ERVs described above, the use of low- and no-VOC paints and finishes, and good water management practices. In addition, the builder chose to make Zero Place a completely emission-free project. There is no gas line into the building and no gas backup heating system. The all-electric building relies on the ground-source heat pump system for all of its water and space heating needs.

To enhance indoor air quality, induction stoves were installed, offering a cleaner cooking alternative to gas stoves. The project also incorporated heat pump clothes dryers, which significantly reduced the energy consumption typically associated with in-unit laundry. ENERGY STAR-rated lighting, ceiling fans, refrigerators, and dishwashers add to energy savings. Even the elevator is energy saving—it uses a unique regenerative power mechanism during descent to effectively offset its energy demands.

The builder installed a comprehensive energy monitoring system that has the ability to measure energy usage down to individual loads in each unit, enabling the detection of improperly functioning equipment to

help identify excess energy consumption and address issues before they escalate. For example, by employing sensors on the domestic hot water circulation system, they were able to identify the possibility of slowing down the circulation pumps, resulting in a 20 percent reduction in energy usage.

"Combining ICF, geo and solar to create a high-performance building system is incredibly effective," Libolt says. "ICF walls require a lot less attention to detail in the field than other wall assembly systems to achieve the same or greater levels of air sealing and insulation performance."

Geothermal is readily available and is two-to-three times more efficient than the next best system for relatively the same costs after incentives are capitalized.

For Libolt, the project has been the fulfillment of a lifelong commitment to better housing, especially for the underserved. "I grew up in a very poor urban setting," he notes. "Providing environmentally clean, safe places for people to live has always been important for me."



NIGHT LIGHTS. A roof-mounted solar array generates backup power that can be used during outages. A smart control device then directs energy to specific locations, such as a computer, refrigerator and lights.

PHOTOS COURTESY OF CGA STUDIO ARCHITECTS

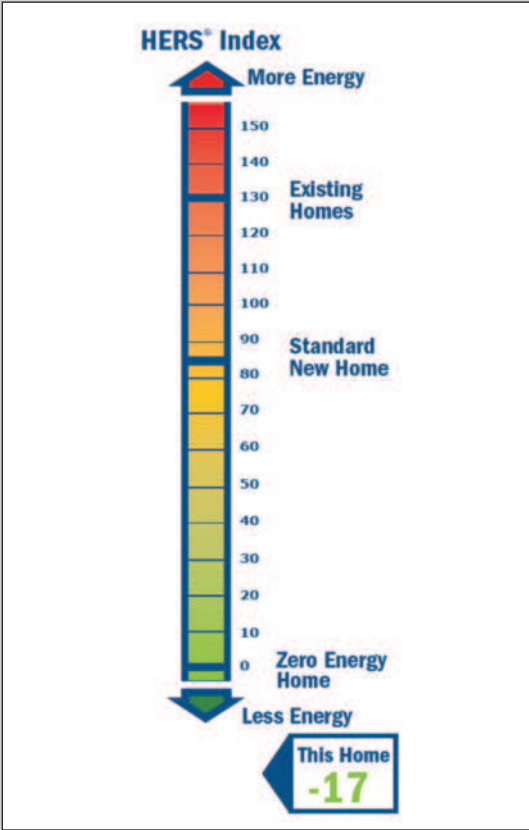
Project Info

PROJECT NAME: Forever House, Hastings-on-Hudson, New York

CATEGORY: Custom for Buyer

BUILDERS: CGA Studio Architects, Hastings-on-Hudson, N.Y.

COMPLETED: June 2022



Passive Perfection

This New York-area Forever House shows how Passive development is successfully done.

When Architect Christina Griffin bought a tiny 1905 cottage in the village of Hastings-on-Hudson, New York, she retained the physical footprint of the old home but gave the property an all-new carbon footprint. She replaced the 998-square-foot gas- and oil-burning house with a modern 1,713-square-foot, two-story carbon-neutral home that meets the U.S. Department of Energy's Zero Energy Ready Home (ZERH) certification requirements.

Judges for DOE's Housing Innovation Awards were so impressed with the zero-carbon "Forever House" that they gave it a grand award for decarbonization. The home also achieved a "Passive House + Source Zero" designation from Passive House Institute US (PHIUS) and was recognized by PHIUS with a Passive Project Design Competition award.

This project is the fifth for which Griffin has sought a Passive House designation, and the first home designed by her firm, CGA Studio Architects, to receive a ZERH certification. Griffin first heard about the DOE program through PHIUS, as the two programs have a collaborative relationship. "PHIUS makes it pretty clear on its website that Passive House is a path to DOE ZERH," Griffin says.

Griffin's home energy rater, Anthony Lisanti of Integral Building & Design, Inc., also recommended that she consider pursuing a DOE Zero Energy Ready certification.

Griffin has long been interested in sustainability. She built the first LEED for Homes platinum-rated project in Westchester County, N.Y., in 2010. (That

home also earned a design award from the American Institute of Architects.) A speech by early Passivhaus pioneers Dr. Wolfgang Feist and Katrin Klingenberg in New York City in 2011 inspired Griffin to become a Certified Passive House Consultant with PHIUS in 2012 and with Passive House International (PHI) in 2015.

A PASSION FOR PASSIVE

Griffin is an active member of New York Passive House, a network of professionals, builders, and contractors working together to problem solve and promote Passive House projects. A math whiz since high school, Griffin taught herself the modeling programs used by Passive House. With practice, she learned to run a WUFI (moisture risk) 3D model on a home in two hours. Griffin says the WUFI model provides a clear picture of what impacts different energy-efficiency options can have on a home's performance.

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

The tours sold out within two hours. "Taking a tour takes the mystery out of Zero Energy and Passive House projects," Griffin says. "It's really a revelation to people when

they can see and feel the energy-efficiency features we include in these homes."

One thing Griffin includes in the tour is a 90-second video comparing the thermal envelope of a Passive House to putting on a down jacket with continuous insulation between outer and inner airtight layers. "I've put a down jacket on this house," she says.

Although Griffin has experimented with several building materials over the years, she settled on stud walls and blown cellulose, both for their low-embodied carbon content and because they are common in the construction industry.

The home's double walls are constructed of two 2-by-4, 16-inch on-center walls set 8 inches apart, with exterior CDX plywood sheathing on the exterior. A smart vapor control membrane covers the inside face of the interior wall to hold in the 18 inches of dense-packed cellulose, which provides a whopping R-55 insulation value to the walls. The builder tacked 2-by-2 furring strips over this interior vapor retarder to provide a service cavity behind the drywall so electrical boxes could be set and wiring run without having to put holes in this air barrier layer.

The exterior CDX plywood sheathing layer was topped with a 4-layer smart vapor-control waterproof membrane with a three-dimensional mesh, which serves as an integrated vented rain screen behind the tongue-and-groove random-width, horizontal knotty cedar siding with a semi-solid stain finish.

The attic is insulated with 18 inches (R-64) of dense-packed cellulose held in place from below by an airtight smart vapor-control membrane. Like the walls, 2-by-2 furring strips create a space between this membrane

ZERH HOUSING INNOVATORS ROUNDUP 2024
UNLIMITED OPTIONS

Annual Energy Costs

\$1,800
(without PV)

-\$705
(with PV)

Annual Energy Cost Savings*

\$1,100
(without PV)

\$3,600
(with PV)

Annual Energy Savings

7,450 kWh
(without PV)

19,000 kWh
(with PV)

* vs typical new homes

Key Features

AIR SEALING: 0.82 ACH 50, interior walls and ceiling wrapped in airtight, vapor-open membrane. Fluid-applied airtight coating over subfloor, window and basement sills.

ATTIC: Vented cathedral ceilings, R-64 total: 18-inch dense-pack cellulose, airtight smart vapor-control, 2-by-2 furring service cavity.

ENERGY MANAGEMENT SYSTEM: Apps for tracking energy use, PV output, battery and HVAC.

FOUNDATION: Uninsulated basement, reused existing concrete slab, CMU walls, and 2-by-8 plus new 2-by-10 joists dense packed with R-34-41 cellulose held in by airtight membrane and 1.5-inch rigid mineral wool.

HOT WATER: Heat pump water heater, 80-gallon, 3.61 EF. Compact plumbing, R-7 on pipes.

HVAC: Ducted mini-split air-source heat pump, 12.6 HSPF, 18 SEER, 1 indoor plus 1 outdoor unit.

LIGHTING AND APPLIANCES: LED lighting. ENERGY STAR appliances, induction cooktop.

ROOF: Rafter gable roof: 5/8-inch CDX plywood, 2-by-3 furring, 1/2-inch CDX plywood, 3-layer airtight, smart vapor-control house wrap, fiberglass roof shingles. Continuous ridge and soffit vents.

SOLAR: 10.8-kW solar PV; 9-kW solar battery.

VENTILATION: ERV, with separate ductwork from HVAC.

WALLS: Double wall, Total R-55: Two 2-by-4 16-inch on-center (OC) walls 8-inches apart, R-55 dense-pack cellulose. Interior smart vapor-control membrane. Exterior CDX plywood, smart vapor control membrane plus mesh rain screen; cedar siding.

WINDOWS: Triple-pane, Passive House qualified, U=0.15, SHGC=0.34, shaded.

OTHER: All electric; reused existing foundation; no foam.



Kitchen energy aids. LED lighting, ENERGY STAR appliances and an induction cooktop in the kitchen are among the energy-saving elements of the Forever House.

and the ceiling drywall to provide an air-sealed space for electrical boxes and wiring. The attic itself is ventilated with continuous ridge and soffit vents. The CDX plywood decking is covered with a taped and sealed weather-resistant membrane and is topped with fiberglass roof shingles.

CARBON FOOTPRINT FIGHTERS

Because Griffin is “totally committed to having the lowest carbon footprint we can,” she was very conscientious about the materials she chose, such as the cellulose insulation, which is made from recycled newspapers. That is one reason she chose to reuse the existing concrete foundation walls, rather than breaking them up and pouring new high-embodied carbon concrete.

Because the basement walls and slab were already in place, Griffin left the basement uninsulated and installed insulation below the subfloor with dense-pack cellulose insulation in the floor cavities, and 1.5 inches of moisture-resistant rigid mineral wool insulation attached to the bottom of the floor joists over an airtight smart vapor-control membrane. She was able to retain the original 2-by-8 joists and diagonal plank subfloor for 72 percent of the flooring. Where

new flooring was installed, she used 2-by-10 floor joists; therefore, 72 percent of the floor was insulated to R-34 and 28 percent was insulated to R-41.

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

The air sealing strategy for the home consisted primarily of the airtight smart vapor control membrane that wraps the entire interior of the home, including beneath the ceiling insulation, on the interior of the wall insulation, and below the floor insulation, with service cavities between this membrane and the drywall in the walls and ceiling to maintain the air barrier. In addition, a smart vapor-control weather-resistant barrier and rainscreen was installed over the sheathing on the exterior walls. A similar membrane was installed over the roof sheathing. Also, a





liquid-applied air barrier was applied at the windowsills and basement sills. All of these techniques combined to achieve blower door test results of 0.82 air changes per hour at 50 Pascals pressure differential.

ERV IN ACTION

An energy recovery ventilator was installed to bring in fresh air that is tempered and filtered before distribution throughout the home via a separate duct system from the heating and cooling system. The ERV exhausts air from the bathrooms and kitchen.

The ERV has controls to notify homeowners when the filters need to be changed.

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

room, living/dining area, and all bedrooms.

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

TRAINING, RETRAINING—AND MORE

Griffin built this home to not only “talk the talk” but to “walk the walk.” She has also served as a Passive House consultant for several years. In 2013, she co-founded the Center for Sustainable Development, a nonprofit that conducts seminars and workshops on Passive House and green materials for homeowners, architects, engineers and builders.

Griffin acknowledged that finding or training knowledgeable contractors is a challenge. “Training is really difficult,” she says. “Even if the head framer knows what’s going on, the other guys often don’t. There is a lot of retraining.”

She arranged to have the manufacturer of the vapor-smart membranes come to the site to teach the workers how to install the membranes and tapes. When she can’t find a Passive House contractor, Griffin sometimes serves as her own general contractor. For the Forever House, she was fortunate to get an experienced contractor and site supervisor to help finish the project.

Future Forever House-similar projects are on the horizon. CGA Design Studio includes three architects and an interior designer. “We do about 15 to 20 homes per year, including single-family new homes, townhomes, mixed-use, renovations, and retrofits,” Griffin says. “We have quite a few 8- to 16-unit multifamily projects in older downtowns along the Hudson River and we are dedicated to designing these buildings to achieve Passive House and DOE ZERH certification.”



RESILIENT OPTION. Fiberglass roof shingles have a Class A fire rating, and they are thinner and easier to install.

SECOND LIFE. Thick exterior walls are stuffed with 18 inches of blown cellulose made from recycled newspaper, equivalent to R-55 insulation.

WINDOW OF OPPORTUNITY. The house design includes south-facing triple-pane glass windows that offer beneficial solar gain in the winter.

CONTINUED PURPOSE. Existing concrete foundation walls were used, instead of being broken up and replaced with new, high-embodied carbon concrete.

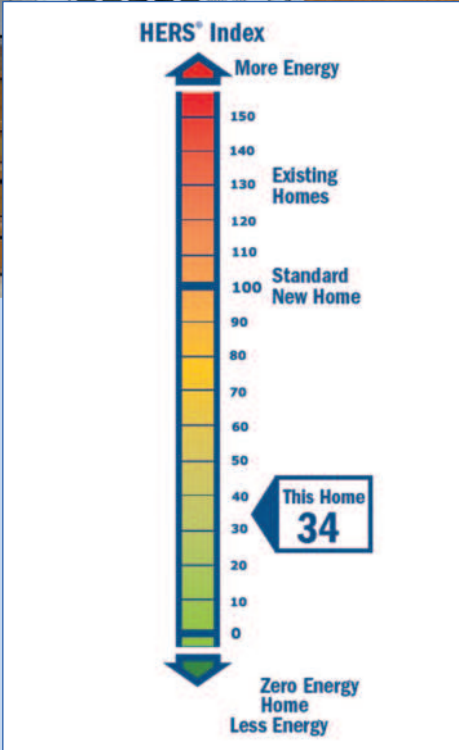
Group effort. Habitat for Humanity North Central Connecticut built a 3-bedroom, 1.5-bath, 1,396-square foot home—the “Cleveland Avenue Home”—with the help of dozens of volunteers who utilized DOE Zero Energy Ready Home program performance criteria.



PHOTOS COURTESY OF HABITAT FOR HUMANITY NORTH CENTRAL CONNECTICUT

Project Info

- PROJECT NAME:** Cleveland Avenue Home, Hartford, Connecticut
- CATEGORY:** Affordable
- BUILDER:** Habitat for Humanity North Central Connecticut, Hartford, Conn.
- COMPLETED:** August 2022



Beyond Basic Training

Learning to build a Habitat for Humanity home exceeds mere 'how to' sessions.

Class is in session every day on a Habitat for Humanity job site, so it is no surprise that Habitat for Humanity North Central Connecticut (HFHNCC)'s "Cleveland Avenue Home" won the "Class is in Session" Grand Award in the 2023 U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) Housing Innovation Awards (HIA).

The organization gets about 5,000 volunteers a year—from corporate, faith, and civic groups to high schools and colleges—making them the largest group HFHNCC educates on an annual basis. "Every shift starts with an explanation and demonstration of what, how, and why we do things a certain way," said Director of Construction Kristopher McKelvie. "There are a lot of conversations about the importance of DOE ZERH construction and why it benefits our homeowners. Given the extent and diversity of our volunteers, our reach and impact with this group alone is significant in the community."

HFHNCC takes homeowner education seriously as well. "Many of our Habitat homeowners are first-time home buyers and they have a lot to learn, so we start the process early to educate them about their home," McKelvie explains. "Prospective Habitat homeowners must complete 150 hours of 'sweat equity.' They help build walls, install radon pipes, connect duct work for the ERV unit, and so much more. The hands-on experience helps them understand the function of each component."

Once the home is completed, HFHNCC provides a thorough in-person walk-through. Homeowners are shown where filters are located, how they are cleaned or replaced, how to monitor and maintain each system, and the importance of simple behaviors such

as keeping windows and doors closed to allow the ERV to control the interior air quality. "I developed an educational training video based on the DOE Zero Energy Ready homeowners' manual," McKelvie says. "The video reviews all the information from their in-person walk-through, and critical information about owning a DOE ZERH."

Homeowners have access to this and other online training and can contact Habitat directly with any questions or concerns as they ease into their new home, McKelvie adds.

PROMOTING ZERH BENEFITS

Before families move in, HFHNCC hosts a home dedication event, which creates another opportunity for the affiliate to educate the greater community on sustainable homebuilding methods. "Everyone involved in the construction of the home, neighbors, sponsors, and anyone from the general public can meet the family, tour the home, and learn more about what DOE Zero Energy Ready construction involves," McKelvie says. "These events always garner media attention, which often leads to further inquiries from home builders and curious individuals into how we achieve DOE ZERH standards and what that entails."

Participation in the DOE HIAs has also helped the affiliate increase awareness about sustainable construction and the DOE ZERH Program. The Habitat affiliate won its first DOE Housing Innovation Grand Award in 2020 after building its first certified DOE ZERH.

The success of that build motivated the affiliate to commit to building all of its new homes to the DOE ZERH standard. HFHNCC has certified 10 homes and won three HIAs plus two Grand Awards. "The

media attention we garnered after completing our first ZERH generated great interest locally and nationally," McKelvie says. "We received requests for personalized tours, copies of our house plans, and cost breakdowns from other affiliates, home builders, architects, and schools."

HFHNCC spoke frequently with local news outlets, presented at conferences, and provided case study data to help other builders construct to DOE Zero Energy Ready standards." These interactions provided us with a great opportunity to discuss the benefits of DOE certifications for the builder and homeowner, McKelvie says.

The affiliate now has four different house plans that have been modified to meet DOE ZERH certification. As it expands into different neighborhoods, HFHNCC will continue to improve upon and modify its designs. "We are committed to showing that DOE ZERH construction is valuable and needed," McKelvie notes.

"DOE ZERH significantly reduce utility costs and provide healthier indoor air and comfortable climate control for families," McKelvie explains. "As a builder, there are incentives and rebates to help offset expenses." The affiliate estimates it costs about \$10,000 more to meet the DOE ZERH criteria than just building to code. Current energy incentives in Connecticut cover the additional expenses.

EXCITED ABOUT CONSTRUCTION REQUIREMENTS

Every home certified through the DOE Zero Energy Ready program must meet the criteria of ENERGY STAR Certified Homes Version 3.1 or 3.2 and the U.S. Environmental Protection Agency (EPA)'s Indoor airPLUS program. Builders must also meet other

Annual Energy Costs

\$1,700
(without PV)

Not Supplied
(with PV)

Annual Energy Cost Savings*

\$2,150
(without PV)

Not Supplied
(with PV)

Annual Energy Savings

10,300 kWh
(without PV)

Not Supplied
(with PV)

* vs typical new homes

Key Features

- AIR SEALING:** 1.48 ACH 50, ICF walls, all penetrations taped or foam sealed.
- ATTIC:** Vented, R-60 total: 17-inch blown cellulose, 14-inch raised-heel trusses.
- FOUNDATION:** Insulated basement, R-27.14 total: 11.25-inch R-24 ICF walls, spray-applied waterproofing membrane; 0.75-inch R-3.1 insulated drain board, 0.25-inch parging. Passive radon mitigation system installed with wiring in place for future fan if needed.
- HOT WATER:** 50-gallon heat pump water heater, COP 3.45. Compact plumbing distribution.
- HVAC:** Ductless mini split air-source heat pump; 14 HSPF, 33 SEER, 2 indoor air handlers, 1 outdoor compressor. Variable speed compressor. 14.0 Btu. Transfer fans over bedroom doors pull conditioned air into room when door is closed.
- LIGHTING AND APPLIANCES:** LED lighting; ENERGY STAR appliances, all electric.
- ROOF:** Gable truss roof, IBHS Fortified, 0.5-inch coated OSB sheathing with seams taped, two rows of self-adhered membrane at eaves. Drip edge. Architectural asphalt shingles. Roof trusses engineered for heavy snow load and solar panels.
- SOLAR:** No photovoltaic (PV) installed. Solar ready: conduit to roof, ample electric panel space, and roof orientation to maximize future solar.
- VENTILATION:** ERV, 50 cfm continuous, MERV 8 or 13 filters. SRE 75 percent; ASRE 75 percent; ATRE 40 percent.
- WALLS:** ICF R-25 total: 11.25-inch ICF blocks, vinyl siding with integral 0.5-inch EPS.
- WINDOWS:** Triple-pane, U=0.22, SHGC=0.23, low-e, argon fill, vinyl-framed, double-hung.
- OTHER:** All electric; electric vehicle (EV) charging pedestal.



efficiency requirements such as the hot water distribution requirements of the EPA’s WaterSense program; the insulation requirements of the 2015 International Energy Conservation Code; HVAC and water heating efficiencies; third-party verified air sealing targets; installation of *ENERGY STAR* appliances, windows, and lighting; and ducts in conditioned space. In addition, homes are required to have photovoltaic (PV) panels installed or have the conduit and electrical panel space in place for future installation.

The DOE program offers considerable leeway in what building assembly methods the builder can choose to meet the insulation requirements. HFHNCC typically builds stick-frame construction, but for this project it used ICFs for the exterior walls. The National Concrete Ready Mixed Association and the CT Concrete Promotion Council donated concrete, forms and training. McKelvie was happy with the ICF construction, but

noted it took longer due to coordination with contractors, suppliers and city inspectors.

Construction Project Manager Diana Gasca says the volunteers were excited to try the ICF blocks, which consist of two rigid foam panels 8 feet long, 18 inches tall, and 2.625 inches thick, held apart by plastic spacers to form hollow blocks 11 inches wide. The blocks are stacked like bricks, and steel rebar is laid across the spacers horizontally and vertically. Then, the hollow wall is filled with concrete that hardens in place to form a very sturdy mold-, pest-, fire-, and wind-resistant wall.

“It’s like adult Legos,” Gasca says. “I would give a quick demo in the morning. Then we would jump into it. The volunteers did everything.”

Volunteers put the walls together, cutting them to size where needed, reinforcing the forms, and created an alignment system for pouring the concrete. They sealed the seams with canned foam where needed but they



Full-length airlock. The use of insulated concrete forms (ICFs) provided a solid air seal in the walls from the footings to the underside of the roof.



didn't need to seal most of them because the ICF product forms very tight seams, according to Gasca.

A subcontractor installed a spray-on polymer-modified asphalt liquid-applied membrane and an insulated protective drainage panel over the exterior surface of the below-grade ICF foundation walls. The exposed area between the ground and the vinyl siding was covered with a parge coating that resembles concrete. The vinyl siding was attached directly to ICFs at integrated vertical 1.5-inch fastening strips located every 8 inches across the ICF wall.

The vented attic was air sealed around light boxes and drywall seams before 17 inches (R-60) of cellulose was blown in over the attic floor. Raised-heel trusses allow 14 inches of insulation over the top plates. A strip of sill gasket was stapled into the corner formed by the top plates and ceiling trusses to air seal the corners before installing ceiling and wall drywall.

Volunteers installed the windows under the supervision of Gasca or one of the three experienced volunteer crew leads on site. The windows were installed in 2-by-12 window bucks and set flush with the exterior walls then sealed with flashing tape and a high-performance polyurethane sealant around and over the nailing flange. At the encouragement of its energy rater, the affiliate chose triple-pane windows. The vinyl-framed windows were made in Maine and had an insulation value of U-0.22. "Going from

double pane to triple pane, we got a better HERS Index score, and it made it quieter inside the home," says McKelvie.

The ICFs provided a solid air barrier and contributed to the overall air tightness of the home, which had only 1.48 air changes per hour at 50 Pascals pressure differential of air leakage, he adds.

To provide fresh air to Cleveland Avenue Home, an energy recovery ventilator (ERV) was installed with volunteer labor. The ERV draws in fresh outside air that is warmed by heat transferred from outgoing air. The incoming air passes through a MERV 8 or 13 filter before being distributed throughout the home.

A ductless mini-split heat pump provides very efficient heating and cooling to the home at a heating efficiency of 14.0 HSPF and a cooling efficiency of 33 SEER. The heat pump has one outdoor compressor and two indoor air handlers, one for each floor of the home. In-wall transfer fans located over bedroom doors pull heated and cooled air into the bedrooms at the flip of a switch when doors are closed.

LOOKING TO THE FUTURE

Building energy-efficient and durable homes has always been a priority for the HFHNCC. After considering several certification programs, the affiliate adopted DOE's Zero Energy Ready program as its new standard because DOE did the initial hard work of analyzing and recommending best practices to achieve an airtight and high-performance home, according to McKelvie.

"What we discovered was that making simple changes to our designs, and thoughtful use of materials and equipment, would allow us to achieve the DOE Zero Energy Ready certifications without having to drastically modify our building style, house plans, or budgets," he explained.

Homeowners have been extremely appreciative, McKelvie notes. "It's more comfortable living," he says. "It's less drafty and it's easier to maintain a consistent temperature in the house. Because we've switched to heat pumps, the homes now have air conditioning in the summer. Also, many families with kids have seen greatly reduced allergy and asthma symptoms."

The affiliate is in the process of constructing a cluster of 10 DOE Zero Energy certified homes on a single land parcel in East Hartford. It broke ground in June 2023; plans call for having all homes completed by the end of 2025.

DOLLAR SAVERS. ENERGY STAR-labeled lighting and appliances help cut home utility bills to less than \$150 per month.

MODERN TIMES. All appliances throughout the home are electric, which lowers energy costs, makes it compatible for environmentally friendly upgrades such as electric chargers, and reduces its carbon footprint.

BENEFITS OF BEING NEW. Windows that are triple-pane, low-e and argon filled help lower the home's HERS Index energy efficiency score to nearly one-third that of an older, comparatively sized house.





A winning idea. The “Today’s New Living Experience at Walnut Farm” home was so carefully crafted, it received a HERS Index score of 8—about 10 times better than a built-to-code, comparably sized new home.

PHOTOS COURTESY OF HEALTHY COMMUNITIES

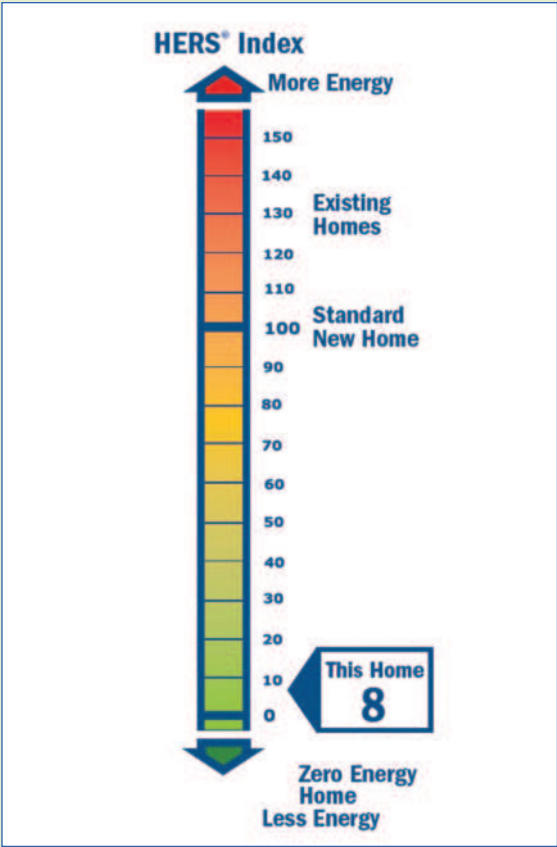
Project Info

PROJECT NAME: Today’s New Living Experience at Walnut Farm, Williamsburg, Virginia

CATEGORY: Production, Affordable

BUILDER: Healthy Communities, Williamsburg, Va.

COMPLETED: September 2022



Breathing Space

'Today's New Living Experience at Walnut Farm' places indoor air quality at the forefront of the 'simplicity of the build.'

For veteran home builder Jay Epstein, a lifetime of construction experience can be distilled into one phrase: The "simplicity of the build." For Epstein, this philosophy means combining standard construction and quality installation with better materials and a few new technologies, added only where they make sense from a cost or performance perspective. It's been a winning combination for Epstein, who recently crowned his 44-year career in the home building industry by earning a grand award in the "Off the Shelf" category in the U.S. Department of Energy (DOE)'s 2023 Housing Innovation Awards (HIA) competition. The award honored his project, "Today's New Living Experience at Walnut Farm."

As Epstein prepares to hand over the reins of his Healthy Communities construction company in Williamsburg, Virginia, to his daughter, Morgan Epstein Wojciechowski, he reflects back on a career that's seen the construction and certification of more than 95 homes to the DOE Zero Energy Ready Home (ZERH) criteria, with 90 more currently in the pipeline.

For Epstein, simplicity of the build means designing energy-efficient homes that contractors can easily put together without requiring a lot of new skills. For example, Epstein uses site-built stick-frame construction or factory-made exterior wall panels. But instead of 2-by-4 16-inch on-center, Epstein specifies 2-by-6 24-inch on-center framing with simple advanced framing adjustments such as turned three-stud corners, insulated headers, and ladder blocking at intersecting walls so the walls

can hold more insulation while using less lumber.

Instead of wrapping the sheathing with house wrap, Epstein specifies 0.625-inch R-3 graphite-enhanced expanded polystyrene (GPS) rigid foam. "It's lightweight; it does not need to be structural due to the 0.5-inch plywood it's attached to," he says. "Nine cap nails can hold a 4-by-8 sheet, and we can nail the fiber cement siding right through to the studs."

With seams taped, the rigid foam serves triple-duty as a weather-resistant barrier, drainage plane, and thermal break to stop heat transfer through the studs. "We are not really doing anything special," Epstein notes. "It's not rocket science. We're back to the basics, just with better tools."

BUYER BENEFITS

Epstein's winning philosophy has also paid off for the homeowners. When Epstein had the award-winning home performance tested and modeled by an energy rater, it achieved a Home Energy Rating System (HERS) Index of 8. A typical new home would score around 80; a net zero energy home—one that produces as much energy as it consumes in a year—would score a 0. The owners of this home told Epstein they have yet to pay anything for power beyond the utility's \$6 monthly demand charge.

According to Epstein, energy independence is perhaps the most notable advantage of zero energy homes—their ability to free homeowners from the uncertainties of rising energy costs. "With renewable energy sources onsite, homeowners can significantly reduce or even eliminate their

reliance on the grid, resulting in considerable energy savings," he says. The owners of Today's New Living Experience at Walnut Farm will have calculated annual energy savings of \$2,650 per year compared to the same home just built to code. They'll also get the added benefits of improved comfort and better indoor air quality.

Every DOE ZERH is also certified to the criteria of ENERGY STAR Certified Homes Version 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 the hot water distribution requirements of the EPA's WaterSense program; the insulation requirements of the 2015 International Energy Conservation Code; HVAC and water heating efficiencies; third-party verified air sealing targets; installation of ENERGY STAR appliances, windows, and lighting; and ducts in conditioned space. In addition, homes are required to have photovoltaic (PV) panels installed or have the conduit and electrical panel space in place for future installation.

CONSTRUCTION ABCS

This home is on a lot at Walnut Farms where the builder has already constructed 58 of a planned 75 DOE Zero Energy Ready certified homes. These semi-custom homes start with wall panels that are constructed in clean, dry conditions in a factory, then shipped to the site, along with open-web floor joists and engineered roof trusses, for quick assembly, allowing the shell to be constructed in just three days and ready for windows, doors, shingles and siding. "This panelized approach enables us to maintain control over

Annual Energy Costs

\$1,200
(without PV)

\$300
(with PV)

Annual Energy Cost Savings*

\$1,750
(without PV)

\$2,650
(with PV)

* vs typical new homes

Annual Energy Savings

9,450 kWh
(without PV)

17,050 kWh
(with PV)

Key Features

AIR SEALING: 1.94 ACH 50; 3.5-inch sill gasket plus expansive caulk at rim. All wall joints are caulked, then sealed with 1-inch closed-cell spray foam to back of cavity wall. Top plates spray foamed.

ATTIC: Vented attic, 14-inch R-49 blown cellulose. Attic hatch gasketed and insulated.

ENERGY MANAGEMENT SYSTEM: Web-enabled HVAC, diagnostics, locks, video surveillance, lights, shades, garage doors, and energy usage monitoring.

FOUNDATION: Unvented crawlspace, R-10 interior rigid foam, R-19.5 open-cell spray foam in rim joist. Raised dirt floor with 8-millimeter poly vapor barrier.

HOT WATER: Heat pump water heater, 50-gallon, 3.35 COP, recirculation pump, compact plumbing.

HVAC: Air source heat pump, multi-stage compressor. 9.6 HSPF 18 SEER, variable speed.

LIGHTING AND APPLIANCES: LED lighting, ENERGY STAR appliances.

ROOF: Gable truss roof, 0.5-inch plywood decking, synthetic underlayment, continuous ridge vent, 30-year architectural shingles. Storage cradle built into trusses 14-inch raised heels.

SOLAR: 6.32-kilowatt photovoltaic panels. Electric hub installed for future electric vehicle charger, subpanel, and battery backup.

VENTILATION: ERV integrated with central HVAC air handler. Uses HVAC supply and returns.

WALLS: Panelized, 2-by-6, 24-inch on center (OC), R-25.5 total: advanced framed. In wall cavity: 1-inch closed-cell spray foam, then 4.5-inch R-19 fiberglass batt compacted to R-16. Plywood sheathing; 1-inch R-5 graphite GPS; fiber-cement siding. 5.5-inch open-cell foam in rim joists.

WINDOWS: Double-pane, U=0.28, SHGC=0.22. Low-e, argon fill, vinyl framed.

OTHER: Building integrated modeling.

MULTIPLE POWER BENEFITS. The home is equipped with ENERGY STAR-labeled appliances, lighting, ceiling fans and windows for energy savings.



pricing and material waste,” Epstein says.

The wall panels are insulated onsite with a flash-and-batt approach that includes spraying 1 inch of closed-cell foam into the wall cavities to seal the sheathing to the framing, then filling the remainder of the wall cavities with blown cellulose or fiberglass batt. The exterior is wrapped with a 0.625-inch R-3 layer of graphite-enhanced expanded polystyrene (GPS) that stops thermal bridging through the walls via the studs and brings the walls’ total insulation value to R-24.

The seams of the rigid foam are taped so it can serve as the weather-resistant barrier and drainage plane for the above-grade walls. The below-grade walls of the conditioned crawlspace are insulated along the interior with an R-10 layer of GPS, and the rim band is filled with 5.5 inches (R-19.5) of open-cell spray foam. The interior level of the crawlspace floor is higher than the exterior grade around the home, so no perimeter foundation drainpipe is needed.

Before filling the attic with R-49 of blown cellulose insulation, all top plates were sealed from the attic with 2 inches of open-cell spray foam. The attic access hatch was insulated and sealed with a gasket. The 24-inch on-center trusses of the gable roof align with the wall studs and included 14-inch raised-heel trusses to allow space over the exterior wall top plates for the full depth of attic insulation.

The truss design was strengthened from 10 pounds to 15 pounds per square foot to accommodate the solar installation. A unique “storage cradle” or platform was designed into the trusses to provide desirable storage space that is elevated from the attic floor enough to allow a full R-49 of insulation underneath.

ENERGY STAR-rated double-pane windows with low-emissivity coatings complete the highly efficient building envelope. The windows have an insulation U-factor of 0.28 and a solar heat gain coefficient of 0.22. Epstein worked with



INDOOR ENVIRONMENTAL AIDES. Low- or no-VOC cabinets, flooring and finishes help provide better indoor air quality.

TEMPERATURE MAINTENANCE TOOL. Walls include closed-cell spray foam and compacted fiberglass batt to help with climate control.

the local window manufacturer who made several design changes to improve air tightness after visiting Healthy Communities' homes during blower door testing to see the impact leaky windows can have on a home's overall air tightness.

ENERGY STAR-rated appliances, a highly efficient heat pump water heater, and a push-button controlled recirculation pump on the hot water distribution system contribute to hot water and energy savings. The recirculation pump alone is estimated to save 9,125 gallons a year in water at an estimated homeowner savings of \$130 per year.

With all of the air sealing measures implemented, Epstein's homes are able to achieve an air tightness of 1.94 air changes per hour at 50 Pascals pressure differential (ACH50), within the 2.5 ACH 50 needed to meet the program specifications for his climate zone.

KEEPING MINDS ON THE WORK

"Employing a common-sense approach and taking the time to do it correctly makes the 'simplicity of the build' easier," Epstein says. "Collaborating with your insulation installer to complete the wall system seal is critical. It is also crucial to work closely with your third-party rater, as they are there to assist you in building a superior home rather than just to find problems."

Indoor air quality is a critical element for Epstein, who first became interested in home building when he was looking for a healthier home for his daughter, who had asthma. To ensure good air quality in well-sealed homes, Epstein installs an energy recovery ventilator that brings in fresh filtered air and tempers it with outgoing conditioned air via a heat exchanger that transfers heat and humidity to reduce the amount of humidity brought into the home. The incoming air passes through a MERV 8 or MERV 13 filter and is distributed throughout the home via the central air handler's supply ducts. A central return draws stale air from the home.

This home's heat pump system was also equipped with an air cleaner that can remove 99.98 percent of allergens from the air.

The ERV and HVAC can be remotely operated via an app. For spot ventilation, the bathrooms are equipped with **ENERGY STAR** quiet exhaust fans that have humidity sensors to increase fan speed during and after showers.

A central heat pump provides space heating with an efficiency of 9.6 HSPF and cooling with an efficiency of 18 SEER. The unit has a variable-speed air handler and multistage compressor that uses a network of sensors to monitor and optimize humidity and temperature in the home, adjusting compressor and fan speeds in real time to provide consistent temperature with maximum efficiency.

The multistage system can adjust output to operate from 0.75 tons to 2 tons as needed. The system automatically adjusts the indoor unit's fan speed at startup to draw more moisture from the air for better humidity control. All of the ducts are mastic sealed, insulated to R-8, and located in the insulated conditioned crawl space.

According to Epstein, one key to efficient HVAC performance is proper equipment sizing. Many HVAC contractors "still use old rules of thumb and end up oversizing equipment." Epstein has his energy rater perform heating and cooling load calculations to determine equipment sizing in accordance with the industry standard, Manual J.

Healthy Communities also uses a compact duct layout following Manual D, both from the Air Conditioning Contractors of America (ACCA).

Efficiency pays off. Homeowners could save an estimated \$2,650 in annual utility bills thanks to a highly effective building envelope, and 6.32 kilowatts of solar panels.

Certified Cove. K. Hovnanian Northeast Division constructed a 48-unit building in Asbury Park, New Jersey, to the high-performance criteria of the DOE Zero Energy Ready Home (ZERH) program—complete with energy saving, air quality improving and environmental control elements.



PHOTOS COURTESY OF K. HOVNANIAN NORTHEAST DIVISION, INC.

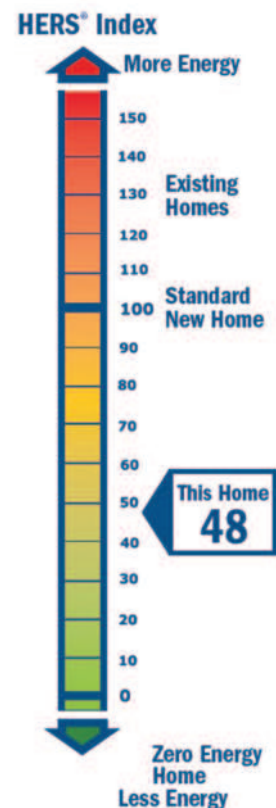
Project Info

PROJECT NAME: The Cove at Asbury Park, Asbury Park, New Jersey

CATEGORY: Multifamily

BUILDER: K. Hovnanian's Northeast Division, Edison, N.J.

COMPLETED: July 2022



Multiple Choice Density

'The Cove at Asbury Park' is K. Hovnanian's latest grand venture into sustainable building.

A winner keeps winning: The latest project by K. Hovnanian's Northeast Division, the "Cove at Asbury Park" in Asbury, New Jersey, won a Housing Innovation Award (HIA) in the U.S. Department of Energy (DOE)'s 2023 annual competition. Asbury Park also gave the company more than 650 homes that are certified to DOE's Zero Energy Ready Home (ZERH) program standards, placing it sixth on the agency's list of most Zero Energy Ready certified homes—which resulted in an HIA for most homes certified in one year.

The Cove at Asbury Park is a multifamily community of 48 four-story townhomes consisting of two models that range in size from 1,765 square feet to 2,916 square feet with 3 or 4 bedrooms, 3.5 or 4 baths, rooftop decks, and one-car garages with electric vehicle (EV) chargers.

The Cove exterior's mix of multi-grey-toned cantilevered boxes and shingle siding gives the four-story building a modern-meets-coastal vibe. But it's what's "behind the walls" that helped the project win a DOE HIA. The building, like every home certified through the DOE Zero Energy Ready program, met the criteria of *ENERGY STAR* Certified Homes Version 3.1 and the U.S. Environmental Protection Agency (EPA)'s Indoor airPLUS program.

Builders must also meet other efficiency requirements such as the hot water distribution requirements of the EPA's WaterSense program; the insulation requirements of the 2015 International Energy Conservation Code; HVAC and water heating efficiencies; third-party verified air sealing targets; installation of *ENERGY STAR*

appliances, windows, and lighting; and ducts in conditioned space. These requirements should help homeowners achieve average annual energy savings of \$1,900 per home compared to similar town homes built to just meet code.

A NEW TYPE OF MODEL HOME

K. Hovnanian uses building integrated modeling to design its projects. The 3D modeled designs are provided to the builder's mechanical, electrical and plumbing (MEP) designers to help in laying out MEP system for the homes.

For this construction, the builder chose a slab-on-grade foundation that is insulated with two inches (R-10) of rigid foam on the slab edge perimeter extending down 24 inches, and 1 inch (R-5) of rigid foam extending 24 inches horizontally under the slab edge. The walls use 2-by-6 wood-stud framing spaced with 24-inch on-center stud spacing for most walls, and 16-inch on-center spacing in some wall sections. The walls are filled with R-19 of fiberglass batt insulation. Advanced framing techniques were used, such as 3-stud insulated corners and open, insulated headers to reduce the amount of framing and increase the amount of space for insulation in the walls.

The truss roof includes gabled and flat sections. The unvented attic was filled with up to 18 inches (R-38 to R-63) of blown in cellulose. Raised-heel trusses allowed 10.125 inches of insulation over the top plates. The 0.5-inch OSB deck sheathing was covered by 15# roof felt and 30-year dimensional asphalt shingles on the sloped roofs and PVC membrane over the flat roofs.

This project featured large rooftop decks above the living space for each unit. This presented a challenge to provide the proper amount of insulation while eliminating the need to vent the attic space due to structural constraints. Joe Lstiburek of Building Science Corporation helped design an unvented hybrid roof assembly that met the insulation requirements of the energy code while controlling the amount of moisture that can condense beneath the deck.

The flat roofs consisted of a coated OSB sheathing with seams taped, R-20 of rigid XPS, 0.75-inch plywood, then PVC membrane and the flooring of the rooftop decks.

Careful detailing and installation of the self-adhered PVC membrane air barrier and strict adherence to the ratio of rigid insulation to the total R-value of the assembly created an attic/roof design that minimized the risk of accumulation of condensation, eliminating the need to vent the attics.

Efficient *ENERGY STAR*-labeled double-pane windows with insulation values of U-0.24 and solar heat gain coefficients of 0.29 help block out summer sun while keeping in winter heat. The windows included some airtight casement-style ones, but most were fixed-glass with tempered glass outer panes to protect against coastal storms.

SEALS AND BARRIERS

K. Hovnanian conducts extensive air sealing practices to create a continuous air barrier or "pressure boundary" around the building and each unit in it, consisting of taping or sealing all the wood-to-wood seams and

ZERH HOUSING INNOVATORS ROUNDUP 2024
UNLIMITED OPTIONS

Annual Energy Costs

\$1,300
(without PV)

Not Supplied
(with PV)

Annual Energy Cost Savings*

\$1,900
(without PV)

Not Supplied
(with PV)

Annual Energy Savings

16,100 kWh
(without PV)

Not Supplied
(with PV)

* vs typical new homes

Key Features

WALLS: 2-by-6, 24-inch on-center (OC), R-19 total: advanced framed, R-19 fiberglass batt. 0.5-inch OSB sheathing, synthetic house wrap; fiber cement siding.

ROOF: Gable truss roof and flat roof, 0.5-inch OSB sheathing, 15# roof felt, 30-year dimensional asphalt shingles, PVC membrane on flat roofs.

ATTIC: Unvented (hot roof); 18-inch R-38 blown cellulose in gable attic; polyisocyanurate insulation board under PVC membrane on flat roof.

FOUNDATION: Slab on grade; R-5 rigid foam extends 24 inches horizontally at the perimeter; R-10 extends down 24 inches vertically at the slab edge perimeter.

WINDOWS: Double-pane, U=0.24, SHGC=0.29.

AIR SEALING: 4.40 ACH 50. Extensive air sealing with foam and caulk of all ceiling and wall penetrations. Fire-rated sealant on any penetrations through wall plates or between floors.

VENTILATION: Controlled central fan with fresh air intake and timered exhaust.

HVAC: Single-stage furnace. 96 AFUE, with zone dampers for floors 1-3. Minisplit on 4th floor.

HOT WATER: Gas tankless, 0.93 EF, Water heater centrally located. Compact plumbing design.

LIGHTING AND APPLIANCES: LED lighting, ENERGY STAR appliances.

SOLAR: None.

ENERGY MANAGEMENT SYSTEM: Ventilation controls.

OTHER: Contemporary townhome-style condominiums with rooftop decks a short walk from the beach and downtown that meet DOE Zero Energy Ready Home certification and 2021 IECC energy codes.



penetrations through floors, walls, and ceilings to prevent air movement in or out of the home. Specific strategies include applying caulk or foam at foundation sill plates; wall sill plates; band and rim joists; exterior wall and band or rim joist corners; around doors, windows, wiring, pipes, and vents; at any dropped ceilings; and any ceiling penetrations to the attic. Fire-rated sealants are installed on any electrical, plumbing, or HVAC penetrations through wall plates or vertical chases; at fireplace chases, and at cantilevered floors.

Additional air sealing steps include air sealing at wall-floor joints; the garage-house walls; exposed joist areas; electrical box cutouts in walls and ceilings; and around fireplaces, plumbing pipes, A/C lines, dryer exhaust vents, junction boxes, gas lines, outside plumbing lines, and fire sprinkler heads. K. Hovnanian employs a subcontractor whose main job is to perform this air sealing.

As with all homes certified to the DOE ZERH criteria, K. Hovnanian's homes are blower door tested for whole-house air tightness by a third-party energy rater. If the home or building does not meet the

specified air tightness requirement, the contractor must correct the problem and pay for the cost of retesting.

To provide fresh air, each townhome is equipped with a controlled central fan with fresh air intake and timered exhaust for balanced whole-home ventilation. The outdoor air duct brings fresh air to the return side of the central high-efficiency 96 AFUE gas furnace which uses a compact zoned duct system to provide heating to the first three floors. The fourth floor of each unit is equipped with a ductless mini-split heat pump which provides high efficiency heating and cooling.

MORE RULES TO FOLLOW

In addition to this code-compliant ventilation, the building is designed to meet all requirements of the U.S. Environmental Protection Agency's Indoor airPLUS program.

The builder installs Energy Star-rated appliances, lighting, and ceiling fans for energy savings. A centrally located efficient tankless water heater, compact plumbing layout, and EPA WaterSense-rated plumbing fixtures add to hot water and energy





Power station. The Cove at Asbury Park features ENERGY STAR-rated appliances, lighting and ceiling fans for energy savings.

savings.

To be able to offer home buyers a cost-effective product while maintaining quality, K. Hovnanian has standardized many construction details. “This minimizes wasted materials and allows our trade partners to execute consistency in their respective contributions,” says Sean Neumann, vice president of operations for K. Hovnanian’s Northeast Division. “Maintaining a close relationship with our energy rater ensures that our homes are computer modeled according to the DOE Zero Energy Ready program requirements during the design phase and are tested prior to occupancy to ensure that each home matches or exceeds the performance expectations of the DOE program.”

By identifying the features and styles that most people want in their new home and offering just those options, K. Hovnanian simplified the development of new home plans from the design process to the sale of the home. “Reducing the multitude of options we’ve historically offered has greatly increased the simplicity and replicability of our production process,” Neumann says. “Buyers see the features they want and are not bombarded with a myriad of

choices. Our trade partners can offer higher quality construction since the homes feature details that can be consistently executed and delivered.”

Training and technical expertise have also been hallmarks of K. Hovnanian’s efforts to ensure consistent quality in their single- and multifamily homes. K. Hovnanian has partnered with DOE Building America researchers, including Joe Lstiburek of Building Science Corporation and IBACOS, as well as the New Jersey Builders Association, for training and technical guidance.

“We have comprehensive construction documents and a thorough shop drawing review process of various components of the home,” Neumann says. “Our plans incorporate many IBACOS-developed or reviewed details. We also have a complete constructability review by a third-party engineer. That same third-party engineer is then contracted to perform six inspections throughout the build process, documenting nonconforming items. Non-conforming items must be appropriately closed out with photo-documentation following the repair.”

Additionally, K. Hovnanian uses internal quality associates who conduct their own inspections throughout the build process, including a framing inspection, drainage plane inspection, scratch coat inspection, and quality standards inspection prior to homeowner orientation.

The builder conducts monthly targeted training sessions for their internal associates, on topics such as HVAC or moisture management. They also conduct an in-house 18-month extensive classroom and field-based training program for their newer Associates, and they conduct various safety and technical training sessions for their subcontractors. “Our safety meetings are held once a week,” says Neumann. “Our technical trainings are less frequent but are typically geared towards a specific trade and target construction practices such as buried ducts and truss bracing.”



WEATHER READY. Some of the windows are fixed glass with tempered glass outer panes to protect against coastal storms.

WATER GUARD. An insulated, unvented roof deck controls moisture and potential condensation beneath the deck.

COMPLETED CLOSURES. Air sealing steps are taken throughout the house, including in locations such as garage-house walls and outside plumbing lines.

First Look

For these Housing Innovation Award winners, thinking beyond everyday building is the only way to get it done.

For 12 years, the U.S. Department of Energy's annual Zero Energy Ready Home (ZERH) Housing Innovation Awards (HIAs) have honored the very best projects that are headed to net zero. The awards also recognize forward-thinking builders who are delivering a better experience to American homebuyers. Winners of this year's competition were selected for each of five main award categories, and a Grand Winner was announced from each category during the [High Performance Home Builder Summit](#) in October (results were not available at press time).

As a sneak peek, here are seven standout projects selected as winners and eligible as Grand Winners at the summit, and a bit on what makes them so special.

ZERH HOUSING INNOVATORS ROUNDUP 2024
UNLIMITED OPTIONS



CREDIT: ADDISON HOMES

BUILDER: Addison Homes of Greenville, S.C.

Addison Homes of Greenville, South Carolina, is leading the charge for healthy, more-durable and more-efficient homes in the state. The company is spreading the word through social media platforms and YouTube videos encouraging other local builders to try high-performance measures like continuous exterior insulation, spray foam-insulated attics, ventilating dehumidifiers, and high-efficiency heat pumps with small-duct high-velocity air distribution.



CREDIT: BEAZER HOMES

BUILDER: Beazer Homes

In September 2022 Beazer Homes completed its first home certified to the requirements of DOE's ZERH program. By August 2024, the production home builder had certified more than 1,912 homes, putting Beazer first in the U.S. in number of homes Zero Energy Ready certified. This house in Ellicott City, Maryland, achieved a Home Energy Rating System (HERS) Index of 4 thanks to energy-efficient construction and solar roof tiles, and should save its homeowners nearly \$5,500 in annual energy bills compared to a similar house built to code.



CREDIT: CLIFTON VIEW HOMES

BUILDER: Clifton View Homes of Coupeville, Wash.

Clifton View Homes of Coupeville, Wash., built these three small (650 square foot) homes on a single 7,200-square-foot lot in Langley, not far from Seattle, to show how energy-efficient, low-carbon construction could also be affordable and attainable for middle-income home buyers. The homes use environmentally friendly materials such as cedar siding, lower-carbon insulation, and tile instead of concrete walkways. Operational carbon and energy consumption is reduced with highly efficient heat pumps and heat pump water heaters.



CREDIT: DANIEL COLOMBINI

BUILDER: Daniel Colombini

Builder Daniel Colombini was able to build this DOE Zero Energy Ready, LEED, and Passive House certified 3,000-square-foot home in Ossining, N.Y., for a mere 8 percent over the cost of the same size home built to code—thanks to attention to detail and reuse of materials from an existing home on the lot. A highly insulated envelope with Larsen truss walls, a high-efficiency heat pump, 12-kilowatt (kW) photovoltaic panels, and two 16-kW batteries will help the homeowners cut energy bills by \$9,000 annually while also helping them ride out frequent weather-related power outages.



CREDIT: POWERHOUSE DESIGNS

BUILDER: Powerhouse Designs

Powerhouse Designs focused on carbon reduction while designing this 2,391-square-foot house near Bellingham, Wash., one that looks like a single-family home but actually encompasses three living spaces. A highly insulated SIP envelope and highly efficient air-to-water heat pump greatly reduced operational carbon in the all-electric home, while photovoltaic panels and batteries more than cover energy needs for the home and cars.



CREDIT: HOWARD BUILDING SCIENCE

BUILDER: Howard Building Science

Howard Building Science can build an exceptionally efficient building envelope in just three days using structural insulated panels with an outer surface of coated OSB. This takes the place of house wrap for even greater time and labor savings. An insulated crawlspace, ductless mini splits, and ENERGY STAR appliances add to energy savings in these cottage homes aimed at low- to middle-income buyers in Granite Falls, N.C.



CREDIT: THRIVE

BUILDER: Thrive

Thrive's E-PWR Volt Townhome is a DOE Zero Energy Ready, EPA Indoor airPLUS, ENERGY STAR Next Gen, and LEED Platinum marvel of high performance and energy efficiency disguised as a contemporary first-time homebuyer townhome in the Loretto Heights neighborhood of Denver. The all-electric dwelling is constructed entirely with off-the-shelf technologies and familiar construction methods coupled with high-efficiency HVAC selections, attention to detail, and 7 kilowatts of photovoltaic panels to give its home buyers net zero energy bills, exceptional indoor air quality, and year-round comfort.

TODAY'S HOMEOWNER

CREDIT: ISTOCK/VIROJT CHANGYENCHAM

MEETING CONSUMER DEMAND WITH GREEN CERTIFICATIONS

Younger generation homebuyers are demanding sustainable homes more than ever, even if it means more upfront expenses.

BY SARA GUTTERMAN

When it comes to housing, today's homebuyers are looking for a blend of attainability and sustainability. Affordability is certainly top of mind, but they also want the most sustainable home possible that lowers their total cost of homeownership. They're willing to forgo fancy bells and whistles and even extra space in favor of upgrades that will lower monthly utility bills, keep them healthy, and enhance the resiliency of their homes.

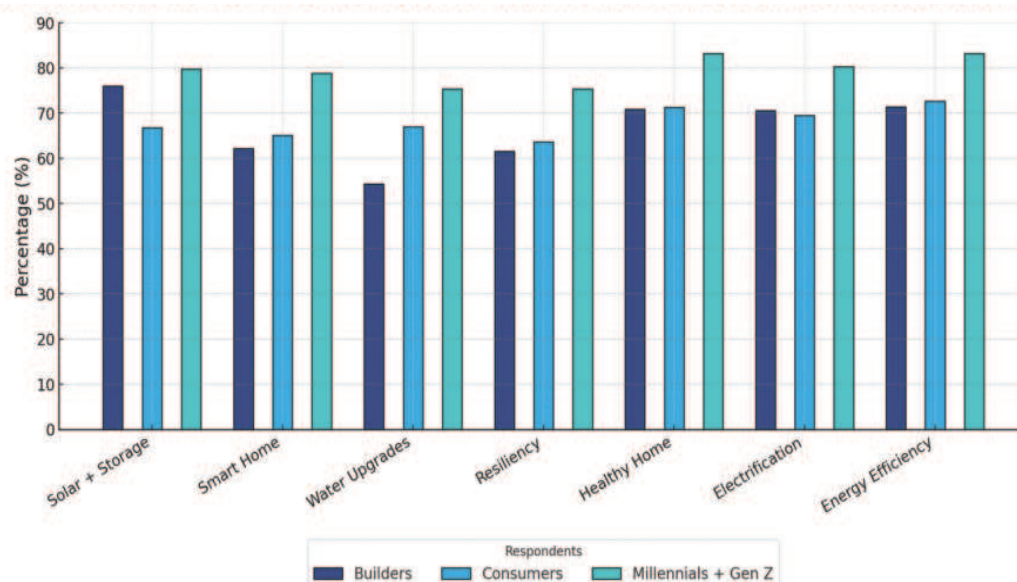
Green Builder Media's COGNITION Smart Data shows more than 50 percent of consumers now look at total value of homeownership rather than lowest upfront cost when purchasing a home. Younger

generations are more willing than older generations to invest in sustainability upgrades to enhance energy efficiency, electrification, healthy home, water conservation, and resiliency if those upgrades will reduce ongoing costs over time.

Roughly 75 to 85 percent of millennial and Generation Z consumers surveyed for COGNITION indicated that they would pay more upfront for sustainability upgrades if they lower the ongoing cost of homeownership over time. This poses a question for building professionals: How do they meet this shift in consumer demand for enhanced sustainability?

One answer: Green certifications.

ARE YOU/YOUR HOMEBUYERS WILLING TO PAY MORE UPFRONT FOR SUSTAINABILITY UPGRADES IF THEY WILL LOWER YOUR ONGOING COST OF HOMEOWNERSHIP OVER TIME?



SOURCE: COGNITION SMART DATA



Value first. More than half of consumers now place priority on total value of homeownership rather than lowest upfront cost when purchasing a home.

CREDIT: ISTOCK/GECE33

ENERGY STAR AND ZERO ENERGY READY HOMES

The Federal government has two primary home certification programs for energy efficiency: ENERGY STAR and Zero Energy Ready Home (ZERH). Both programs are designed to promote the construction of high-performance, healthy homes, but they have different goals and requirements.

ENERGY STAR, which is administered by the Environmental Protection Agency (EPA), focuses primarily on reducing energy consumption through efficient design and technology. The program utilizes building science best practices to reach specific performance targets.

ZERH includes all of the **ENERGY STAR** requirements, but it goes

further to prepare homes to be able to produce as much energy as they consume (i.e., net-zero energy) through the integration of renewable energy systems. It also requires Indoor airPLUS certification, and some water conservation and efficiency elements.

ENERGY STAR FOR HOMES PROGRAM

The goal of the **ENERGY STAR** for Homes program is to enhance energy efficiency, reduce energy consumption, increase occupant comfort, and decrease operating costs.

ENERGY STAR certified homes meet stringent energy efficiency standards through use of high-performance building envelope systems, windows, doors, roofs, insulation, HVAC systems, water



Better than basic. *ENERGY STAR* certified homes meet stringent energy efficiency standards through use of high-performance windows, doors, roofs, insulation, HVAC systems and more. CREDIT: ISTOCK/NES

heaters, lighting and appliances. Homes that meet *ENERGY STAR* 3.2 standards are at least 10 percent more efficient than homes built to the 2021 IECC, resulting in lower energy bills for homeowners.

These homes are also designed for healthy indoor air quality, with rigorous requirements for ventilation, air exchange, moisture control and toxin control.

ENERGY STAR certified homes are eligible for a variety of rebates and incentives at the federal, state, and local levels, as well as from utility companies, which can offset the cost of upgrades. Builders that construct *ENERGY STAR* 3.2 certified homes can qualify for \$2,500 per home in tax credits under Section 45L of the Inflation Reduction Act.

THE ZERH PROGRAM

ZERH certification indicates that a home is so energy efficient that a renewable energy system could offset most or all the house's annual energy use. ZERH homes must meet advanced levels of energy efficiency and be designed to accommodate renewable energy systems like solar photovoltaics and smart electrical panels.

ENERGY STAR and Indoor airPLUS certifications are prerequisites for the ZERH certification, but ZERH homes have additional requirements, such as advanced moisture control, enhanced indoor air quality, non-toxic materials, and renewable energy readiness. Homes built to ZERH v2 are

at least 20 percent more efficient than homes built to the 2021 IECC. ZERH homes are designed with climate responsiveness in mind, with construction practices that augment the durability of the home, reduce maintenance needs and enable homes to withstand extreme temperatures and climate events.

Homes that achieve ZERH certification often have a higher market value because of their energy efficiency, healthy indoor air quality and ability to integrate future technologies and renewable energy systems.

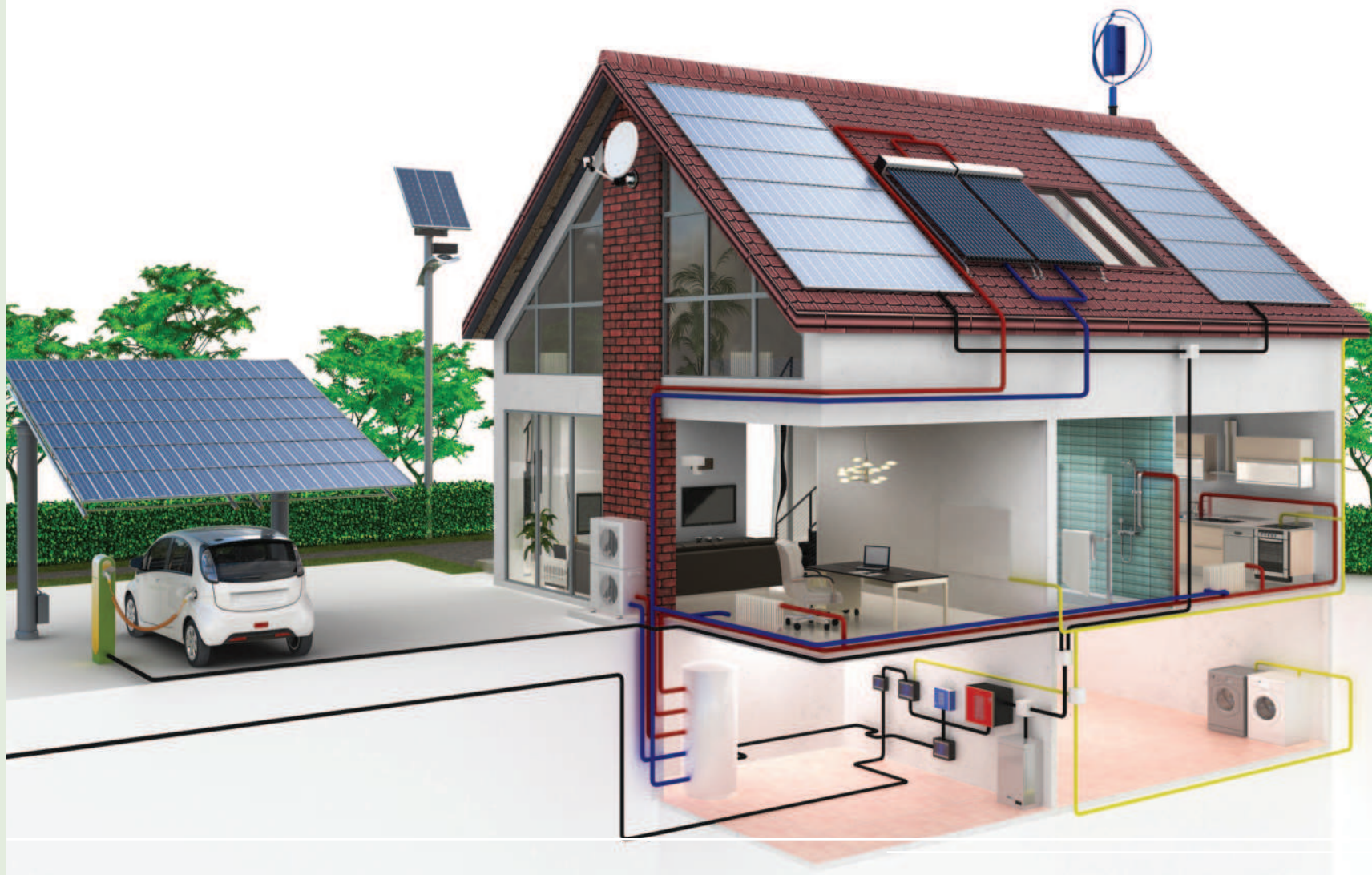
As with *ENERGY STAR* homes, ZERH certified homes are eligible for a variety of rebates and incentives. Builders that construct ZERH certified homes can qualify for up to \$5,000 per home in tax credits under Section 45L of the Inflation Reduction Act.

PROGRAM REQUIREMENTS

There are a variety of administrative and implementation requirements for both the *ENERGY STAR* for Homes and ZERH programs.

For example, a few of the *ENERGY STAR* Residential New Construction requirements include:

- Mechanical equipment must be sized correctly to meet loads and has mechanical or direct venting, or sealed combustion (no atmospheric venting appliances)
- Insulation and windows must meet or exceed 2021 IECC UA requirements



Clean energy educator. Zero Energy Ready Home (ZERH) program requirements prepare homes to be able to produce as much energy as they consume through the integration of renewable energy systems. CREDIT: ISTOCK/MARC OSBORNE

- Advanced framing techniques must be used to reduce thermal bridging
- A whole-house ventilation system that meets test requirements is installed to become ZERH certified, a home must be certified under *ENERGY STAR* Residential New Construction v3.2 and Indoor airPLUS. Some of the additional requirements include:
- Windows must have a maximum U Value of 0.30 and meet specific SHGC requirements
- 100 percent of HVAC equipment must be in conditioned space and ductwork must be installed within the thermal barrier
- House has installed solar PV system or meets the requirements of the [PV Ready Checklist](#) requiring infrastructure to allow simple installation of PV system in future

KEY DIFFERENCES

"For both *ENERGY STAR* and ZERH, a home is not eligible for the tax credit until it is actually acquired," explains EPA *ENERGY STAR* Residential Branch Supervisor Jonathan Passe. "The difference comes in defining which version of the program requirements the home must be certified to in order to earn the credit."

For the purposes of 45L, for *ENERGY STAR*, the minimum eligible program version is determined based on the dwelling's acquisition date.

But for ZERH, it is the permit date that governs the eligible version.

For example, if a builder constructs a home in 2024 that meets our v3.1 requirements and the home is also acquired in 2024, it can earn the tax credit in 2024 (because v3.1 is what is required in the legislation in 2024), Passe notes. However, if the same home is acquired in 2025, then it would not earn the tax credit at the v3.1 level (because the legislation specifically calls out that v3.2 is required for homes acquired in 2025). "For this reason, we've encouraged our partners to be mindful of their build-out schedules, especially as they get toward the end of a year where there will be a known transition in the 45L requirements (as is the case from 2024 to 2025)," he says.

In the case of ZERH, however, the required minimum version is established when the home is permitted, and the version required at the time of acquisition does not matter. So, a home can earn the tax credit using ZERH v1 even if, by the time it is acquired, ZERH v2 would otherwise be required.

"It is also important to note that, in some cases, a home may be certified as *ENERGY STAR* using a version of the program requirements that is not eligible for the 45L credit," Passe says. "For example, even though in 2025 earning the 45L tax credit will require that a home be certified to v3.2, in most states, EPA will continue to allow homes to be certified as *ENERGY STAR* using v3.1. Also of note, for *ENERGY STAR*

certification (outside of 45L), the required version is defined based on the permit date.”

Other differences include specific requirements in the ZERH program that aren’t in *ENERGY STAR*, such as:

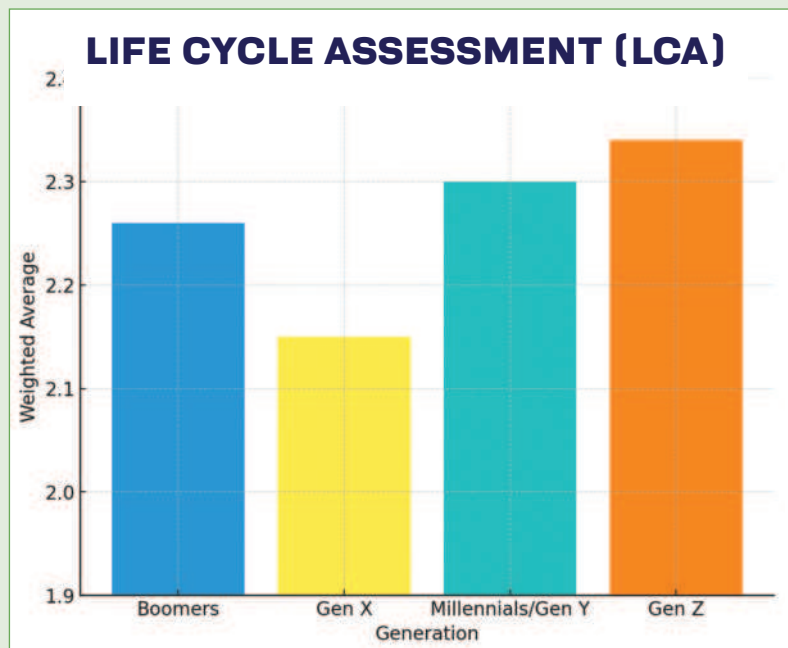
- Higher performance targets and lower HERS scores (low to mid 40s)
- Enclosed attics for conditioned spaces (applicable mostly for slab on grade construction)
- More stringent water conservation and efficiency requirements for water heaters and plumbing distribution systems (which can include WaterSense certification)
- Readiness provisions and a new set of design requirements to ensure that homes are PV ready, EV ready (with 240-watt circuits), and electric infrastructure for space and water heating

THE EPD IMPERATIVE

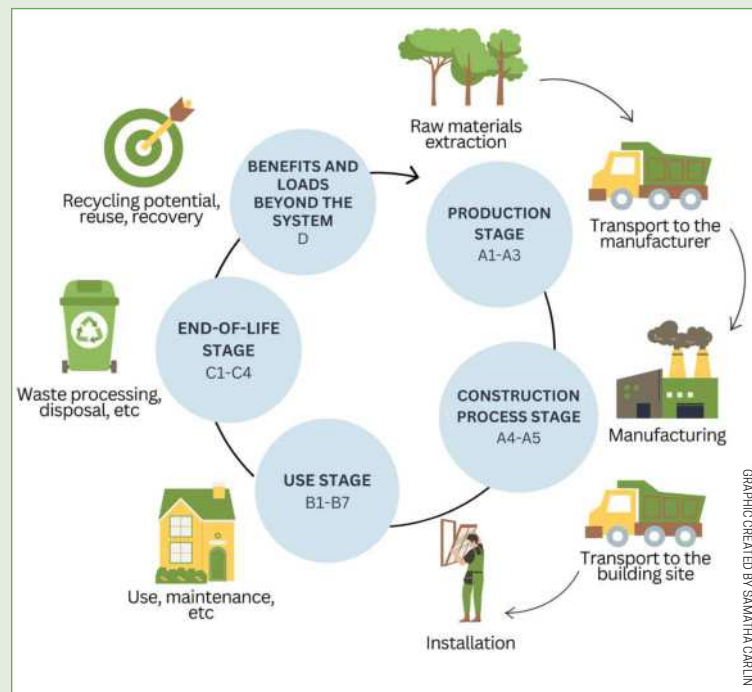
Beyond home certifications, demand for low carbon products, verified by Environmental Product Declarations (EPDs), is soaring.

An EPD is a standardized document that communicates the environmental performance and human health impacts of a product over its lifetime. EPDs are based on a product’s life-cycle assessment (LCA) which measures potential environmental impact from natural resource acquisition, through the production and use stage, and ultimately to end of life disposal or recycling.

EPDs are derived from product category rules, or PCRs, which outline how data is collected for specific types of products. As a result of having PCRs, EPDs enable a standard of comparison between different products in the same category, taking into account the most significant environmental aspects of a product, and showing objective and verifiable information about the environmental impact.



Trend watching. A Life Cycle Assessment (LCA) calculates the environmental impact of products or services throughout their entire lifecycle. Gen Z and millennials understand the importance of having them done. SOURCE: COGNITION Smart Data



Pathfinder. An EPD is a standardized document that communicates the environmental performance and human health impacts of a product over its lifetime. SOURCE: TARKETT

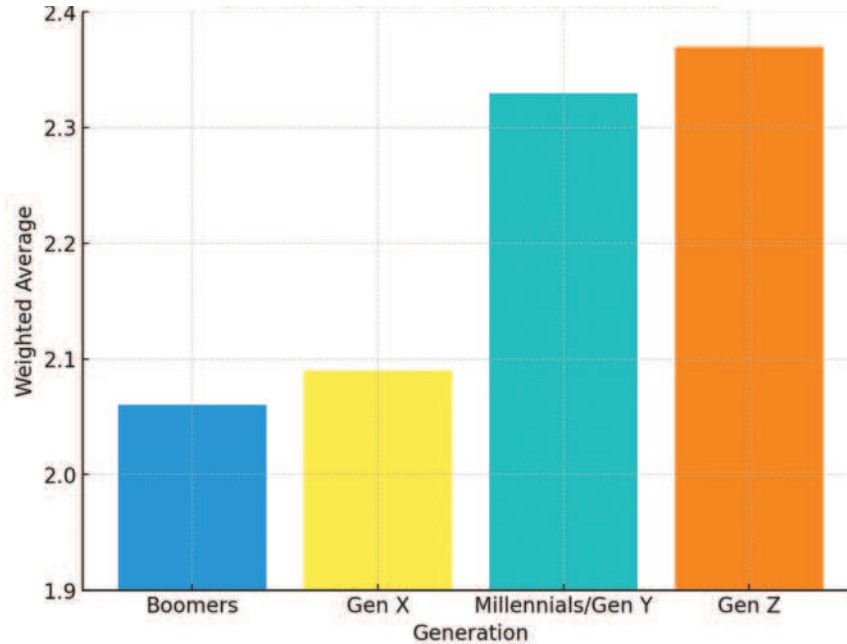
CLARION CALL

In a very short timeframe, EPDs have transformed from obscure to vital. According to a recent COGNITION survey:

- Nearly 70 percent of builders say that they’re familiar with EPDs.
- More than 40 percent of builders state that EPDs are a “must-have” when specifying products, and another 50 percent said that EPDs are influential but not a deal breaker.
- Approximately 85 percent of builders currently specify products with EPDs
- Of those builders who aren’t currently specifying products with EPDs, 50 percent say that they’ll start doing so within the next year, and 45 percent say they’ll start doing so in the next few years. Less than 5 percent say that they won’t specify products with EPDs.
- When asked why they specify products with EPDs, the top three responses were understanding product roadmaps, regulatory requirements, and consumer demand.
- Nearly 50 percent of builders report that they rely on both industry-average and product-specific EPDs equally, whereas nearly 40 percent prefer product-specific EPDs.
- Thirty-five percent of builders look for products with EPDs at the product specification stage, 30 percent during the design phase, and 20 percent at the product comparison stage.
- More than 60 percent of builders assert that they’re seeing an increased demand for products with EPDs by consumers. Another 20 percent respond that while consumers might not be asking specifically for EPDs, they’re looking for product certifications and information to verify sustainability attributes.

This new COGNITION data is important for building professionals and manufacturers alike. For builders, offering homes that have low carbon products backed up by EPDs is an excellent way to differentiate an offering, enhance its brand reputation, justify pricing, and add value to buyers.

ENVIRONMENTAL PRODUCT DECLARATIONS



With age comes wisdom. As homebuyers age by generation, Environmental Product Declarations (EPDs) are an increasingly important factor toward home purchases. SOURCE: COGNITION Smart Data

For manufacturers, EPDs are becoming a baseline necessity for builders and other product specifiers, [as well as for states like California and municipalities like Boston](#) that are beginning to require that homes and buildings [reduce embodied and operational carbon emissions](#).

Interested in learning more? Green Builder Media's COGNITION Academy has robust courses on green building programs like Energy Star, ZERH, Indoor airPLUS, WaterSense, and HERS ratings, as well as EPDs and other green product fundamentals. Visit the [COGNITION Academy](#) microsite for more information. **GB**

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WHIRLPOOL CORPORATION is committed to being the best global kitchen and laundry company, in constant pursuit of improving life at home. In an increasingly digital world, the company is driving purposeful innovation to meet the evolving needs of consumers through its iconic brand portfolio, including *Whirlpool, KitchenAid, Maytag, Consul, Brastemp, Amana, Bauknecht, JennAir, Indesit, Yummly* and *InSinkErator*.

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DIGGING INTO DEMOGRAPHICS: MARKET RESEARCH INFORMS VISION HOUSE LAS VEGAS

Big builders rely on deep research to find out if there's an appetite for the product they want to build.

BY MICHELE LERNER

From the consumer perspective, model homes offer a glimpse of an ideal life to which they can aspire. Prospective buyers admire the color scheme, the flooring, the layout and the accessories placed by interior designers. What they may not realize is that these features have been designed to inspire a specific buyer who values the energy efficient features behind the walls.

Long before Beazer Homes and Green Builder Media began to plan the VISION House Las Vegas: Crossing the Rubicon project, researchers at Beazer Homes pulled together information on the local market to determine where and what to build.

"There are two main components that go into market research for a new product or a new location," says Jesse Zaro-Moore, Atlanta-based director of market and consumer research for Beazer Homes. "Before you begin land acquisition and community planning, you need to look at the surrounding area and the performance of products in that area. Then you can begin to build profiles reflecting the purchasing considerations of people who live within a three-mile radius of the site."

The VISION House Las Vegas, which includes two model homes and a deconstructed model to demonstrate what's behind the walls in Beazer's READY homes, will be built at the 2,200-acre master planned community of Cadence in Henderson, just outside of Las Vegas. The amenity-rich community has more than 5,000 homes today and will have approximately 12,250 homes from 10 builders when the development is complete. The VISION House Las Vegas homes and all future Beazer homes will meet the Department of Energy's Zero Energy Ready Home (ZERH) requirements.

START WITH A LOCAL POINT OF VIEW

Before choosing Cadence as the location to showcase Beazer's high-performance home, researchers reviewed the types of households in the area, the sales record of homes at different price points in the area and the types of products being sold.

"The rule of thumb has always been to look locally at buyer trends, but since the pandemic that's shifted," Zaro-Moore says. "We're still adjusting to the new reality that more people work remotely and are willing to move. We're seeing lots more California license plates in Las Vegas, Phoenix and even Texas, which may carry different buyer attitudes."

About 20 percent of buyers in the Cadence community are from out of state, says Jayne Bradley, Southern California-based director of marketing for Beazer Homes.

Still, the baseline of most buyers coming from within a relatively tight circumference of a location holds true in most communities, Zaro-Moore says. That's because regardless of the flexibility of their jobs, people want to live near their kids, their friends, and the institutions they're familiar with.

"Birds of a feather flock together, so we know that new households will behave similarly to households already in the area," Zaro-Moore says. "We look for household compositions, and for trends or population shifts, to inform what we build."

Then, Beazer's researchers look for signs that they can attract some of these households to buy a new home.

"We look at various personas across different life stages and consumption patterns where we want to build," Zaro-Moore says.





EMPTY NESTER – single or couple, no kids at home

- **Income:** \$100,000+
- **Interests:** Dining out, family and friends
- **Key preferences:** Low maintenance, energy efficient, smaller home with space to socialize
- **Location:** Gated community with amenities for their kids and grandkids
- **Where they spend:** Whole Foods, Target, Trader Joes, Wegmans, Harris Teeter, Amazon
- **Priorities:** Health and fitness
- **Car:** Purchase or lease new Mercedes, Lexus, Lincoln or BMW

SOURCE: COGNITION SMART DATA

“We want to know what problem we’re solving for and what are the main drivers of a move. We anticipate how people may live in a house and what they might need.”

For example, a downsizing couple may want a “lock-and-leave” home with low maintenance. Others may want their home to be in a specific school district.

“We look into what tradeoffs buyers might make to be in that school district,” Zaro-Moore says. “Maybe they’re willing to sacrifice a little bit of space to be in a new house in the right location.”

AGGREGATING POTENTIAL BUYERS

A massive array of attributes becomes part of various audience segments.

“Affordability is subjective, and what seems affordable to a buyer is not just based on income but also on the demands upon someone’s income,” Zaro-Moore says. “For instance, a larger family has more demands on its income compared to a couple without children and the same income.”

Beazer utilizes nearly 200 audience segments to analyze buyer behavior profiles.

“The main drivers for how we group people together are life stages, which are somewhat linear for most people, and consumption behaviors,” Zaro-Moore says. “We look at data to understand how people with the same income and lifestyle spend money. Some people are more comfortable living in the middle of everything and will be happy

with less privacy, while others want the largest house in a quiet, gated suburban community.”

Beazer can review data across the entire footprint of their portfolio to drill down to a specific location and household level.

“First we want to know if we can be successful in a location, and then we can look at how heavy a lift it will be to sell homes there,” Zaro-Moore says.

Researchers also pay attention to lifestyle trends.

“Over the past several years, we’ve adjusted our floor plans to match the way people want to live, with an open area for family and friends to gather, along with a separated primary bedroom for privacy,” Bradley says. “We’re designing homes with an easy transition



YOUNG COUPLE/NO KIDS

- **Income:** \$75,000 to \$100,000
- **Interests:** Dining out, concerts, streaming music, cooking at home, outdoor pursuits, watching sports on TV
- **Key preferences:** Two-story home with efficient use of space, smart floor plan, tech ready, guest bedroom and bathroom
- **Location:** Desirable school district, safe neighborhood with amenities for daily needs
- **Where they shop:** Amazon, Target, Costco, PetSmart, Chewy
- **Priorities:** Fitness, healthy lifestyle with lower cost
- **Pets:** Yes; they think of it as a “starter family”
- **Car:** Buys a new one every 5-6 years so they can pay it off each time

SOURCE: COGNITION SMART DATA

between indoors and outdoors.”

More recently, floor plans have been tweaked with private pocket areas for people to work, and what Bradley calls a “messy kitchen” like a “pantry on steroids” so the open kitchen stays neater.

“We try to understand how people want to live in a house, which includes breathing healthy air, feeling comfortable and as if they have found sanctuary,” Bradley says. “People may not realize how important it is to have a quiet house even when the air conditioning is running, and how nice it is to have temperature controlled so there are no hot spots, either.”

A large master planned community like Cadence can be noisy, particularly because there’s nearly continuous construction, Zaro-Moore points out.

“When people visit our model home, they often comment on how quiet it is, like a haven,” Zaro-Moore says. “They don’t always realize that the quiet comes from our construction and insulation practices.”

BUYER POOL SHIFTS IN LAS VEGAS

Home sales began at Cadence in December 2014, which means historical sales data is available for builders. Beazer will build townhouses and single-family homes in the Aria Crossing neighborhood that includes the VISION House Las Vegas.

“Seven to nine years ago, we saw more ‘value buyers’ in the Las Vegas market, but it’s evolved now and we’re targeting more-affluent buyers,” Bradley says. “Cadence buyers are typically first or second move-up buyers, often double-income households or age 55-plus buyers who

are looking for a quality home.”

Prior to the pandemic, many age 55-plus buyers were looking for an energy-efficient townhouse that required little maintenance so they could travel, Bradley says.

“During COVID, people really thought about what they wanted,” Bradley says. “Now there’s more focus on indoor air quality and having a home office. We’re also seeing an influx of remote workers in Las Vegas, especially from California.”

ZERO ENERGY READY BUYERS

Marketing Zero Energy Ready Homes (ZERH) requires buyers and finding those who already understand the value proposition of healthier living in a high-performance home.

“We look for areas with a high concentration of electric vehicles, households that appreciate new technology,” Zaro-Moore says. “We look for information about people’s habits such as whether they recycle and whether it’s important to them to have sustainable products.”

That information helps Beazer understand where their ZERHs may be the most successful.

“We also review recent sales history to determine why a buyer chose to purchase a ZERH,” Zaro-Moore says. “Was it purely the location or was it something about Beazer’s design that appealed to them?”

“The equation of why someone would buy a ZERH is different depending on the location. For example, Texas has low energy costs but the high heat and issues with the grid make this type of home better for resilience,” he says. “In other markets, energy savings are

more important.”

“We are learning how to talk to buyers about [ZERHs],” Zaro-Moore says. “Some people are highly committed to sustainability and naturally understand why this is important. Others geek out over the science and technology, while others just like the quality construction.”

BUYERS WITH VISION

Beazer’s research team identified four groups of buyers who are more likely to purchase homes like the VISION House Las Vegas in Aria Crossing in Cadence.

“We anticipate the primary buyers at Aria Crossing to be mostly move-up buyers who want a larger home with areas for entertaining and for guests to visit,” Bradley says. “Location is key for these buyers, and they also want upgrades throughout the home.”

Typically, people in this buyer pool own their homes and have significant home equity. According to Beazer’s research, these persons have a high credit score, a low debt ratio and investible assets. More than half are college graduates. They have a household income of \$100,000 to \$150,000.

Overall, Gen X buyers prefer single-family homes in suburban communities that fit their lifestyle, according to Green Builder Media’s **COGNITION Smart Data**. They prefer homes with private sanctuary spaces along with common areas for entertaining, a home office and space for fitness.

Research on this group of Gen Xers shows that they want to be in an area with easy accessibility for convenience and



OLDER MILLENNIALS WITH KIDS AT HOME

- **Income:** \$50,000 to \$150,000
- **Interests:** Dining out, entertaining at home, outdoor activities, fitness, domestic travel
- **Key preferences:** Two-story home with four or five bedrooms, practical upgrades such as flooring that stands up to kids, nice kitchen because of eating at home often
- **Location:** Amenity-rich neighborhood with good schools, other families, convenient to shops
- **Where they shop:** Target, Walmart, outlet malls, Costco, Amazon
- **Priorities:** Value – location matters less than price; community amenities
- **Purchase or lease used cars:** Toyota, Honda, Ford, Chevrolet
- **Pets:** Yes, part of the family

SOURCE: COGNITION SMART DATA



GEN X FAMILY WITH OLDER KIDS OR NO KIDS AT HOME

- **Income:** \$100,000 to \$150,000+
- **Interests:** Dining out, entertaining at home, live music, yoga
- **Key preferences:** First-floor primary bedroom, gourmet kitchen for entertaining, covered patio, 3-5 bedrooms for future boomerang children and grandchildren, smart home features
- **Location:** Walkability to shops and entertainment, close to amenities
- **Where they shop:** High-quality clothing stores, Amazon, Target, Whole Foods, Trader Joes, local specialty markets, online meal prep subscriptions
- **Priorities:** Fitness, personal trainer
- **Car:** Buy a new high-quality Tesla, Lexus, Mercedes or BMW every 5 years
- **Other:** Subscribes to online meal prep like Freshly or Blue Apron

SOURCE: COGNITION SMART DATA

lifestyle. They're willing to buy a smaller, low-maintenance home as long as there's three to five bedrooms for future boomerang kids or young grandchildren. They don't necessarily need a large yard as long as they have a well-thought-out backyard.

Another prospective group of buyers at Aria Crossing may be first-time buyers.

"Many in this buyer pool have a dog," Bradley says. Location and surrounding amenities are key for this group. They're looking ahead to be in a good school district in the future."

These buyers are more value-oriented than other buyers, Bradley says. They tend to want practical upgrades in the main living areas such as higher ceilings, lighting, built-ins,

and surround sound systems. They also want a tech-ready household with a Nest thermostat, high fiber availability and multiple areas for study and electronics. They have a household income of \$75,000 to \$100,000.

Overall, millennial buyers prefer compact floor plans and prioritize healthy, resilient homes, according to COGNITION Smart Data. They are more concerned about the cost of homeownership than other generations. The chart [below, to the left] shows millennial homebuyer responses about the causes and topics they prioritize.

Beazer also anticipates that buyers across generations will find value in the homes at Aria Crossing.

"These buyers are looking for new construction and less maintenance," Bradley says. "Location is also a huge factor."

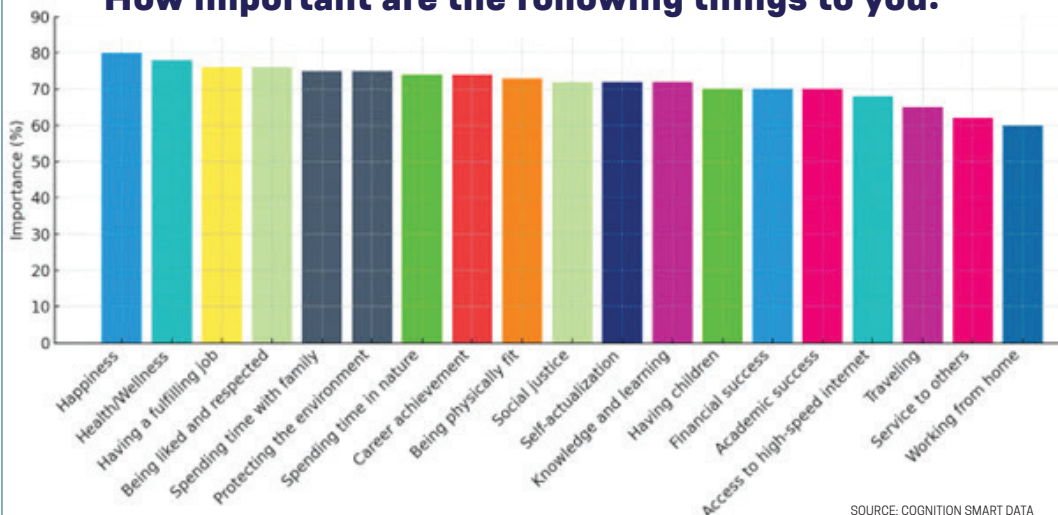
This buyer pool, with a household income of \$100,000 or higher, typically has significant home equity and investable assets.

"These are move down buyers without kids at home who enjoy travel and want at least two or three bedrooms for friends and family to visit," Bradley says. "They also understand the benefits of energy efficiencies in the home."

Since they have personal wealth, these buyers are more likely to want upgrades throughout the home.

"Technology is important to these buyers, who want upgrades like smart locks and smart home devices," Bradley says. **GB**

How important are the following things to you:

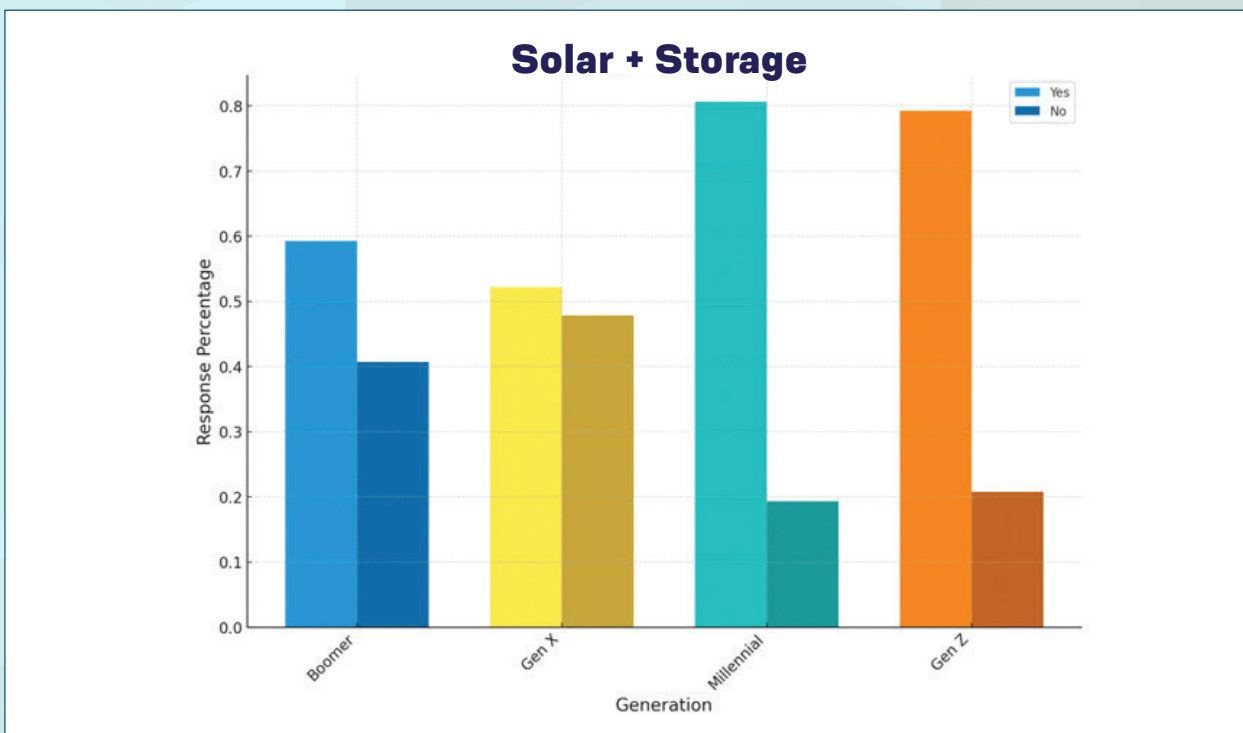
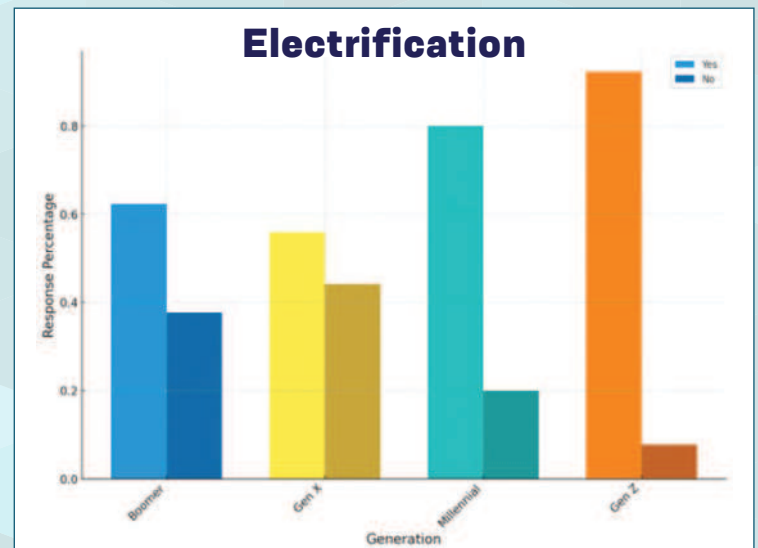
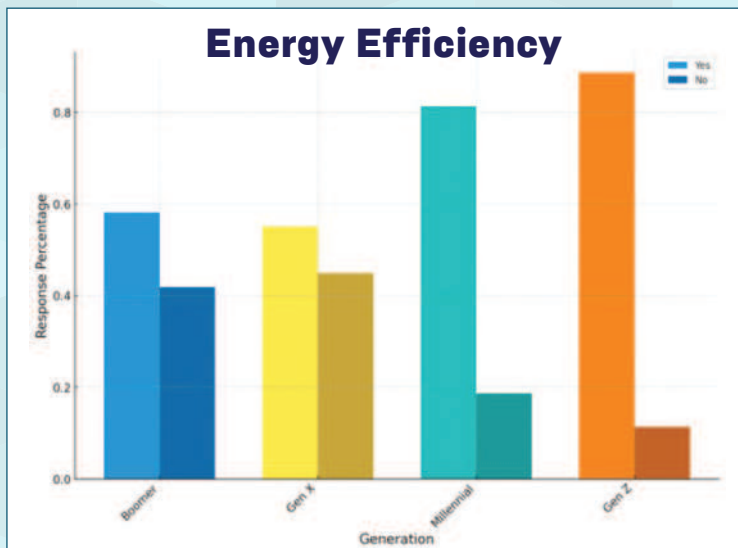


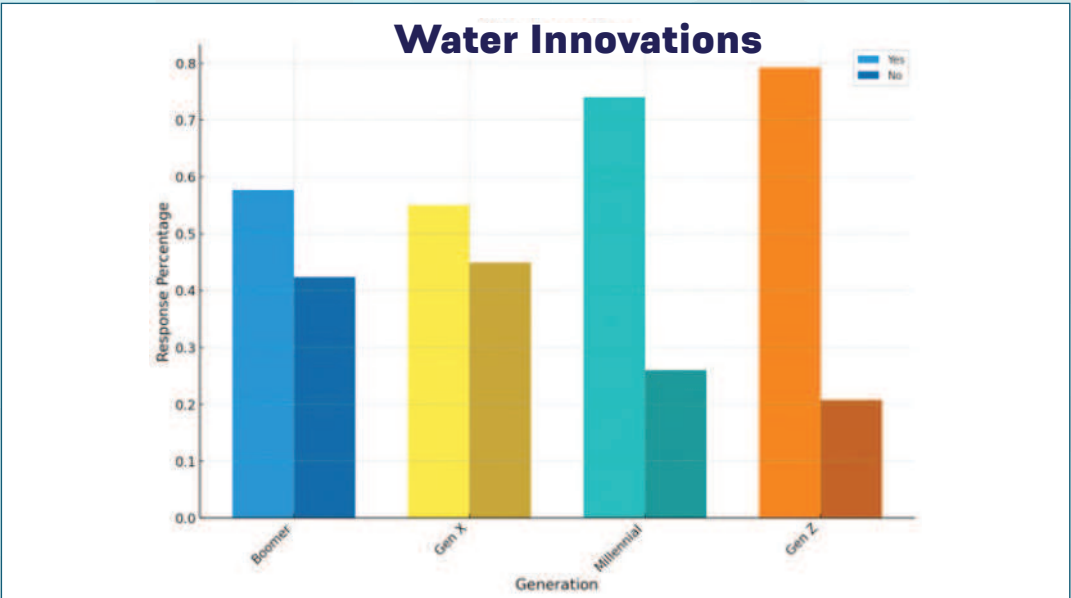
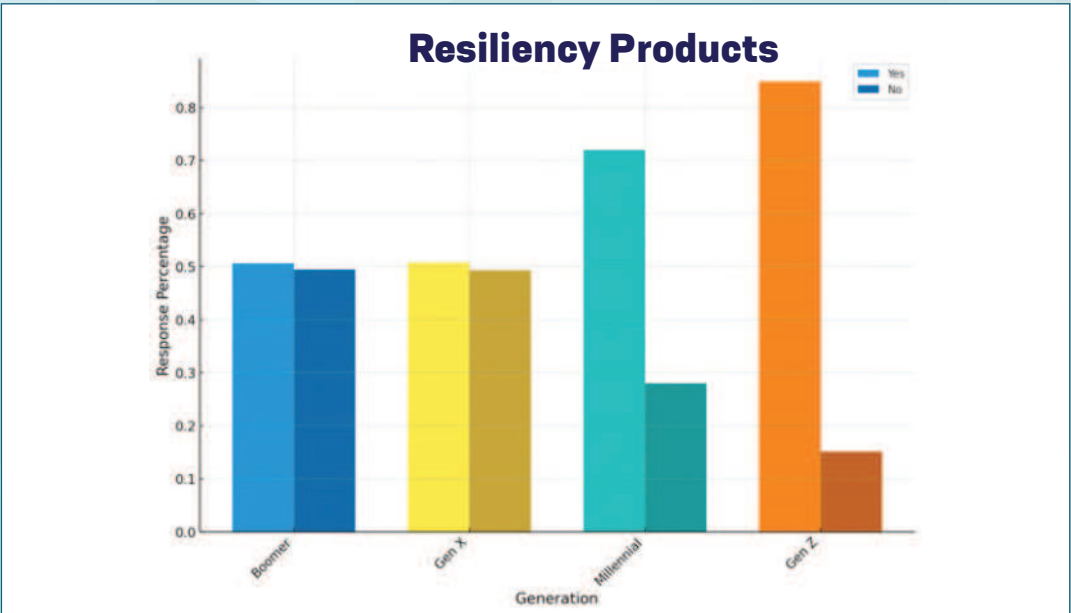
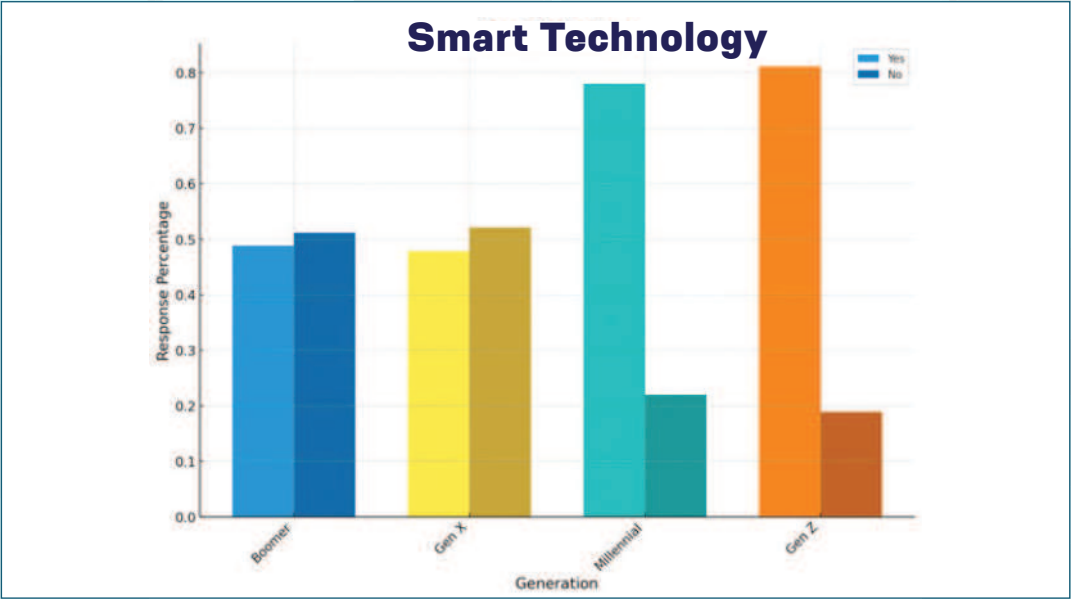
SOURCE: COGNITION SMART DATA

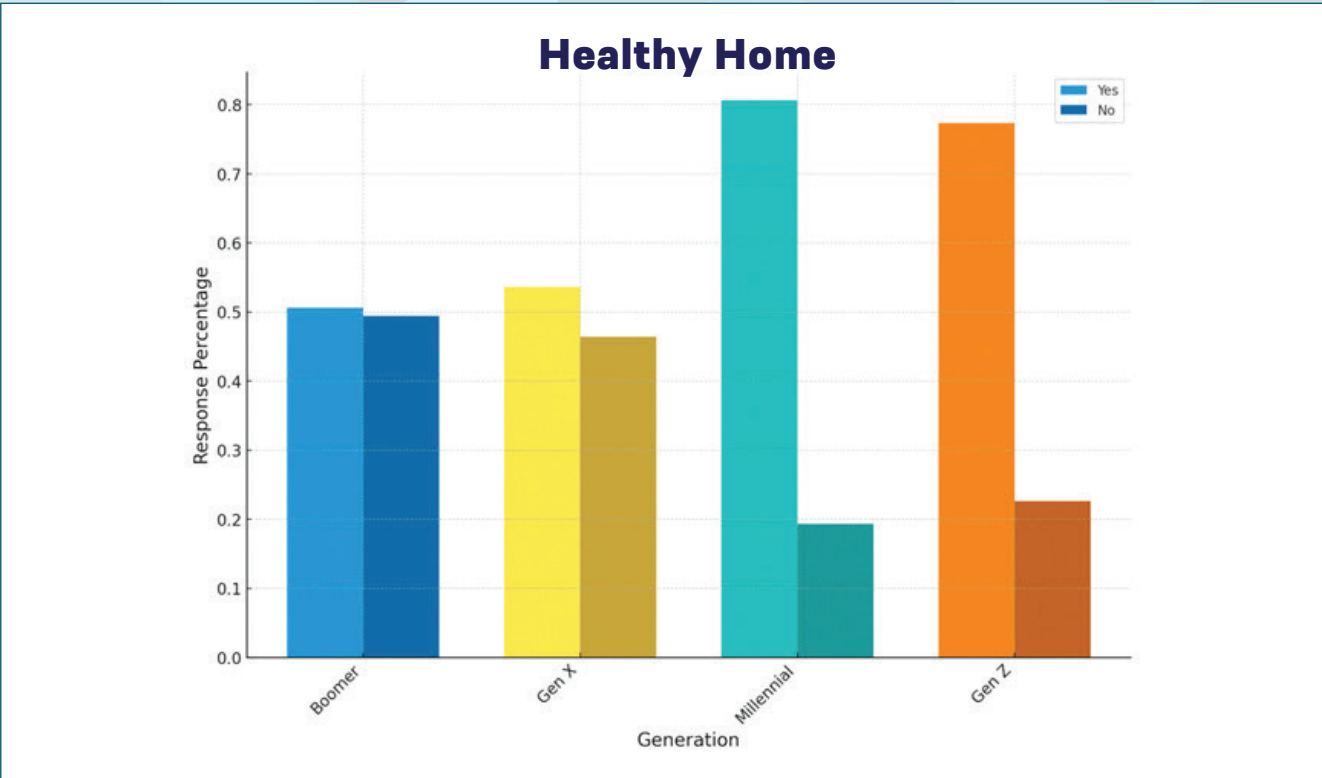
UPGRADES BY THE AGES

Solar with storage, smart technology and resiliency products are especially appealing to younger generations of buyers. But at least half of every age cohort says they are willing to pay more upfront for sustainability upgrades that will lower the cost of homeownership over time, according to COGNITION Smart Data.

The following charts from COGNITION Smart Data demonstrate how willing homebuyers are to pay for upgrades by generation.







Who's On Board?









THE ALCHEMY OF CLIENT DESIRES:

VISION House Austin transforms abstractions into reality

BY MICHELE LERNER

While some people may perceive architects as rule-following draftsmen, architects committed to creating innovative and sustainable homes are comparable to artists as well as scientists. Their job requires the talent of a polymath to translate abstract concepts such as a client's desire for a "light and airy" home into concrete design elements.

Perhaps the ultimate example of a polymath, the architect, artist, sculptor and engineer Leonardo Da Vinci integrated his scientific research into everything he designed along with his artistic interpretation. The thread that wound through all of his intellectual and creative pursuits was *saper vedere* ("knowing how to see").

"Our primary guide for any project is the site," says Alan Barley, co-owner of Barley|Pfeiffer Architecture in Austin. "The site tells us



Courtesy of Barley|Pfeiffer Architecture

Action plan. Barley|Pfeiffer Architecture's project programming offers suggestions to clients about style elements available for their new homes, such as window and door placements, and energy-efficient roofing materials.

what to do, then we work with our clients to dig deeply into what they want and seamlessly integrate their priorities into the design.”

Many custom home buyers think first about features they want and the details they’ve seen on sites such as Houzz and Pinterest rather than the overall design that fits their land and lifestyle, says Peter Pfeiffer, co-owner of Barley|Pfeiffer Architecture.

“Every house needs to start out with a well-thought out design,

which is why we serve as trusted advisors to help people make informed decisions,” Pfeiffer says. “Just like when you talk to your teenage kids, sometimes you need to ask the questions that aren’t being asked enough, like ‘why are you doing this?’ We call our process ‘project programming.’”

Through project programming, the architects gain clarity about the purpose of the project and the purpose of each client request, he says.

An Age-Resilient Design

One priority of VISION House Austin homeowners Robert and Judi George is to age gracefully in their home, particularly as they begin to face mobility issues. At the same time, they want a home without obvious concessions to age. “The open floor plan is popular with most buyers, but it also works well for aging in place,” Effland says. “We designed this house to have zero elevation changes to make it easier for someone using a walker or wheelchair, but that’s also just a nice design choice.”

Age-resilient elements in a home can be incorporated subtly and work well for owners of any age. “A simplified floor plan, all on one level and with spaces closer together, can make it easier to age in place,” Barley says. “When we design a home like the Georges’, which has a smaller footprint of about 1,900 square feet, it also makes the home seem larger to keep the walls to a minimum.”

As a rule of thumb, Barley and Pfeiffer try to make bedrooms large enough to allow for three feet from a wall to a bed for possible wheelchair access.

“We always install blocking for grab bars in the bathroom,” Effland says. “Grab bars are helpful after mobility issues begin but they’re even more helpful to prevent falls. We encourage people to install the grab bars from the beginning, not just the blocking.”

For clients who want a separate water closet, they design the space so the dividing wall can be removed in the future if the bathroom needs to be ADA compliant, Effland says.

After the design phase, the “icing on the cake” for the Georges’ house is the choice of slip-resistant flooring, including the bathroom tiles and outdoor decks, Effland says.

“Color choices are also important because as people age, they need more light,” Barley says. “The Georges chose lighter countertops that reflect light off the ceiling and off light-colored walls.”

In the kitchen, pendant lights will be installed above the kitchen sink and island to bring the light source closer to the task area.

Smart technology such as leak detectors and apps that operate lights, shades and security systems can be helpful for some people as they age in place.

“We think of it as our clients writing the next chapter of the book of their lives when they choose to build a custom home...Our job is to help them write it.”

The Big Picture

Three starter questions Barley|Pfeiffer Architecture asks of potential clients as they work together to build a home that perfectly reflects the clients’ lifestyle and aspiration:

1. **WHY** are you building this project?
2. **WHAT** are the most important objectives or goals you are trying to achieve?
3. **HOW LONG** do you plan to own this home?

“Clients don’t know what they don’t know, so we need to ask the right questions to help them think about the right things,” Barley says. “Then we can serve as their guide.”

At VISION House Austin, designed by Barley|Pfeiffer Architecture and built in partnership with Green Builder Media, homeowners Robert and Judi George participated in the exploratory process before Barley and Pfeiffer developed their design.

“We think of it as our clients writing the next chapter of the book of their lives when they choose to build a custom home,” Barley says. “But it’s their book, not ours. Our job is to help them write it.”

SOCRATIC METHOD LEADS TO CLARITY

The team at Barley|Pfeiffer Architecture relies on the Socratic method of asking questions that unearth deeper knowledge rather than talking and telling people what to think. For more than 30 years, they have used a 20- to 25-page questionnaire that customers complete to begin the design process.

“We ask the clients to come back with one set of answers—not his-and-hers answers,” says Joel Effland, project manager for the VISION House Austin with Barley|Pfeiffer Architecture. “It’s too easy for architects to become part-time marriage counselors, so we ask them to make decisions as a couple.”



“Every house needs to start out with a well-thought-out design... sometimes you need to ask the questions that aren’t being asked enough, like ‘why are you doing this?’”

The questionnaire starts with big picture questions about the purpose of building a new home to help people think about their true desires and objectives, Barley says.

“We ask people how long they plan to live in the house, about their household and their lifestyle,” Effland says. “Then we talk about what they like about the property and a neighborhood to get to know and understand them and their goals.”

Questions address topics such as whether buyers are looking for privacy and want to be sequestered from neighbors or prefer to feel connected to them, Effland says.

“Then we get into the nuts and bolts of the design with an extensive list of questions to think about things like the kind of windows and doors they want,” Effland says.

Few buyers know the style of home they want, Barley says, so they make suggestions.

“We take our cues from the area and the site to recommend locally sourced low-maintenance materials that are fireproof,” Barley says. “Our favorite roofing material is metal for safety and energy efficiency.”

The macro and micro issues are pulled together in one document to provide a guide for the architect and the project manager.

“We spend two or three hours going through the questionnaire after the clients complete it,” Barley says. “The document becomes the recipe for the house that we match with the recipe of the site.”

Client preferences also must be matched with their budget.

“When it’s time to make decisions, we listen to the clients and understand each opinion,” Effland says. “Then we explain the ramifications of each decision and put it in the context of their budget.”

Features and finishes that can be included are kept in the plan as much as possible, but the project manager also identifies items that may need to be adjusted to fit the budget.

“Budgeting is part of the programming guide because we want to reconcile the plans early while we still have flexibility to make changes,” Barley says.

A COMMON-SENSE APPROACH TO SUSTAINABILITY AND ARCHITECTURE

The programming guide is part of the practical, reasoned approach to architecture embraced by Barley and Pfeiffer.

A home shouldn’t be a “ball and chain” that requires homeowners to do too much work to make it sustainable, Pfeiffer says.

“We believe in ‘doing by design’ so that the house operates as it should,” he says. “Even indoor air quality can be improved by choosing materials that don’t contribute any off-gassing, so your air is cleaner from the beginning.”

While a custom home should meet the clients’ desires, architects also need to design homes with principles of sustainability that ultimately result in a better home, Pfeiffer says. For example, homes are often designed with a wall of windows to capture a desirable view without regard for western exposure. The homeowners end up with a view they love that must be covered with blinds most of the day to avoid the impact of solar heat.

“Architects should start by doing to their home what they would do to their body to make it more comfortable,” Pfeiffer says. “That means providing shade and a breeze in a hot climate.”

Just as the natural philosophers of the Enlightenment like Descartes emphasized the value of reason, rationalism and scientific understanding, architects such as Pfeiffer and Barley rely on their investigation of sunlight, air flow, seasons and climate to inform their designs. **GB**

NATURAL COOLING STRATEGIES

Isaac Newton's Enlightenment era principles of natural philosophy were formed by rational thought and enhanced with scientific studies and techniques. For centuries, people built homes in locations and with design elements to maximize natural cooling. Homes were set under trees, close to water or on hillsides to catch breezes. Features such as deep front porches and roof overhangs made it easier to survive hot summers all over the world.

Barley and Pfeiffer embrace that philosophical approach for every home they build, including the VISION House Austin.

"We like to build green homes by design that will function efficiently even before we put systems in place," Barley says. "The systems such as air conditioning can be smaller if you build the house to be shady where it needs shade and is sited to catch breezes."

Most homes the firm designs include an overhang of at least three feet or more if needed, Effland says.

"That reduces the direct sunlight and glare from windows," Effland says. "To combat the glare in homes that are not designed this way, homeowners often close the blinds and turn on the lights, which then heat up the home."

In addition to overhangs, Barley and Pfeiffer design homes in tune with nature and each site. They avoid placing large expanses of glass doors and windows on the western side of each home to reduce exposure to the hot afternoon sun in Austin. Instead, they focus on placing windows and glass doors on the northern and southern sides of each home and the southern side, which allows natural light into the home without heat.

"When we lay out a house, we try to design it so most rooms have natural light coming from at least two sides," Effland says. "This provides natural ventilation when the air is cool enough, plus you need less artificial light."

Rooms in the VISION House Austin are placed strategically so that the ones that are unlikely to be occupied in the afternoon—such as the guest bedroom and bathroom—are on the western side of the house. The south side of the house is shaded. The rooms most likely to be used in the daytime are sited to face the northern side of the house, which also has the best views.

"There's a natural breeze that comes from the south and southeast, so we placed the swimming pool and green spaces to catch the breezes and enhance them rather than block them," Effland says.

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RETHINKING WHAT IS TRULY AFFORDABLE HOUSING

Providing shelter is a good start. Nurturing wellness in all its forms is a crucial next step.

BY SAM RASHKIN

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



More than 2.5 million homes have earned ENERGY STAR certification. Approximately 200,000 more are expected to be certified this year. This program's transformative impact never ceases to amaze me, especially in contrast to the huge struggle we had gaining traction with builders during my first year as national director. This article is about an experience I had at the very beginning of this extraordinary journey—one I'll never forget.

An early big "win" for the ENERGY STAR Certified home program a commitment by the Habitat for Humanity Houston affiliate to certify all the homes in its 1996 Blitz Build. I was honored to attend the dedication ceremony, where I wound up on stage sitting next to their iconic and reveled co-founder, Millard Fuller. As soon as we met, charisma oozed from his entire



Wellness planning. Nonprofit organizations such as Habitat for Humanity Houston coordinate construction of affordable housing, as well as provide strength, stability and self-reliance in homeownership. But there's a harder road ahead when it comes to integrating wellness in affordable housing. CREDIT: COURTESY OF HABITAT FOR HUMANITY HOUSTON

being. His profound impact on Habitat's success was immediately obvious.

And then came the moment when he posed a simple question to which a much smarter person would have given a much safer answer. The question: "So Sam, what did you think of the home we completed today?" The not-so-smart answer: "Very impressive—but I wondered if Habitat considered including garages?"

If looks could kill, someone else would have authored this article. Once Millard composed himself, he slowly enunciated his emphatic reply that I am sure he had expressed many times: "Habitat for Humanity builds shelter

for humans, not cars."

Again, a much smarter person would have simply acknowledged this organizational priority and moved on. And then there is me. I engaged. "Millard, I appreciate this policy preference. However, I understand that a family of five will be moving into the home next week and observed there are only three small closets, one for each bedroom.

"From my experiences, low-income families, like all households, need storage for many large items. Bikes, toys, home repair tools, ladders, lawn mowers, yard tools and luggage are a few that come to mind. I've read that clutter is directly linked to stress, which is something low-income families already have in abundance. Moreover, a garage can significantly enhance each homeowner's opportunity to realize greater appreciation since it is a feature commonly expected even in starter homes."

Of course, he had a rigorous response and would not budge from his position. I finally got smarter when he was done. I apologized for the suggestion and shared my admiration for all he and Habitat for Humanity had accomplished on a global scale. It was the best I could do. The dedication ceremony began, we both gave our speeches, and I was in absolute awe of Millard's breathtaking communication skills.

Decades later, this interaction with an esteemed housing leader remains a vivid memory. But I fear I am still not yet smarter about suppressing opinions on affordable housing (yes, this is an opinion article). That is because I feel even more strongly today that we need to expect more from affordable housing. Providing shelter is not good enough. It is critical to also nurture wellness in all its forms.

First, affordable housing should be optimized for healthy living. Second, affordable housing should minimize homeowner financial burden. And finally, affordable housing should be prepared to adapt to huge forces impacting homeownership to minimize obsolescence.

A home is not like a smart phone that is replaced every few years. It is the ultimate consumer product that should last for more than 100 years. In other words, it is imperative for affordable housing to optimize all forms of wellness: health, financial, and future-readiness. Unfortunately, extensive personal observations suggest this comprehensive approach to wellness is lacking in neighborhoods across the country.

No demographic suffers more from this lack of wellness-focused housing than low-income households. The following sections provide a brief overview of the impressive opportunities to apply this larger vision for affordable housing. They are based on my book, "[Housing 2.0: A Disruption Survival Guide](#)," which provides much-greater detail about the many best practices introduced in this article.

HEALTH WELLNESS

Leading the Environmental Protection Agency (EPA)'s Energy Star Certified Home program was the most rewarding job I ever had. No other job before it was remotely as rewarding. Yet, I decided to leave EPA and join the U.S. Department of Energy (DOE) in 2011. A driving force for this change was the opportunity to create a new high-performance home label that ensured comprehensive indoor air quality (IAQ) protection missing from Energy Star Certified Home version 3. We did that by creating the DOE Zero Energy Ready Home (ZERH) program and making EPA Indoor airPLUS certification mandatory.

That was a good start. However, health wellness goes far beyond IAQ. A wide range of choices made while planning communities and designing homes have significant impacts on health related to stress, depression, sleep loss, productivity, cortisol levels, immune system, conditioning, vitamin D levels and healing. Where health is not optimized, low-income households suffer the

Health Wellness		
Strategies	Best Practices	Outcomes
Indoor Air Quality	- Source control - Whole-house ventilation - High-capture filtration	Comprehensive contaminant control SOURCE: EPA Indoor airPLUS
Natural Light	- South orientation - Solar shading	- Boosted vitamin D - Reduced seasonal depression - Improved sleep - Enhanced productivity SOURCE: Harvard Business Review
Clutter Control	- Storage system - Built-in furniture	- Reduced stress - Reduced cortisol levels - Improved productivity SOURCE: Mayo Clinic
Natural Fresh Air	- Operable windows oriented to prevailing breezes - Outdoor living	- Eliminated stale air - Reduced dust - Reduced depression - Improved concentration - Improved healing SOURCE: BlueCross BlueShield
Social Connection	- Community open spaces - Front porches - Recessed or rear garages	- Reduced disease - Lower rates of anxiety - Stronger immune system - Improved cognitive function - Better conditioning with exercise SOURCE: World Health Organization

Future-Ready Wellness		
Strategies	Best Practices	Outcomes
Timeless Communities	- Open spaces - Optimized views - Streets optimized for solar orientation - Expert landscaping - Quality amenities - Strong governance - Ensured maintenance	- Ready for appreciation: - Communities and homes that live better - Communities and homes that last better - Certified performance that meets or exceeds future standards - Ready for protection: - Prevailing disaster risks - Post-disaster occupancy - Better warranty coverage - Ready for low-cost upgrades: - All-electric home - Smart homes - Solar systems - Battery systems - Electric vehicle charging
Timeless Design	- Site appropriate materials - Proper site drainage - Natural comfort - Optimized floor plans - Optimized simplicity	
Timeless Performance	- Certified high-performance - Smart home ready - All-electric ready - Disaster ready - Solar ready - Battery ready - EV charging ready	
Timeless Quality	- Quality construction - Long-term warranties	

Financial Wellness		
Strategies	Best Practices	Outcomes
Optimize Construction Cost	- Community: - Square vs. rectangular lots - Design: - Simple architecture - Simple floor plans - Right-sizing for how we live - Integrating attic volume - Integrated systems - Mass-customization - Performance: - True cost optimization - Right-sized HVAC - Compact HVAC - Compact plumbing - Quality - Efficient processes - Lean production - Systems built	- Less construction cost for: - Complexity - Space with no value - Leveraged attic volume - Standard building blocks - Enclosure - HVAC system - Electric system - Plumbing system - Cycle time - Rework - Process - Warranty calls - Material waste
Optimize Ownership Cost	- Community: - South orientation - Sharing sheds - Design: - Site drainage - Natural comfort - Fit-to-site materials - Built-in furniture - Performance: - Efficiency - Moisture control - Indoor air quality - Water efficiency - Disaster resistance	- Less ownership cost for: - Energy bills - Maintenance - Health expenses - Lost wages due to sick days - Insurance costs - Water bills - Furniture expenses - Household items

Best practice principles. The Housing 2.0 optimization framework includes financial wellness strategies, best practices and compelling outcomes that should be considered essential to a truly affordable housing project. SOURCE: SAM RASHKIN

most because they are the least insured, disproportionately impacted by income loss due to sick days, and most challenged preparing their children for success at school. These factors along with simple compassion is why optimized health should be an imperative for affordable housing.

FINANCIAL WELLNESS

Financial burden creates significant and persistent stress linked to physical and mental health. As the housing affordability crisis soars to historic levels, there are significant indicators Americans are financially stressed. This includes reports that nearly two-thirds of households have no savings on a monthly basis; about 40 percent of households cannot afford an unexpected \$400 expense; and more than 60 percent of Americans are worried about paying for housing the next year. More than ever, it is essential to use all tools available to minimize the total

housing cost burden, including first cost and ownership cost.

FUTURE-READY WELLNESS:

Homes are typically the largest investment of a lifetime. Yet, they are at risk of becoming obsolete if not designed and constructed ready to adapt to the imminent future. A future where homebuyers are exponentially more informed and will assign higher value to communities and homes that live, last and perform better. A future where the exponentially increasing frequency and magnitude of disaster events pose much greater risks and higher insurance costs if you can get it. A future where the zero-energy train has left the station along with related expectations looming for all-electric homes, smart homes, solar energy systems, battery storage and electric vehicle charging.

Communities and homes not ready for this future are at risk of less



Life on “The Other Side.” Projects such as “The Other Side Village” in Salt Lake City offer a comprehensive vision for integrating wellness in affordable housing, by managing open space, quality features and value.

CREDIT: COURTESY OF THE OTHER SIDE VILLAGE

appreciation, protection, and readiness to deploy compelling new innovations for mitigating utility bills and superior operation. Those old enough may remember ads promoting oil changes with the tagline, “you can pay me now or pay me much more later.” That same message applies to the choices we make developing communities and homes. In some cases, these choices result in liabilities that are locked in for perpetuity (e.g., lot orientation, open spaces, view optimization, and excessively complex architecture).

WHAT’S COMING NEXT

This article is just the beginning of conversation about the wellness imperative: Where ignored, low-income households will pay the greatest cost because they are most in need of the financial, health and future readiness outcomes.

I understand it’s easy to feel overwhelmed by the extensive recommendations discussed for enhancing wellness. Don’t be. It’s not critical to apply all strategies and best practices. But it is critical to incrementally start adding those you can. Integrating wellness in affordable housing is a journey.

An excellent example is “[The Other Side Village](#)” in Salt Lake City, for people without housing. There have been years of political struggles for the un-housed to finally get it under construction. The early layout for the project shown in the rendering above demonstrates a comprehensive vision for integrating wellness in affordable housing. The key strategies include open spaces (e.g., town center, trails, parks, recreation, and gardens), quality features (e.g., landscaping and hardscaping), and enduring value (e.g., optimized views, front porches and strong governance). It would be a significant lost opportunity to not evaluate and disseminate lessons-learned applying wellness in projects like The Other

Side Village.

Please understand that I do not want to ever discount the vital work done by affordable housing advocates. It takes a huge effort to overcome a myriad of challenges just to get people sheltered. This is just a suggestion that there are impressive opportunities to do better. Or at least try. This begins by rethinking how wellness best practices are essential to affordability for attaining and owning housing. Then we need to create processes to apply them to reduce the financial burden, nurture all aspects of health, and enable critical upgrades for minimizing obsolescence without severe cost penalties and disruption to occupants.

Millard Fuller is no longer with us. He passed away in 2009. Decades after our exchange, I am still urging affordable housing advocates to expand their mission beyond just providing shelter. Hopefully, I am a lot smarter about how to engage inspirational leaders who already give so much of themselves just to put roofs over the heads of low-income families to be more inclusive of wellness. I am too dumb to stop trying. **GB**

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

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MARIPOSA RAIN



Ron Jones
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As I settle in to write, it is only mid-September, but everything feels more like the middle of autumn in the high country. When I was last here, just two days ago, the aspens had turned about 20 percent, already ahead of schedule by normal standards. But today, I would estimate that the total is closer to 40. Some say it is due to the wetter-than-usual August weather we enjoyed, but who knows for sure?

Steady rain again today; forecast says to expect it all day. It sounds wonderful coming down on the metal roof, but there's not much solar gain. My house is off grid and relies on stored energy, and it reminds me of something my friend Richard Morgan shared about capturing rainwater in the Texas hill country: "When you become a water harvester, you become a water steward."

The same thing goes for sunshine. You won't check the charge level in the solar batteries very often on a sunny day, but that changes when skies are dark. It makes you pay more attention to what is in use and burning watts. Each time you reach for a light switch, you're also making a silent calculation.

Mariposa Meadows is in a naturally beautiful, quiet locale. But solitude comes with a side helping of accountability. That's why it's probably a healthy thing to consider compromise sometimes, just like when you're counting calories.

When it comes to shelter, you want dry, warm and safe. The fundamentals are obvious, and they haven't really changed a great deal since our ancestors moved indoors. How many generations passed before we saw running water, central heat or electric lights? Not to mention the big one, air conditioning?

The rate of progress has since accelerated. Exhaust fans. Smoke detectors. Security and fire suppression systems. Whole-house energy monitoring with automated response.

Building science opened the floodgates. The more you know, the more you have to make choices, including on items such as BTUs, kilowatt hours, embodied energy, carbon footprint. Once upon a time, all you had to do was stand upwind of the campfire.

Every new technology, each new solution, all the latest conveniences come at a cost, and these are not just financial (although those certainly can't be ignored). It might also mean assigning responsibility for assuring successful, reliable operation. Who wants to hear from a customer who is aggravated because the Delayed Start function on the dishwasher is misbehaving? Not me.

The learning curve for all of this new technology looks more and more like a hockey stick. My plumbing contractor has been forced to become part engineer. No wonder he can't recruit new people to the trade, at any price. NASA pays more and its jobs come with a lot more prestige. Plumbing stopped, a long time ago, just being about getting your hands dirty.

When I got into the homebuilding business, there were people wearing white collars and there were others wearing blue collars. If the size of your operation was below a certain threshold you probably had to wear both. If you lacked knowledge and skills as a builder, you risked delivering an inferior product. If you couldn't handle the fundamentals of running a business, sooner or later you would find yourself having to make a hard choice between paying your help, your suppliers, your insurance premium or the tax man.

It doesn't stop there. Now you also have to wear a green collar. I'm willing to take a certain amount of credit or blame, depending on your point of view, for that fact. When, as an industry, we opted or were forced to acknowledge the footprint that the built environment leaves on the natural one, we entered a whole new reality.

When that train left the station, the cars carried waste reduction, resource management, energy efficiency and indoor air quality. Before long, we added greater focus on land use, water quality and availability, and proximity to public transportation. That doesn't even start to become a comprehensive list. Now we're grappling with environmental, social and governance (ESG), carbon offsets and regenerative building.

It's a lot to think about. But the sun just peeked through. Think I'll go and check my power readings. **GB**

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