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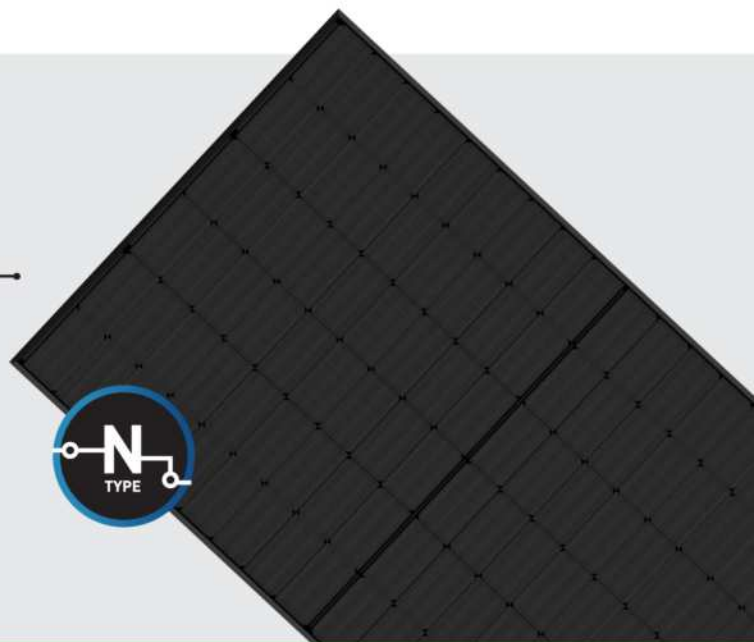
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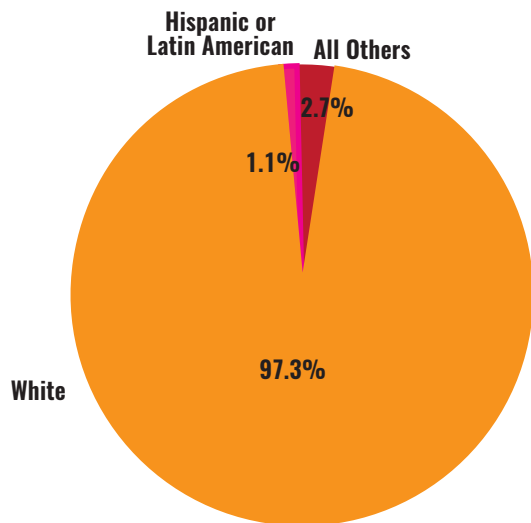


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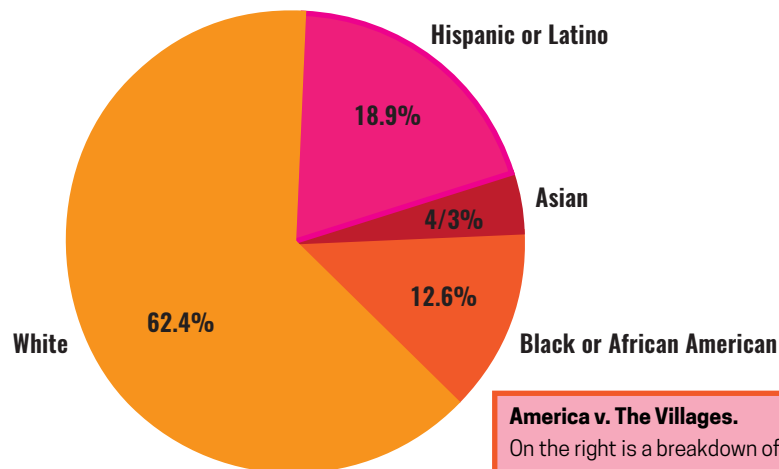
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The Poison Pill of 55-Plus Communities

THE VILLAGE MIX



UNITED STATES DEMOGRAPHICS



America v. The Villages.

On the right is a breakdown of the U.S. population, from the latest Census, compared with "The Villages," at left, the nation's fastest-growing metro.

Age-restricted living worsens the empathy divide.

I've been watching the antics of a professor of marketing at New York University (NYU) named Scott Galloway, who has written a book about how the older generation has failed in its social contract with young people. Although he tends to swear a lot and sometimes come across as a jerk, he's not wrong.

In chart after chart, Galloway can show you how people hitting their retirement years have left a scorched earth economy behind them. They had better wages, more affordable housing, and more reasonable options for parenthood than their adult kids do now. All of the data lines are going the wrong direction.

"The cost of buying a home, the cost of pursuing education continues to skyrocket," Galloway says. "So the purchasing power, the prosperity, is inversely correlated to age. Simply put, as we get older, we're taking away opportunity and prosperity from our youngest."

This result is "rage and shame," he says. "People over age 55 feel pretty good about America, but less than 1 in 5 people under age 34 feel very good about America."

His comments came to mind as I drove past The Villages, Florida's fantastically popular age-restricted community. Here's a physical manifestation of Galloway's thesis:

Grandma and Grandpa (or mom and dad), are getting a new house here, living it up all the way to the bitter end. Meanwhile, their kids and grandchildren struggle to pay rent. Many decide not to have kids.

The perceived message from their elders? "Have fun dealing with the climate crisis we created, kids! Oh, and thanks for paying for our Social Security payments (even though we hate the New Deal) for the rest of your low-paid working life. Don't bother with grandchildren. The

Home Owners Association (HOA)—our neighbors and friends—only allows short family visits here anyway."

The Villages is just one of thousands of age-restricted communities nationwide. It's part of a [national frenzy for 55-plus living](#). The Villages, in fact, is the fastest-growing U.S. metro area, at about 7.5 percent annually. That's why I'm risking elder scorn by calling it out. I can take it. I'm past 55, too.

Thanks to a 1995 regulatory loophole, developers were allowed to build these exclusive camps for gramps with special quotas for aging buyers. The rule made sense when applied to people with modest means. But now some 55-plus homes fall into the luxury end of housing prices. That was not the plan.

It's not just young people who may be getting a raw deal from this white flight to 55-plus living. These cultural expats are paying a price, whether they know it or not. Research suggests they may be damaging their own mental health by avoiding contact with the young. They're also fueling ageism by [losing empathy](#) and connection with other generations. What a sad way to golf cart off into the sunset.

I brought this topic up to lead off our "World Changing Ideas" issue to keep things real. Not every innovation is technological. Often, real change is rooted in a shift in our world view. Populating the country with elder echo chambers instead of multi-generational neighborhoods is a fool's paradise. It's time to remove the restrictions and invite all generations to these communities. **GB**



Matt Power
Editor-in-Chief

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Clean Energy Closes in on Fossil Fuels

A decline in carbon emissions-generating power is now inevitable, according to a climate study.

A rapid rise in generation of solar and wind power has led to renewable energy now accounting for 30 percent of global electricity. According to a report by sustainability think tank [Ember](#), this may be a sign that renewables are set to eventually—and permanently—surpass fossil fuels as the world's top electricity source.

Renewables-generated electricity has already slowed growth in fossil fuels by almost two-thirds in the past 10 years, according to a report in *The Guardian*. Green energy accounted for 19 percent of electricity in 2000. Solar alone generated more than twice as much new electricity as coal in 2023, and it was the largest source of clean energy—ahead of wind—for a second consecutive year.

Use of clean electricity is expected to climb by 2 percent over global fossil fuel generation during 2024, according to Ember. This is a sign that “the renewables future has arrived,” notes Dave Jones, Ember's director of global insights.



Rising run. Solar energy is leading the way as renewables move toward surpassing fossil fuels as the world's No. 1 electricity generator. CREDIT: ISTOCK/BOMBERMOON

Ember's report data covers 80 countries, which represent 92 percent of the world's electricity demand, as well as historic data for 215 countries, according to Ember. **GB**

Gen Zers May Help Solve Trade Industry Job Crisis

Blue collar jobs are increasingly attractive to the young workforce, mostly due to greater job security.

Generation Z is poised to take over skilled trade industry jobs that will be vacated by roughly half a million retiring baby boomers before decade's end. According to a report by Axios, enrollment in vocational programs and applications for trade jobs is slowly rising as younger people look to start their careers without the high cost of a four-year college degree.

Enrollment in vocational programs increased 16 percent in 2023, according to National Student Clearinghouse. Over the past several years, the median age of workers in trades such as carpentry and HVAC maintenance has decreased from the mid-40s to the high-30s.



All aboard. Today's students are opting for education in skilled trades instead of paying for degrees from expensive four-year schools. CREDIT: ISTOCK/FILIPPO BACCI

There's also a shift in priorities. According to a New America survey, 54 percent of Gen Zers believe a high school diploma is enough to get a well-paying, stable job. Meanwhile, 46 percent of parents say they would prefer their kids to pursue alternatives to four-year college, according to a recent Gallup study. Many young people also believe jobs in the trades will be more resilient to the rise of AI than white collar alternatives, Axios notes. **GB**

Lithium Boom Ahead?

New deposits of the controversial but powerful element in rechargeable batteries could ease domestic needs—but at an environmental price.

Geologists in Pennsylvania have discovered an enormous deposit of lithium that could meet nearly half of the nation's needs as the sale of electric vehicles increase in coming years. Lithium is the key element used in rechargeable batteries of all types, from smart phones to cars.

According to the U.S. Department of Energy (DOE), the nation's sole lithium mine meets only 1 percent of consumer needs. The rest must be imported. DOE wants all lithium produced domestically by 2030. The new Pennsylvania deposit, combined with another field discovered in northwestern Nevada in 2023, could generate more than 75 percent.

Lithium mining in the two newest sites would be accomplished by dredging, and then filtering, lithium-rich wastewater from onsite fracking operations. Fracking is a controversial deep drilling technique to obtain oil and natural gas deposits, and is considered by many to be an environmental hazard.

According to Justin Mackey, a researcher at the National Energy Technology Laboratory in Pennsylvania, balancing the two types of mining would be tricky. Environmentalists want to discontinue fracking nationwide, but doing so will mean eliminating a vital component in renewable energy production. **GB**



Necessary evil? Silver Peak in Nevada, the nation's only active lithium mine, may have competition soon. Geologists have found larger deposits in two other locales that will help meet most U.S. consumer demands. CREDIT: ISTOCK/SIMONKR

Study: Many in the Eastern U.S. Want to Downsize

Researchers looked at search patterns to find trends in what would-be homeowners are looking for in new homes.

Eight Eastern states and the District of Columbia are among the top 10 in the nation where homeowners want to downsize, according to a study by a builder of ultra-small or tiny homes. The report by

Clever Tiny Homes analyzed Google search data for terms such as “downsize house,” “tiny home” and “small houses” and measured this against each state’s population to determine which ones had the most searches per 100,000 people.

Tennessee topped the list, with an average monthly search total of 283.36, followed by North Carolina (279.22) and South Carolina (272.02), according to the data. The only non-Eastern state in the top 10 was Oklahoma, which finished ninth (238.64).

Rank	State	State population	Average monthly searches for small homes and downsizing	Average monthly searches per 100,000 people
1	TN	7,051,339	19,981	283.36
2	NC	10,698,973	29,874	279.22
3	SC	5,282,634	14,370	272.02
4	AL	5,074,296	13,700	269.99
5	AR	3,045,637	8,158	267.84
6	GA	10,912,876	28,923	265.04
7	WA	7,785,786	20,050	257.52
8	ME	1,385,340	3,507	253.13
9	OK	4,019,800	10,045	249.89
10	VT	647,064	1,544	238.64

SOURCE: CLEVER TINY HOMES

volatility is making moving into a smaller home a more lucrative idea. “A lot of people don’t realize they can get by with a smaller space, and doing so may allow them to move to a better location entirely as well,” Palley notes. “[As] the idea of downsizing and tiny homes grows, it’ll be interesting to see how and if this top 10 list changes and how this might affect the housing markets in each state.” **GB**

University of Arizona wins 2024 Solar Decathlon Design Challenge

The school's collaboration with Native Americans signals the arrival of clean energy to the Hopi Tribe.

The University of Arizona (U of AZ) in Tucson, Arizona is the Grand Winner of the U.S. Department of Energy (DOE)'s 2024 Solar Decathlon Design Challenge for its partnership with the Hopi Tribe on 24 eco-friendly rowhouses that integrate passive design techniques and a microgrid to promote energy sovereignty for the community.

According to Mandy Mahoney, director of the DOE's Building Technologies Office, the Solar Decathlon challenges the next generation of building professionals to design high-performance, low-carbon buildings powered by renewable energy, promoting student innovation, STEM education, and workforce development opportunities in the buildings industry. The Solar Decathlon's Design Challenge is a one- to two-semester, design-only competition. More than 250 students from 40 finalist teams participated in the 2024 event.

"For 22 years, the Solar Decathlon has been preparing students to lead the clean energy transition," Mahoney says. "I was inspired by this year's teams and their inclusive vision for the spaces in which we live, learn, work and play, including transformative designs for affordable housing and vulnerable communities. The real-world learning experience these students gained from the competition will benefit them for years to come as they transition into the building workforce." U of AZ's Grand Winner project also won the Attached Housing Division. The project addresses an acute housing need on the Hopi reservation, and helps the tribe in its transition to 100 percent clean energy, according to DOE. Second place went to Oklahoma State University–Stillwater, Oklahoma.

U of AZ also finished second in the Multifamily Building Division behind the Indian Institute of Technology Bombay in Mumbai, India.

In other categories, the Georgia Institute of Technology won the Single-Family Housing Division. The joint team of the University of British Columbia Okanagan–Kelowna, British Columbia, and Thompson Rivers University–Kamloops, B.C., placed second. Southeast University and Tibet University received top honors in the Education Building Division, followed by the University of Oregon in Eugene, Oregon.

The awards ceremony, held April 19-21 at the National Renewable Energy Laboratory (NREL) in Golden, Colorado, can be [rewatched online](#).

Since 2002, more than 40,000 students worldwide have participated in the Solar Decathlon's 10 contests. Many of them have moved on to become leading architects, engineers, and other professionals in the



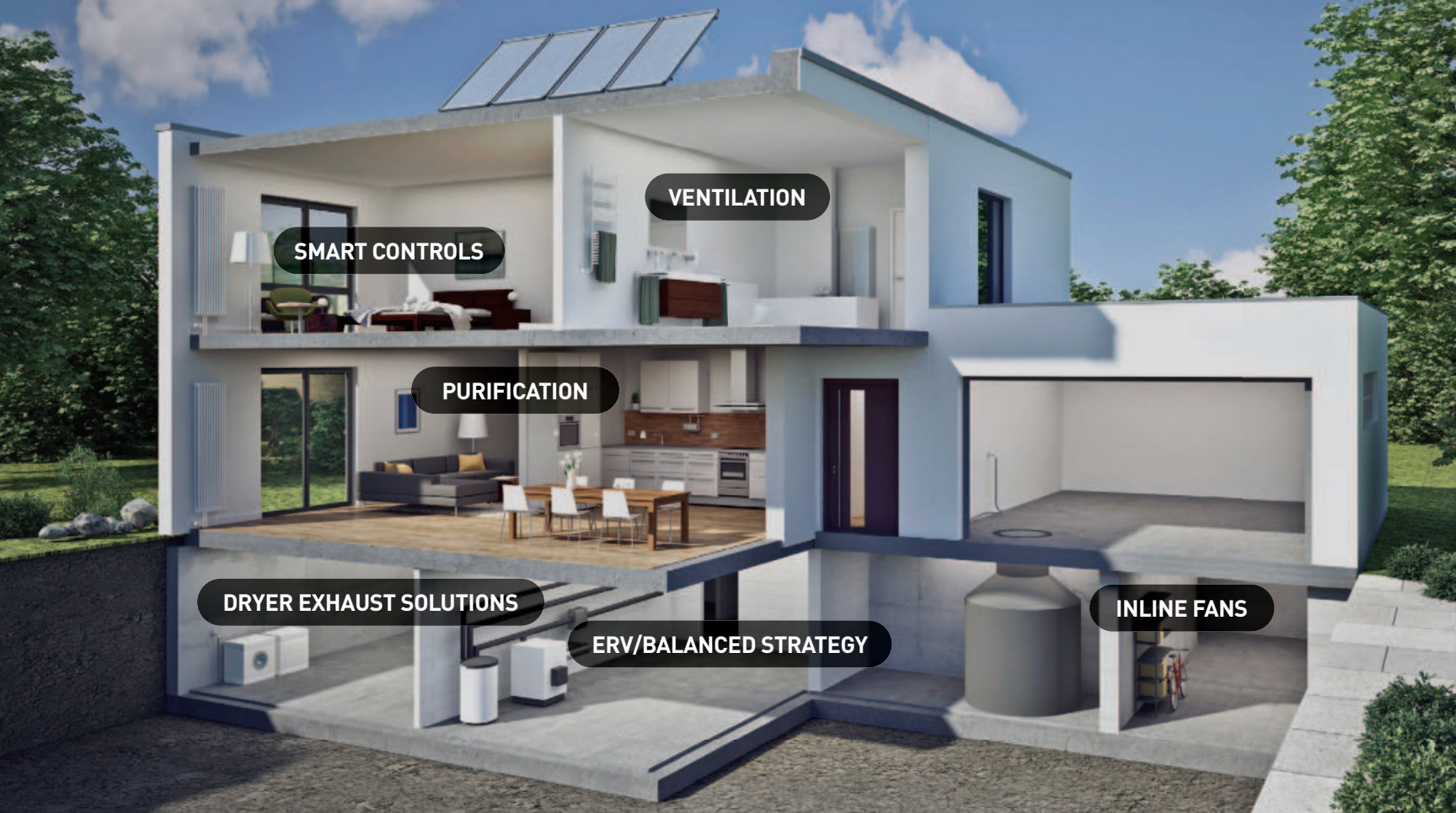
Smiling champions. The University of Arizona's DOE Solar Decathlon Design Challenge team was the competition's Grand Winner for a housing project to aid the Hopi Tribe in its conversion to clean energy. CREDIT: U.S. DEPARTMENT OF ENERGY



A beneficial partnership. The Hopi Tribe is working with the University of Arizona on eco-friendly rowhouses that integrate passive design techniques and a microgrid to promote energy sovereignty for the community. CREDIT: ISTOCK/GRANDRIVER

buildings industry. Applications for the Solar Decathlon 2025 Design Challenge will open this summer; additional details may be found on the [Solar Decathlon website](#). **GB**

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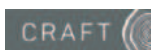
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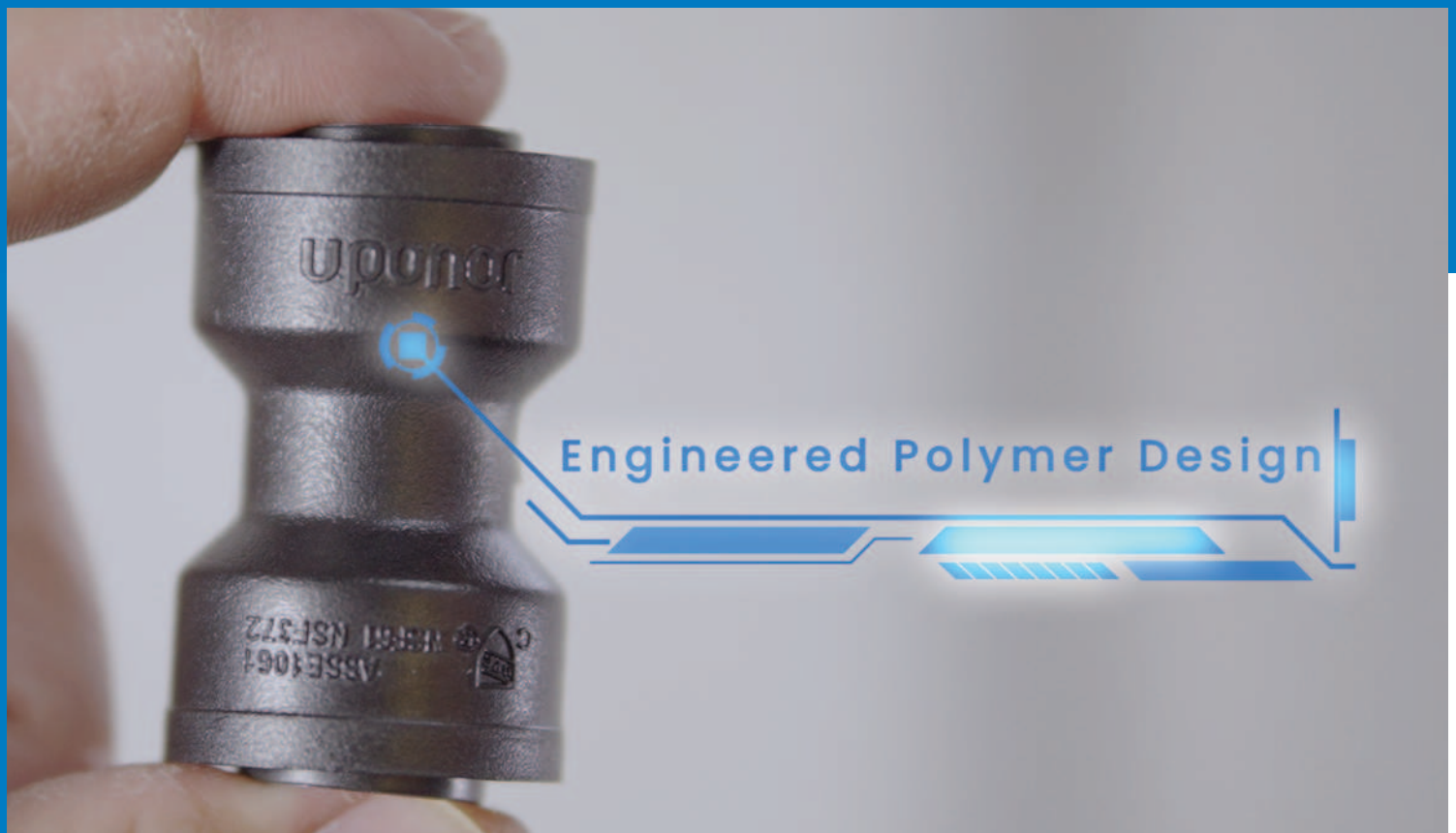
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WORLD CHANGERS

TECHNOLOGY HAS ADVANCED A LOT OVER THE PAST 100 YEARS. THAT'S NOTHING COMPARED TO **WHAT LIES AHEAD.**

BY ALAN NADITZ

Civilization and technology are eternal dance partners—they rely on each other to thrive. The earliest technology, in the form of crude tools and the invention of fire, helped hominids evolve into Cro-Magnon man, which eventually became modern-day humans. Meanwhile, the need to grow as a species led to creation of better tools, weapons, medicines and language skills.

For example, the past century saw the arrival of the airplane. That invention allowed people to more-easily acquire parts and resources needed to make bigger and better planes, and it led to scientific breakthroughs such as a cure for Polio, perfected organ replacement, and design of rockets that ultimately went to the moon.

Construction has advanced as well. Clay and rope gave way to hammers and nails, which have since become concrete and drills. Fuel-based energy became wind- or water-generated power, which now is headed toward solar as a super-clean energy source.

So where do we head now in the 21st century? If you're an optimist, we fly even higher. Air power can be made more cleanly, solar energy harnessed more efficiently and new forms of environmentally friendly products introduced.

Green Builder has rounded up a set of products and projects designed to move society forward over the next decade or so. In return, society will continue to develop technology that carry it even further into the century, and perhaps beyond.

Let the dance continue.

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WORLD CHANGERS

Not-so-golden state. Particulate matter generated by massive wildfires in the Western U.S. made it unsafe to breathe air outside or inside the home. CREDIT: ISTOCK/JASONDOY



Clearing the Air

POLLUTION—INDOORS AND OUT—IS A HUGE PROBLEM FOR HOMEOWNERS. HERE ARE NEW WAYS TO COMBAT IT.

When smoke fills the air, one of the first things people are told is to stay inside because it's a health hazard to remain outdoors. That warning has become commonplace over the past few years, when more than 237,000 wildfires resulted in 37.5 million acres burned across the United States from 2020-2023, according to data from the National Interagency Fire Center (NIFC) and the NOAA National Centers for Environmental Information. In addition, nearly 1 in 7 Americans experienced dangerous air quality from wildfires in 2023, according to NPR.

Those totals appear even more grim when combined with the findings of a [report by the University of Washington](#), which determined that indoor air quality can be four times worse on fire days than non-fire ones.

That, in turn, increases the chance of health hazards ranging from eye irritation, persistent coughing and aggravated asthma, to deadlier events such as heart failure, lung disease, and even dementia, according to a [study by the University of Michigan](#).

Considering that people spend about 87 percent of their time indoors, improving air quality should be a priority, according to Yuming Guo, professor of global environmental health and biostatistics at Monash University in Melbourne, Australia. In recent years the school has conducted several studies of its own regarding global air quality.

According to Guo, the culprits are PM2.5, microscopic particles which at 2.5 micrometers are about 5 percent the width of a human hair. They are capable of bypassing a person's respiratory system defenses, enter the bloodstream and travel to vital organs. They can also seep through closed doors and shuttered windows and contaminate indoor air.

Simply closing up a house during a smoke-heavy day will reduce indoor PM2.5s by about one-third, according to Allen Goldstein, a professor at the University of California at Berkeley's Department of Environmental Science, Policy and Management. Moderate efforts such as indoor air filters can cut the number of remaining PM2.5s by 50 percent. More-sophisticated products such as air purifiers, whole-home ventilators and intelligent air monitors help keep indoor



Clean air adjuster. If the number of unsafe indoor air particles increases due to outside pollution, Broan-NuTone's *BNAP-100* air purifier can compensate automatically and keep the breathing environment beneficial. CREDIT: PHOTO COURTESY OF BROAN-NU-TONE

air quality (IAQ) far closer to outdoor, non-smoke day levels.

Various outside factors, such as a home's age, the distance of a wildfire, direction and speed of air current, and even location of filtration systems within a house will impact how effective air purifying efforts are—as is education of the public on how to properly use the devices. “When people have information about the smoke coming their way, they can act to protect themselves and do it effectively,” Goldstein notes.

Charles Stanier, a professor of chemical and biochemical engineering at the University of Iowa who specializes in air pollution studies, agrees. “Think of smoke waves like heat waves,” Stanier notes. “They’re easier to face if you’re prepared and know they’re coming.”

CLEANUP EFFORTS

What if an IAQ unit could compensate for the amount of particulate

inside a home?

Broan-NuTone has developed an air purifier to that effect. The single-room Broan-NuTone Air Purifier (*BNAP-100*)’s advanced auto-sensing technology automatically detects total volatile organic compounds (TVOCs) and particulates the size of respiratory droplets, dust and pollen. It automatically and quickly increases the fan’s speed to remove detected particles and VOCs.

When the air is clean, *BNAP-100* automatically reduces back to regular maintenance speed, ensuring clean air without sacrificing energy efficiency. The air purifier’s settings can be adjusted with *Alexa*- or *Google*-based devices.

A bonus: While some air filtration units on the market emit low levels of ozone—a chemical that can cause respiratory damage at a cellular level—the *BNAP-100* is third-party certified to emit zero ozone.

The *BNAP-100* also provides homeowners with a Clear Air Delivery Rating (CADR) of 153 for tobacco smoke, 171 for dust and 175 for pollen. (Competitor model CADRs are typically in the low- to



Solid foundation. A new production facility launched by Fortera will increase availability of its *ReAct* sustainable cement product to the construction industry. CREDIT: COURTESY OF FORTERA

mid-2000s.) The unit includes a replaceable 3-in-1 filter (prefilter, activated charcoal and True HEPA), one that is automatically treated by built-in ultraviolet (UV) light.

Meanwhile, a California company has a product that helps with outdoor pollution caused by one of a home's key components. Fortera's *ReAct* cement is a sustainable alternative to the traditional variety, which is responsible for about 8 percent of the world's carbon emissions, according to CEO Ryan Gilliam.

"Basic" cement, derived from limestone, is heated in a kiln, where it decomposes (a.k.a. calcinates) and creates nearly equal parts of calcium oxide (lime) and carbon dioxide (CO_2). *ReCarb* captures the CO_2 and mineralizes it, creating a new form of cement that has 70 percent lower carbon emissions on a ton-for-ton basis. The mineralized CO_2 is permanently removed from the atmosphere.

The *ReCarb* process also lays the groundwork for zero-carbon cement through the use of renewable energy. *ReCarb* is already less energy-intensive due to a lower kiln temperature (1,650 degrees

Fahrenheit vs. 2,500 degrees F), which opens a path to electrification. Fortera's technology is synergistic with all green energy developments happening in this space—including electric kilns (which the company has patented), green energy or green fuel integration, and thermal batteries, Gilliam notes.

"Realizing zero-carbon cement is critical for our continued infrastructure and the health of our planet," Gilliam says. "We recognize this is one step in a much larger effort to reach commercialization globally, and we are committed to scaling our technology using existing infrastructure to mobilize widespread adoption of low and zero-carbon cement."

ReAct can be quickly and efficiently created while traditional cement is developed at existing production facilities, which provides environmental and financial benefits. In April, Fortera opened its first green cement and carbon mineralization facility in North America—next to a cement plant owned by CalPortland in Redding, Calif. More than 6,600 tons of CO_2 and 15,000 tons of low-carbon *ReAct* cement will be produced annually. **GB**

WORLD CHANGERS



Charging Ahead

Mighty energy influencer. For more than 150 years, rechargeable batteries have been a convenient source of energy for numerous devices. They are expected to become even more indispensable as public demand increases and they become more powerful and safer.

CREDIT: CLEMSON UNIVERSITY DEPARTMENT OF PHYSICS AND ASTRONOMY

RECHARGEABLE BATTERIES ARE ABOUT TO GET MORE POWERFUL AND SAFER—COURTESY OF MOTHER NATURE.

Where would we be without the rechargeable battery? Invented in 1859 in a very crude form by French physicist Gaston Planté—about 30 years after the first electricity generator, four decades before the launch of the electrical grid in the U.S., and nearly 90 years before the standard, finger-sized cylindrical battery of today—rechargeables are now indispensable. Imagine not having them available when using typical conveniences such as smart phones, laptops, cameras, battery-driven power tools, portable razors, or even electric cars.

It's a necessity that people are embracing in growing numbers. The global rechargeable battery market is expected to grow from \$110 billion in 2022 to \$196 billion by 2032, according to a report by Precedence Research.

Advancements in charging capacity, longevity, greater research inter-

est by world governments—particularly China, India and the United States (in that order)—and a growing demand for clean energy are expected to drive the market even further, Precedence Research notes.

“The market for rechargeable batteries has been growing rapidly due to the increasing demand for portable electronic devices and the need for sustainable energy storage solutions,” the report notes. “The use of rechargeable batteries also helps to reduce waste and the environmental impact of disposable batteries.”

Rechargeable batteries, especially the most common variety, lithium-ion (Li-ion), have their drawbacks. They're more expensive (at least initially), they require rare and valuable materials such as lithium, cobalt, and nickel to produce, and they are harder to dispose of once they finally burn out after hundreds, if not thousands of charges. And as they age, rechargeables can become weak and unpredictable, and extremely dangerous.



Hot spot. Lithium-ion batteries can catch fire or explode, posing a safety hazard. A new, self-extinguishing type can eliminate that threat.

CREDIT: ISTOCK/WEERAPATKIATDUMRONG

According to a report in *New Atlas*, the lithium battery has been an enormous leap forward. But “when they drop their guts, they can do so in absolutely spectacular destructive fashion.”

The culprit is thermal runaway, a situation where the electrical current flowing through the battery cell on charge or overcharge causes the cell temperature to rise, which increases the current with a further rise in temperature. The battery ultimately leaks, and its primary component, electrolyte fluid, can spontaneously combust.

Li-ion-related fires are rare. Nationwide, there have been 445 lithium-

Taking the lead. Clemson University physics professor Apparao Rao, right, is part of the research team that has developed a rechargeable battery that can extinguish itself if a fire occurs.

CREDIT: CLEMSON UNIVERSITY DEPARTMENT OF PHYSICS AND ASTRONOMY

ion battery fires, 214 injuries and 38 deaths since 2022, according to UL Solutions. About half of the fires were in New York City.

Researchers from Clemson University in South Carolina and Hunan University in China hope to make those totals even smaller. The combined team has created a new type of rechargeable—and non-flammable—potassium-ion battery using components found in a basic fire extinguisher: *3M's Novec 7300* non-flammable heat transfer fluid, and a refrigerant, *Daikin-T5216*.

“We wanted to develop an electrolyte that was nonflammable, would readily transfer heat away from the battery pack, could function over a wide temperature range, was very durable, and would be compatible with any battery chemistry,” explains Apparao Rao, a Clemson physics professor and the project’s lead researcher. “However, most known nonflammable organic solvents contain fluorine and phosphorus, which are expensive and can have harmful effects on the environment.”

Combining *Novec 7300*, *Daikin-T5216*, and several other chemicals



A fine idea. Lignin from pine and spruce trees provides a renewable alternative to graphite-dependent batteries. It is refined into a fine carbon powder, which is then pressed into electrode sheets for use in new rechargeables. CREDIT: COURTESY OF STORA ENSO

resulted in an electrolyte that enables a battery to charge and discharge over a full year without losing significant capacity. More importantly, the electrolyte adjusts a battery's internal heat during a fire that effectively extinguishes it.

The technology should be compatible with standard Li-ions, Rao notes. It is cheaper to make due to the greater availability of its primary element, potassium. Its reduced-flammability also gives it the potential to provide backup for stationary energy storage, such as the power grid.

GOODBYE TO GRAPHITE

The growing popularity of Li-ion rechargeable batteries poses an environmental problem: scarcity of its primary product, graphite. This is especially problematic for electric vehicles (EVs), sales of which have increased by 25 percent annually in 2022 and 2023, bringing the overall total to 40 million worldwide, according to the International Energy Agency (IEA)'s [Global EV Outlook](#).

Combine that sales pace with the fact that graphite makes up 54 percent of mineral demand in a Li-ion battery, and you have a serious problem, according to Otto Kivi, senior battery materials business development specialist at Finland-based renewable products manufacturer [Stora Enso](#).

The company's flagship battery product, [Lignode](#), replaces Li-ion graphite with [lignin](#), a by-product in the production of cellulose fiber and the world's largest renewable source of carbon, according to Kivi. Stora Enso used to simply burn the waste material for heat and energy; now it takes lignin from pine and spruce trees and refines it into a fine carbon powder, which is then pressed into electrode sheets. Lignin-based carbon

can be used in batteries—especially those for consumer electronics and the automotive industry—and in large-scale energy storage systems.

"For the automotive industry, investing in this fossil-free and renewable alternative could mean a significant marketing advantage and a feasible answer to new environmental policies driven by climate change and the need for green energy," Kivi notes.

The firm is partnering with Swedish company Northvolt and plans to begin manufacturing batteries with [Lignode](#) as early as 2025, Stora Enso notes.

NATURAL SELECTION

Not to be ignored, Tokyo-based [PJP Eye LTD](#) has its own alternative rechargeable battery with homegrown roots—almost literally. The company's *Power Bank* battery and its Cambrian technology is marketed as a way to solve the biggest negative to Li-ion batteries: They're not environmentally friendly.

Instead of rare earth metals like cobalt, nickel, manganese and graphite, *Power Bank* uses organic material, such as cotton, sugar cane and olive oil, and combines it with "more-abundant metals"—the company won't say which ones because it's a "secret recipe"—in the battery's respective negative and positive electrodes.

The result, a single-carbon battery, is a portable unit that charges eight times faster than conventional batteries, retains 84 percent of its charging capability after 8,000 cycles (about double the number vs. a basic Li-ion), and has no risk of bursting or exploding, even if it is overcharged, overheated, or short-circuited, according to the company. **GB**

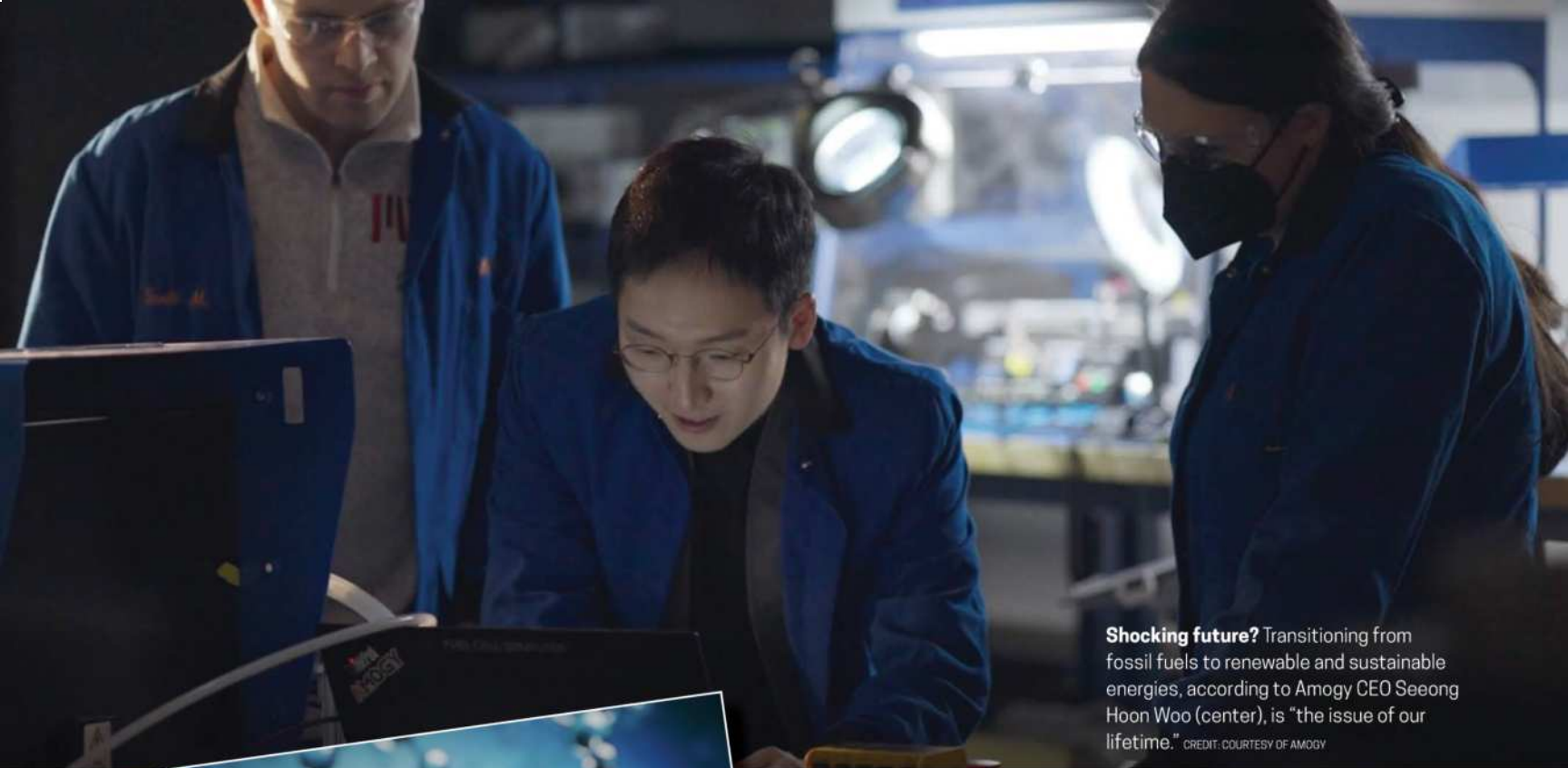


Changing of the guard. With a few scientific tweaks, green hydrogen, produced using renewable electricity, can be converted to green ammonia, a more-efficient and environmentally safer gas for heat generation. CREDIT: COURTESY OF AMOGY

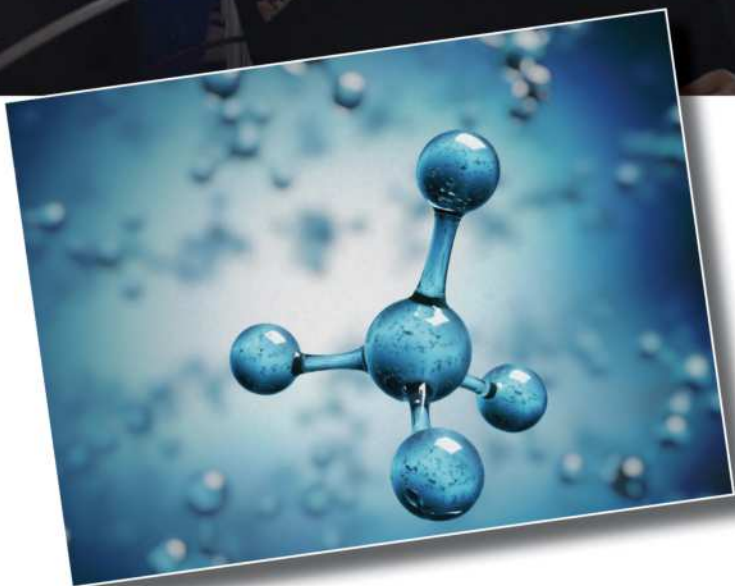
Powering Up

‘THE HYDROGEN ECONOMY’ IS STARTING TO WANE AS CLEANER ENERGY SOURCES CATCH THE PUBLIC EYE.

When people think about fossil fuel alternatives, ammonia is not one of the things that first comes to mind. The product is better known as a part of a household cleaner, or as a fertilizer. But with the public clamoring for cleaner ways of providing energy, researchers and businesses are taking a long, hard look at “the other natural gas.”



Shocking future? Transitioning from fossil fuels to renewable and sustainable energies, according to Amogy CEO Seeong Hoon Woo (center), is “the issue of our lifetime.” CREDIT: COURTESY OF AMOGY



A perfect pair. The key to making ammonia a beneficial energy source is to break or “crack” it into nitrogen and hydrogen.

CREDIT: ISTOCK/VCHAL

Hydrogen has long been viewed as one of the key role players in greenhouse gas reduction. According to a study by carbon-free energy solutions provider **Amogy**, more than 1,000 large-scale hydrogen projects worldwide have been announced, amounting to a \$320 billion investment. By 2050, hydrogen could contribute to a 20 percent reduction in global emissions. The potential of this powerful—and plentiful—element is impossible to ignore, according to Amogy Senior R&D Strategy Analyst Poornima Natarajan.

But despite being one of the world’s cleanest-burning energy solutions, “The Hydrogen Economy” is being held back by availability. Generating hydrogen in a pure form requires separating it from other elements such as oxygen or nitrogen. It’s an energy-intensive and sometimes emission-heavy effort, too. Storing pure hydrogen is expensive and requires a lot of energy to pressurize or refrigerate. It’s also highly flammable, colorless, odorless, and near-invisible when burning, making it difficult to detect in the event of a leak or fire, Natarajan notes.

In contrast, ammonia has 2.7 times the energy density of compressed hydrogen, can be easily stored as a liquid, and requires significantly less energy to store and transport safely. Ammonia is also the world’s second-most-produced chemical and it is also far less flammable than hydrogen. In the event of a leak, ammonia is much easier to detect thanks to its strong and distinctive odor.

“Ammonia is an easy way to transport hydrogen over long distances, and its widespread use in agriculture means there is already an established infrastructure for producing and moving it,” notes Matteo Bertagni, a postdoctoral researcher at Princeton’s High Meadows Environmental Institute. “You could therefore create hydrogen in a resource-rich area, transform it into ammonia, and then transport it anywhere it’s needed around the globe.”

According to Young Suk Jo, Amogy’s chief technology officer and co-founder, the key to using ammonia—especially in high-demand areas such as transportation—is to pull it apart. A company-developed chemical reactor—a “cracker”—breaks ammonia down into nitrogen,



CO₂ dome. Energy Dome's innovative power plant turns carbon dioxide into an emissions-free energy source that can power thousands of homes.

CREDIT: COURTESY OF ALLIANT ENERGY

which can be safely released into the atmosphere, and hydrogen. That hydrogen can then be used in a fuel cell to produce electricity.

"We believe that introducing a clean energy source for the hard-to-abate sectors is not only needed but is also urgent," notes Amogy CEO Seeong Hoon Woo. "With our planet's natural ecosystems, biodiversity, climate stability, and air quality at stake, we envision a cleaner, sustainable future with ammonia at the source."

Amogy has focused its ammonia-to-energy effort primarily on maritime applications. But in April, the company entered a partnership with Norwegian electricity-driven heavy builder products maker Terox to begin generating electricity at construction sites. "This [marks] a significant step towards sustainable energy solutions in the construction industry," says Kjell Vidar Hamre, managing director at Terox. "We are looking forward to showcasing the viability of ammonia-based power systems and contributing to the decarbonization of the construction industry."

ENVIRONMENTAL "BAD GUY" MAKES GOOD

Ammonia is not the only gaseous element being put to new use. Milan, Italy-based Energy Dome has constructed a pilot energy storage plant in Ottana, Sardinia that uses carbon dioxide (CO₂) to help supply the local energy grid.

Put simply, excess electricity from nearby solar and wind power farms is used to compress CO₂ into liquid, which is then stored in carbon-steel

tanks. When power is needed, the liquid is run through an evaporator and turned back into a pressurized gas. The gas is sent through an expansion turbine, where it rapidly expands to drive an energy-generating rotor. Some of the power generated during this process goes back to the outside grid.

The uncompressed CO₂ is then stored in a flexible, inflatable "energy dome" at ambient temperature and pressure for later re-use.

In effect, it's a self-perpetuating giant battery that generates clean energy in part by using climate change-inducing CO₂. There are no emissions into the atmosphere, the dome's key components—steel, water and CO₂—are easily available, and overall costs are low. Multiple energy dome plants worldwide would be possible, according to company CEO Claudio Spadacini.

"We have a simple yet powerful mission in mind: we want to help start decarbonizing the world today because our world can't wait," he notes. "How many companies can say they have the technology to change the world today? We can, and we want to do it for our future and the future of our children."

The company is now building a commercial-scale dome in Portage, Wisc., that can hold more than 40 times as much CO₂-derived energy vs. the adjacent pilot model. The 200 megawatt-hour plant, which on its own is capable of supplying power to about 20,000 homes for 10 hours, is expected to be fully operational by 2026. **GB**

WORLD CHANGERS



Dual purpose. Next2Sun and iSun's vertical solar panel system can act as property fencing as well as a provider of clean energy.

CREDIT: NEXT2SUN

Follow the Sun

AS SOLAR ENERGY TECHNOLOGY EVOLVES, SO DOES THE WAY IT BENEFITS THE POPULATION .

Of all the forms of clean energy, solar has always had the highest profile. From the 7th century B.C., when a crude magnifying glass was used to concentrate the sun's rays to make fire, to the present day, when photovoltaic cells collect and store solar energy to power just about anything, the bright yellow star in the daytime sky has reigned supreme.

One might say solar power is in a golden age. Numerous studies show a growing demand by the public to harness the

sun's free power for electrical grids. Products are being invented and then upgraded to collect the energy for ever-longer use. Farmers are using solar power to make crop harvesting a 24-hour, all-year affair. Builders routinely include solar power in new homes, which makes an attractive (and often, expected) selling point.

There are solar energy-driven devices that are larger than cars and as small as a human thumb. And they're increasingly affordable (for better or worse): According to a report in *Forbes*, in the past 10 years,



Always in the light. SolarisFloat's *Proteus* solar farm uses light sensors and dual axis tracking to precisely gauge the elevation of the sun's path as it moves from east to west. CREDIT: COURTESY OF SOLARISFLOAT

the cost per kilowatt of solar energy has decreased from nearly \$2 to about 34 cents; a solar roofing system that cost about \$50,000 to install in 2014 might now cost about \$35,000.

By all accounts, the solar power industry looks set for years to come. The need for clean energy isn't going away. The sun isn't burning out anytime soon. New generations of products are becoming more efficient every year.

But there is still one challenge: competition. As with any market, there is a need to stand out from the crowd. Or, to paraphrase a classic sci-fi show: Go where others haven't gone before.

Not surprisingly, there are companies that are literally doing just that.

ONE PLACE TO GO: FLOATING SOLAR FARMS

Floating solar panel technology is not new—although rare, photovoltaic “farms” on the surface of lakes, hydropower reservoirs, agriculture reservoirs, industrial ponds and near-coastal areas have been an eye-catching sight since its arrival in 2007. It's one that people will become even more accustomed to: Floating solar capacity has grown exponentially in the past decade, from 72 gigawatts (GW) in 2011 to 843 GW in 2021, according to a BBC report. Meanwhile, the worldwide floating solar market is expected to grow by about 43 percent from 2023 to 2031, topping 23.5 billion, the report adds.

“Floating solar is a rather new renewable energy option, but it has huge potential globally,” notes Thomas Reindl, deputy chief executive of the Solar Energy Research Institute of Singapore (SERIS), in a report from BBC Future Planet. “Covering just 10 percent of all man-made

reservoirs in the world with floating solar would result in an installed capacity of 20 terawatts (TW)—20 times more than the global solar photovoltaic capacity today.”

There are numerous advantages to floating solar, such as an absence of land acquisition and site preparation issues associated with traditional solar installations. Floating solar also allows for power generation to be sited closer to areas where demand for electricity is high, such as in countries with high population density and limited available land.

A floating solar farm can complement existing hydropower infrastructure. At a large hydropower plant, only 3-4 percent of the reservoir would need to be covered with floating solar panels to double the electricity generation capacity of the dam, according to a study by The World Bank. And, placement over water helps keep the panels cool, reducing the loss of efficiency caused when they heat up from constant use.

But traditional floating solar farms, just like their land- or roof-bound cousins, have a disadvantage: They function at their peak when they're facing the sun. Efficiency can drop by as much as 60 percent during other times of the day, according to a report by CleanTechnica.

Duke Energy is testing one solution. As part of its Vision Florida program, the company's Florida division has developed a 1-megawatt (MW) array made up of more than 1,800 bifacial solar panels. These can generate 10-20 percent more electricity than traditional farms because they capture sunlight on both sides. “We're shaping the energy future with cleaner, smarter solutions that our customers value,” says Melissa Seixas, Duke Energy Florida president. “That means looking



Sizeable benefits. Floating solar farms, such as Duke Energy's test product, can be far more productive than landlocked versions. But sometimes, they need to be quite large, covering an entire pond.

CREDIT: COURTESY OF DUKE ENERGY

for ways to manage costs while making strategic investments to expand renewables and cut emissions without compromising reliability.”

Going a step further, there's Portugal-based [SolarisFloat](#) and its pilot project, *Proteus* (a.k.a., PROTEVS), a floating photovoltaic system designed to follow the sun throughout the day. *Proteus* uses mechanical, geospatial and light sensors, dual axis tracking and electric motors to precisely gauge the elevation of the sun's path as it moves from east to west. Because of constant alignment, the amount of energy generated by the system's 180 solar panels can be up to 40 percent more than stationary systems, according to the company.

Although systems such as *Proteus* can be installed in numerous locations, they must be chosen carefully to avoid tidal forces and stormy weather from destroying the panels, as well as their mooring and anchoring systems. Sun tracking systems will also not make much difference at locations near the equator, where the panels are installed almost horizontal and face the sun most of the day, Reindl says.

Proteus panels can be detached, which means they can be merged with other units to form a larger floating solar farm. The company also touts the system's beneficial effects on the bodies of water where they are located: The shadows formed by the floating structure and solar panels reduce the temperature of the water beneath the array, and there is a 60 percent reduction of evaporation in the body of water below.

The company also says water quality is improved due to a reduction of algae and other micro-organisms because of that shadowing. This reduction can be further enhanced by the installation of oxygenating



Thinking thin. An upright solar panel also means a low profile when it comes to land required for installation and operation. CREDIT: NEXT2SUN

equipment on board the floating islands.

SolarisFloat is not alone in its pursuit of the sun. Similar systems have been developed by California-based [Noria Energy](#) (and its *AquaPhi* unit), Vermont-headquartered [Solaflect Energy](#) (and its self-named unit), and Israeli startup [Xfloat](#). All are reporting customer and financial success along the same lines as SolarisFloat.

It all sounds good. But so far, floating solar farms make up less than 2 percent of the world's solar installations, according to Michael Walls, a professor of photovoltaics at the Centre for Renewable Energy Systems Technology at Loughborough University in England. This is partly due to factors such as technical, mechanical and financial constraints, and concern over a farm's impact on other aquatic activities, such as swimming, boating or angling.



Two-sided success. While most solar panels point upward, Next2Sun's vertical panels collect sunlight from two directions, improving energy efficiency by almost 50 percent. CREDIT: NEXT2SUN

"[Companies are] making important progress toward more efficient solar arrays," CleanTechnica notes. "That increased efficiency makes the business case for solar energy more appealing by shortening the time needed to achieve a positive return on investment for residential and commercial solar customers alike."

STAND UP STRAIGHT

While a solar floating system points upward to obtain energy, a solar fence does its work while completely upright. Solar technology companies [Next2Sun](#) and [iSun](#) have collaborated on a vertical agrivoltaics system, a product that allows for solar development on farms without the conversion of agricultural land.

Next2Sun's bifacial vertical panels collect solar energy on two sides and take up 90 percent less land area than horizontal, south-facing panels. This vertical system is an opportunity for landowners who may want their land to serve multiple purposes, providing the potential

for additional income from solar energy generation, according to iSun CEO Jeffrey Peck.

"Thanks to the vertical mounting of the modules and the adaptability of the installation to the needs of the farmer, the valuable land is almost completely preserved for agriculture," Peck says.

While most solar panels collect the majority of energy at midday when the sun is high, the two-sided panels may collect energy in the mornings and evenings when solar generation is typically low, he notes.

Solar expansion is expected alongside the global goal of tripling renewable energy capacity in the coming years, so this method could provide a solution to land use conflicts between the agricultural and renewable energy sectors, he adds.

Next2Sun and iSun also offer a solar fence that uses the same concept as agrivoltaics, enabling use of the solar panels as a fence for livestock farming or residential use. **GB**

Wild Cards

THESE RADICAL IDEAS COULD LESSEN NEGATIVE IMPACTS OF INDUSTRY SOCIETY.

AN EMPOWERED PARASOL

Earth is on its way to increasing in temperature by more than 2 degrees Celsius by 2100 due to rising greenhouse gas (gHg) emissions. Scientists want to solve the problem by blocking the amount of sunlight that hits the planet. To do that, they would use a giant space umbrella as a sun shield while it orbits the world.

According to Dr. Yoram Rozen, director of the Asher Space Research Institute at the Technion-Israel Institute of Technology, the umbrella would have to block about 2 percent of the sun's radiation to cool the planet by 1.5 degrees Celsius, or 2.7 degrees Fahrenheit, keeping Earth within manageable climate boundaries. Scientists consider a temperature increase of more than 1.5 degrees C to be a point of no return environmentally, with all damage from that point becoming permanent.

But the umbrella's size is a literally a huge problem. The shield would have to measure about 1 million square miles—nearly the size of Argentina—and it would weigh 2.5 million tons, making it too heavy to launch into space. One solution could be to use a series of smaller umbrellas to cast shadows on different parts of Earth. "We can show the world, 'Look, there is a working solution. Take it and, increase it to the necessary size,'" Rozen told the *New York Times*.

Proponents say a sunshade would not eliminate the need to stop using fossil fuels. But it would buy the planet more time to continue gradually reducing their use. Many companies have set 2050 or sooner



Sails unfurled. To cool a rapidly warming Earth, scientists are considering placing a giant sunshade into space to block solar radiation.

CREDIT: TECHNION ISRAEL INSTITUTE OF TECHNOLOGY AND ASHER SPACE RESEARCH INSTITUTE



Grand metamorphosis. A newly developed bacteria is capable of converting environmentally hazardous methanol into a chemical that makes other climate-changing ones an Earth-friendlier carbon neutral.

CREDIT: ETH ZURICH/GABRIELA D'HONDT



Drink it up. Researchers at the University of California at Berkeley have developed a compact device that can pull H₂O molecules out of the atmosphere to create drinkable water.

CREDIT: UNIVERSITY OF CALIFORNIA AT BERKELEY

as a deadline for becoming net zero in terms of carbon emissions produced vs. reduced.

Critics say the plan would be too expensive, not technologically feasible at the moment, and could not be completed in time to do Earth any good. In addition, any damage to one of the shields due to space debris or solar storms could result in sudden rapid, disastrous planetary warming.

Rozen says he and his team will build a prototype of the umbrella as soon as they can raise the estimated \$10 million to \$20 million in funding needed. "This alone will not save the planet," he says. "But it's going to show that there are things we can do to prove it ultimately can be done."

METHANOL-FRIENDLY BACTERIA

The organic chemical compound methanol (CH_3OH)—a.k.a. "wood alcohol"—is in an unusual position when it comes to sustainability. Nature's simplest form of alcohol is a building block for hundreds of everyday materials, not all of which are earth-friendly (e.g., paints and plastics), and it's hazardous to life and the environment if granted long-term exposure. But it's also a clean energy alternative for fossil fuel-powered automobiles, trucks, fuel cells, boilers and stoves.

Now, researchers at ETH Zurich in Switzerland have developed a way to turn wood alcohol into a long-term environmental good guy. They have engineered a bacteria that feeds on CH_3OH and then becomes a clean way to produce items that are currently made using fossil fuels.

Each year roughly 500 million tons of crude oil, coal and other carbon-emitters are used to create plastics, dyes, artificial flavors and other environmentally hazardous products, according to Dr. Julia Vorholt, a professor at the Institute of Microbiology at ETH Zurich.

If that production total sounds bad, cheer up: The reality is far worse. "Since these chemical conversions are energy-intensive, the true carbon (CO_2) footprint of the chemical industry is even 6 to 10 times larger, amounting to about 5 percent of total emissions globally," she notes.

Ironically, the chemical that can slow atmospheric damage begins as part of one that causes it. CH_3OH is easily synthesized from CO_2 and water. The bacteria, known as methylotrophs, metabolizes methanol for several years before becoming a chemical that can convert carbon and other greenhouse gas (gHg)-related compounds into climate-neutral ones. These can then be used toward the production of those previously mentioned plastics, dyes and artificial flavorings (as well as other not-so-green items), in place of fossil fuels.

The result "allows renewable chemicals to be produced that do not burden the environment," says Michael Reiter, a postdoctoral researcher in Vorholt's research group.

Although the microbes provide a highly versatile "plug-and-play" option where the methylotrophs can convert CH_3OH into desired biochemical substances, research has only begun, according to Vorholt. The researchers still need to significantly increase the yield and productivity to enable economically viable use of the bacteria. A recently received innovation fund will help the team reach that goal, she notes.

A [white paper on the team's research](#) is available at nature.com.

EXTREME-WEATHER WATER

University of California at Berkeley researchers have designed a hand-held device that can extract and convert water molecules from the air into drinkable water using only ambient sunlight as its energy source. The unit can go a long way toward helping one-third of Earth's population survive in water-stressed regions, the university reports.

The atmospheric water harvester uses an ultra-porous material known as a metal-organic framework, MOF-303, to extract water repeatedly in even the hottest and driest places, such as Death Valley National Park. These tests showed the device could provide clean water anywhere, addressing an urgent problem as climate change exacerbates drought conditions, according to Omar Yaghi, the UC Berkeley chemistry professor who invented MOFs and is the project's lead researcher.

Almost 2.5 million people experience some type of water shortage during the year, according to the United Nations. That total may double by 2050, Yaghi notes. "This is quite relevant to harnessing a new source for water," he says.

While water harvesting technology is not new—researchers at MIT developed a harvester four years ago—UC Berkeley's model is smaller—it can fit in a handbag—and more portable. It functions efficiently in high humidity or in "dry" air. And it is powered entirely by ambient sunlight and doesn't require additional energy sources to operate—which also means no planet-warming emissions.

It generates drinking water from 85 to 90 percent of the atmospheric vapor it captures, resulting in up to 285 grams of water in a day—enough to fill a coffee cup. There's a lot for it to work with: The U.S. Geological Survey estimates that Earth's atmosphere contains nearly 4.7 million cubic feet of water—more than six times the volume of the world's rivers.

The device should be able to operate for five or six years without being replenished or modified, Yaghi notes. And at the end of its lifetime, the unit can be disassembled and reassembled in water with zero discharge and in a sustainable manner.

Of course, as time goes on, there will be additional developments in efficiency, size and scale. But Yaghi expects an eventual widespread adoption of household-based, MOF-powered water harvesters and community-scale water harvesters. **GB**

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Ordinary secrets. Although the structure is built with conventional materials, air sealing and insulation were meticulous, resulting in an extremely tight shell and “baseline” for performance. COURTESY OF PEARL CERTIFICATION



Thoughtful beauty. The Machuga house outperforms most others of its size and class, thanks to careful detailing, optimized HVAC and smart energy management. CREDIT: CUTRONA-DSCF



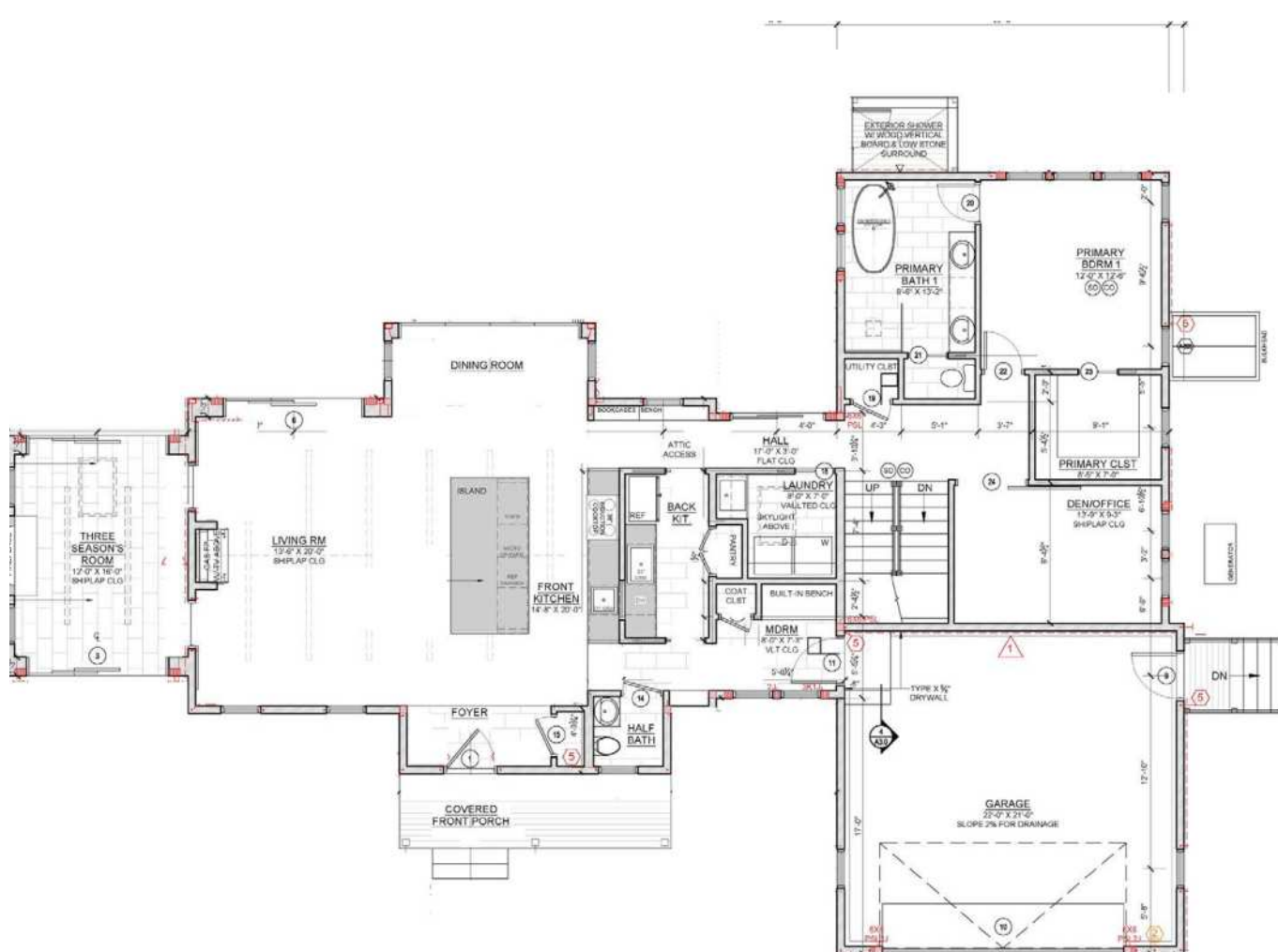
HIGH-PERFORMANCE HOME LABORATORY

MORE THAN JUST A COMFORTABLE HOME, THIS **PLATINUM-CERTIFIED** DWELLING IN MASSACHUSETTS WILL PUT RHEEM PRODUCTS TO THE TEST.

BY MATT POWER

There's no denying Alan Machuga's custom home is spacious, energy efficient and thoughtfully designed. But what the casual visitor may not realize is that the house, designed by [A3 Architects](#) and built by [Philbrook Construction Services Group, Inc.](#), has many layers of building science in its back story. In coming years, it will act as a real-world laboratory. That's not accidental.

Machuga says his decision to build a new home fell into perfect synergy with his position as chief technology officer and executive vice president of Rheem Manufacturing. Rheem is a well-established and respected brand, producing a wide range of heating, cooling, water heating, pool and spa heating, and commercial refrigeration products. Machuga's home is right on track with where he wants to take the company.



"I was thinking about the context of my new role, about what's happening in the market," he explains. "New home building standards are being introduced, and our products are becoming more enabled to integrate with smart grids and apps." Also coming on fast, he adds, are electrification and "greening" of buildings. "There's a big push toward all things green," he says, "from solar panels to heat pumps to electric vehicles."

Given this growing awareness, Machuga and his wife decided to make the construction of their home into a testing ground—a place to apply and monitor green products and principles.

And of course, [Rheem's portfolio of products](#) would play its part.

"The idea would be that I could take Rheem's products with me on that journey," Machuga says. "It would culminate in a home, but also in a lab where we could test different things in the future."

In other words, the house may not be "one and done," but rather a work in progress, he explains. It will be a place where products can be exchanged or updated in the future, and monitored for real time performance data.

A PEARL PARTNERSHIP

To raise the bar on the home's construction, Machuga partnered with [Pearl Certification](#), a company that takes a multi-pathway approach to ensuring that a building's systems work together to optimize energy efficiency. Pearl Certification also offers a consumer-facing [Green Door](#) app, which guides homeowners through steps to higher performance.

Another tool in Pearl's chest is "badges," which act as a seal

of approval for a specific aspect of the home. For instance, Pearl might award a Solar Badge, or an Electrified Home Badge, for "above and beyond" performance in those categories.

Casey Murphy, a senior vice president with Pearl, worked closely with Machuga on this home.

"When I first learned about the project, I was just trying to figure out, okay, what are they trying to accomplish?" Murphy recalls. "I figured it would have a lot of Rheem products, but I also figured that they would probably want to achieve our highest level, which is Pearl Platinum."

Murphy says the Machuga project took advantage of Pearl's expertise as an advisor on product selections and as a liaison to appraisers, helping them understand the probable return on investment (ROI) of products and systems.

"We fill out the appraisal institutes' forms and energy-efficiency addendum for every home," Machuga explains, "so that the appraiser can then take the home's high-performing features into consideration when forming their opinion of value."

As a result, he explains, appraisers can provide "a sort of a side-by-side comparison with a more typical conventional home, such as what the difference in performance would be. There's an art and a science to how appraisers take these things into consideration."

THE RHEEM CONNECTION

Machuga refers to his focus at Rheem as "digitization." The key, he says, is crossing the divide between mechanical and digital tools. As he discovered while planning this project, that often means

Certification Level



Platinum
1102 Pearl Points



Building Shell:
332 / 340 points



Heating and Cooling:
374 / 400 points



Baseload:
193 / 160 points



Home Management:
203 / 300 points

U.S. Homes Eligible for Pearl Certification Levels



This home was enrolled in HERS Index. Further details are provided in this report.

Top shelf. Machuga's house achieved Platinum certification, as shown in this Pearl analysis, with a big boost in the baseload category. What that means is that the home's overall energy demands were much lower than comparable structures. SOURCE: PEARL CERTIFICATION

Pilgrim Rd 12 -5dYo7IJ2

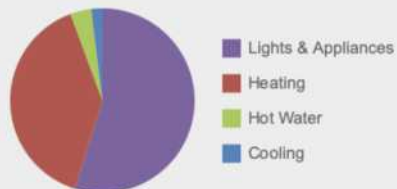
Year Built 2022	Sq. Footage 4,170 ft²
Number of Bedrooms 3	Primary Heating Fuel Natural Gas
Assessment Date December 15, 2022	Energy Specialist Paul Graney

Yearly Energy Use

Natural Gas
730 Therms

Yearly Energy Costs*

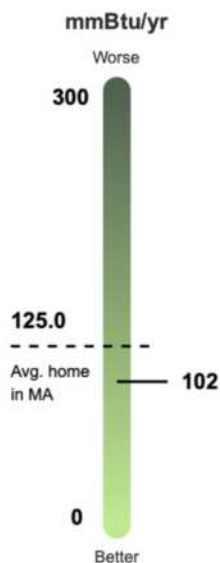
Total
\$1,210



Natural Gas: \$1.66/Therm

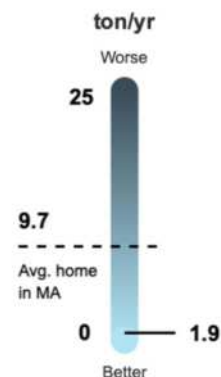
Home Energy Use

This shows the estimated total energy use (electricity and heating fuel) of your home for one year. The lower the energy use, the better.



Home Carbon Footprint

This shows the estimated annual carbon emissions associated with your home and is based on your home's estimated total annual energy use. The lower the score, the less carbon pollution is released into the atmosphere.



HERS® Index

-2

RESNET's HERS® Index assesses the energy efficiency of a home. A HERS-100 home is as energy efficient as a home built to 2006 code. A HERS-0 home uses zero net energy in a typical year. Learn more at [hersindex.com](https://www.hersindex.com)

*These are estimated costs. Actual energy costs may vary and are based on many factors such as occupant behavior, weather and utility rates.

Another angle. This chart compares the home's performance across all sizes. Despite it being more than 4,000 square feet, the Machuga home uses less energy annually than much smaller buildings. SOURCE: PEARL CERTIFICATION

HERS® Index Score:

-2

Your home's HERS score is a relative performance score. The lower the number, the more energy efficient the home. To learn more, visit www.hersindex.com

Annual Savings

\$6,293

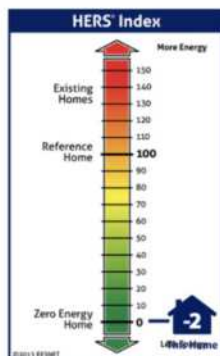
*Relative to an average U.S. home

Home:

Builder:
A3 Architects

Your Home's Estimated Energy Use:

	Use [MBtu]	Annual Cost
Heating	70.4	\$1,176
Cooling	0.9	\$58
Hot Water	1.8	\$110
Lights/Appliances	28.5	\$1,630
Service Charges		\$0
Generation (e.g. Solar)	59.8	-\$1,764
Total:	101.6	\$1,210



Home Feature Summary:

Home Type:	Single family detached
Model:	N/A
Community:	N/A
Conditioned Floor Area:	4,170 ft ²
Number of Bedrooms:	3
Primary Heating System:	Furnace • Natural Gas • 98.7 AFUE
Primary Cooling System:	Air Conditioner • Electric • 13 SEER
Primary Water Heating:	Residential Water Heater • Electric • 4 UEF
House Tightness:	1200 CFMS0 (1.54 ACH50)
Ventilation:	115 CFM, 115 CFM, 115 CFM • 101 Watts, 101 Watts, 101 Watts
Duct Leakage to Outside:	50 CFM @ 25Pa (2.5 / 100 ft ²)
Above Grade Walls:	R-23
Ceiling:	Vaulted Roof, R-46
Window Type:	U-Value: 0.3, SHGC: 0.27
Foundation Walls:	R-14
Framed Floor:	R-30

This home meets or exceeds the criteria of the following:

2015 International Energy Conservation Code
2012 International Energy Conservation Code
2009 International Energy Conservation Code
2006 International Energy Conservation Code

Rating Completed by:

Energy Rater: Paul Graney
RESNET ID: 2649950

Rating Company: Home Energy Raters LLC
180 State Rd, Suite 2U Sagamore Beach MA 02562
508-833-3100

Rating Provider: Energy Raters of Massachusetts
2 Woodlawn Street Amesbury, MA 01913
978-270-3911



Paul Graney

Paul Graney, Certified Energy Rater
Digitally signed: 12/15/22 at 4:26 PM



Energy savings calculated without modifications to the energy model. (As Modeled)

Ekotrope RATER - Version:3.2.4.hf.3037
The Energy Rating Disclosure for this home is available from the Approved Rating Provider.
This report does not constitute any warranty or guarantee.

taking a hybrid, as opposed to a singular approach.

Case in point: Machuga's house takes full advantage of heat pump technology, with three units installed, but also has three high-efficiency gas furnaces for deep winter. This might sound like HVAC overkill but, don't forget, Machuga is using the home as a hands-on laboratory. Some of what he'll be testing is how these different heating methods perform in the coldest part of the year. Can the cold-climate electric heat pumps handle the home's demand? How much assistance can they provide to the gas furnaces?

"We've actually added plumbing and electrical infrastructure to the house that will allow us to test both gas and electric products," Machuga notes. "As we introduce new products to the market, I'll be able to give them a field test and swap out products. I really want the house to serve as a field lab."

At the same time, Machuga will measure and monitor the home's indoor air quality, to learn how it's affected by different products and lifestyle choices.

"As we're thinking through our control strategy and our systems' digitization, we'll continue to connect the products, to evaluate the performance of the whole system—especially when it comes to indoor air quality," he says. "A lot of folks are targeting indoor air quality in commercial buildings, but residential buildings are still susceptible to the same kind of indoor conditions."



Temperature control. To take full advantage of Rheem's heat pump technology, Machuga's house has multiple units installed, along with high-efficiency gas furnaces for deep winter. CREDIT: ALAN MACHUGA

ECONET: AN EVOLVING LEVEL OF SMART CONTROL

If you've installed one of Rheem's popular *ProTerra* hybrid heat pump water heaters, you may be familiar with the [EcoNet app](#). Machuga says the scope and power of that app is expanding to manage all Rheem products.

Overview. Clerestory windows illuminate the main living room, with its modern open floorplan, high ceilings and walls of solar-oriented glass. CREDIT: CUTRONA-DSCF



Wall-mounted interface. The Rheem RETST700SYS EcoNet Smart Thermostat works with Rheem products in the home as an alternative to the smartphone app. COURTESY OF RHEEM MANUFACTURING

“EcoNet works right out of the box, but there’s a set of additional features we’re considering,” he says. “Right now, I can look at all the Rheem systems in the house, and that allows me to think through how they communicate with each other.”

He explains how the “smart” aspects of those controls might be enhanced. For example, water heaters may need to self-adjust to different levels of hot water storage depending on the family’s activities.

Cooking may cause a spike in air pollution that requires higher diffusion from ERVs. Reduced airflow sensed in a furnace might mean filters need replacement, or ducts need to be cleaned.

Living in the house already has him thinking about other ways smart sensing and control might be used.



Tight and bright. With spray foam in the walls and ceiling, and high-performance Andersen windows and doors, the home stays comfortable during cold Massachusetts evenings. CREDIT: CUTRONA-DSCF

Front facing. The spacious home fits in with the New England traditional aesthetic, yet has high-tech systems throughout, and above-and-beyond insulation and air sealing. CREDIT: CUTRONA-DSOF



“For example, I’ve got a smart [electrical] panel in the house,” Machuga explains. “This makes it easy to do some calculations about the energy usage for each product. But maybe we can make it even easier, where I don’t need to read them off the panel—feedback is sent [to the app] for a comprehensive view of my energy consumption in the house.”

A WELL-BUILT HOUSE AS BASELINE

Although Machuga’s focus now is on smart products and controls, the home’s construction details form the backbone of its future role as a laboratory. With a Home Energy Rating System (HERS) Index rating of minus 2, its spray foam, leak sealing, proper duct design, daylighting and other choices make the home efficient enough to respond to small tweaks from any of the HVAC systems.

Murphy at Pearl points out that projects such as this Platinum-certified house can shift the way homeowners think about energy efficiency. Too often, he says, high performance homes are not valued properly by appraisers or realtors. They underestimate how important this aspect is to long-term maintenance and resale value.

“People spend \$600 billion every year on home improvements,” Murphy says. “The vast majority of that is not spent because of tax credits or rebates. They know if they remodel the kitchen, they’re improving the value of the investment. But when it comes to energy efficiency, that’s completely ignored.

“We want to change that,” he says. “We want that ‘hidden’

value made visible at the time of sale.”

To that end, certification is one key tool, as part of a conversation that revolves around resilience and durability, Murphy adds.

“With this [Machuga] house, for example, you’ve got a bunch of interconnected products tied to the Rheem *EcoNet* app, so ultimately you have a home that is more resilient, more responsive to the grid,” he explains. “It can participate with the smart grid on the demand side.”

And, when you consider the solar array, “the house can actually monetize that connectivity,” Murphy adds. “It could act as a battery and be a good citizen of the grid.”

As for how Pearl and Machuga pushed the house to Platinum heights, Murphy says part of the credit goes to the people on the ground, and ongoing conversations. “They made sure they had the right contractors and pros on the job,” he recalls. “That’s essential. But also, when you’re working with a manufacturer, you know it has certain opinions about other companies. But that manufacturer still needs products to complete the house. So, it becomes a discussion of fiberglass insulation versus cellulose versus spray foam.”

Pearl can work with whatever products a builder or homeowner prefers, according to Murphy. “The group sometimes urges them to spend a little more to raise the bar,” he notes. “Ultimately, it’s the whole design that will make or break the home’s performance. In the case of this home, the proof is in the final certification numbers.” **GB**



ZERO ENERGY-READY LIVING TO THE MAINSTREAM

Building giant Beazer Homes develops high-performance homes nationwide. Now it plans to take its commitment to sustainability to a new level.

BY MICHELE LERNER

There's no turning back now—not that anyone from Beazer Homes wants to. The VISION House® Las Vegas: Crossing the Rubicon project, a collaboration between Beazer and Green Builder® Media, will raise the bar for all builders in terms of sustainability.

The VISION House Las Vegas, at the master planned community of Cadence in Henderson just outside of Las Vegas, will meet the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) requirements—as will all Beazer homes nationwide by the end of 2025.

“Beazer’s commitment to building energy efficient homes isn’t new,” says Kyle Tibbitts, division president for Beazer Homes in Las Vegas. “We’ve been committed to sustainability for more than a decade. We’re just expanding this to the next level.”

Beazer Homes, an early adopter of the EPA’s ENERGY STAR program, has been named as an Energy Star Partner of the Year every year for a decade, consistently earning the top honor of Sustained Excellence.

“Our CEO’s vision is that we don’t do what everyone else does,” Tibbitts says. “We go beyond the code and build quality, durable homes that are less costly to operate because of their construction. We want to be better than every other builder.”

ZERO ENERGY READY FOR THE FUTURE

DOE’s ZERH program requires homes to be Energy Star certified and *Indoor airPLUS* qualified, but it doesn’t stop there. To meet program requirements, each house must have increased energy efficiency, better indoor air quality, water

efficiency features and a renewable energy-ready design. The DOE estimates that homes built to this standard are 40 percent to 50 percent more efficient than a typical new home, according to Tibbitts.

“The Zero Energy Ready program makes sense because it builds on the EPA’s programs,” says Justin Anderson, Las Vegas-based director of operations for Beazer Homes. “It also resonates with the buying public, especially when we can educate people about the reduction in operating costs.”

Some of the steps Beazer takes to achieve Zero Energy Ready certification include using 2-by-6 exterior walls instead of 2-by-4s to allow for additional insulation, ERVs for better indoor air quality, moving mechanical units inside conditioned space, building with slab insulation and drastically reducing air infiltration. The Home Energy Rating System (HERS) Index rating for these homes is anticipated to be in the 30s, according to Beazer. In addition, every house must be ready for homeowners to add solar if they choose.

Beazer chose the Cadence community near Las Vegas to showcase its commitment to building homes to an elevated standard, and because of the high visibility of one of the top-selling master planned communities in the country, Tibbitts notes.

“Cadence has a high profile and it is known for its sustainability, with parks, outdoor trails and synergy within the community,” Tibbitts says. “There are also lots of other builders and new homes there, so it gets plenty of traffic from potential buyers.”



Preview of paradise. When finished, VISION House® Las Vegas will offer amenities similar to neighboring Cadence subdivisions. CREDIT: DESIGN WORKSHOP

Cadence offers a good platform for buyers to compare homes, says Jayne Bradley, Southern California-based director of marketing for Beazer Homes.

“Cadence has a good reputation, and we expect to see more discerning buyers there who understand the value of sustainable building,” Bradley says. “This is the last Cadence neighborhood to offer detached single-family homes, and it will be among the most energy efficient we build.”

Beazer’s Energy Series articulates the level of performance for all communities nationwide. Those built to the Zero Energy Ready requirements are part of Beazer’s READY series. At Cadence, each of the 61 single-family homesites and an adjacent section of 178 townhome sites will be part of READY.

BUSINESS CASE FOR BUILDING SUSTAINABLY

Beazer’s ethical commitment to sustainability is the main driver for its decision to build all future homes to meet its READY standards. Competitive advantage also plays a role in this choice. “This level of sustainability is a differentiator for us,” Tibbitts says. “It helps us stand out from the competition.”

As building codes change, builders must adapt, but Beazer is ahead of the market and code changes already, Bradley says.

“Our trade partners are learning along with us because we all know it’s inevitable that homes will have to be more energy efficient three years from now,” she says.

At meetings of the Southern Nevada Building Industry Association, other builders often approach Beazer representatives to ask them what steps they’re taking to meet code requirements.

“We dealt with [code changes] a few years ago,” Anderson says. “With our commitment to [ZERH], we’re definitely raising the bar again. Customers value better materials and products, and we see payoff in fewer warranty requests.”

Like all builders, Beazer competes for buyers based on the location of their homes, floorplans and pricing, Tibbitts says.

“We have the highest-performing homes on the market, which makes it easy to compete in that category,” Tibbitts says. “Some buyers come in and know what to ask about sustainability and how we build our homes, but most people don’t know what they’re looking for until it’s there. We’re building what people want before they know they want it.”

The concept of the VISION House Las Vegas will help educate buyers about how Beazer’s homes are different by demonstrating the building science that sets them apart. For example, Beazer’s sales team explains HERS scores to help consumers understand the difference between the home Beazer is building and other houses.

“It’s an easy conversation with buyers to promise a lower utility bill,” Bradley says. “But really, it’s what is behind the walls that impacts how you live, including the healthy indoor air quality and quiet and comfort that come with enhanced insulation, for example. You don’t have to wait for the first utility bill to experience that in the model.”



Sustainable reputation. The Cadence community is known for its parks, outdoor trails and environmental synergy.

CREDIT: SAMANTHA CARLIN



The best for last? Although it will be the last Cadence neighborhood to offer detached single-family homes, it will be among the most energy efficient Beazer builds. CREDIT: SAMANTHA CARLIN

To demonstrate those features to consumers, suppliers, trade partners and other builders, the VISION House Las Vegas project will include a deconstructed house and two model homes.

TWO MODELS AND ONE DECONSTRUCTED HOUSE

At the VISION House Las Vegas project, Beazer is building one baseline model of a ZERH and an upgraded version. The baseline house will meet Beazer's READY requirements, include a solar array on the roof, and feature WaterSense-labeled products that reduce water use by at least 20 percent.

The upgraded VISION House Las Vegas will include an upgraded solar array and battery storage, as well as other advanced products, systems and technologies. Both homes will feature numerous environmentally conscious products and building techniques.

In addition, Beazer is building a "deconstructed" model as an educational showcase to visually explain what's happening behind the walls and why. "Building the deconstructed model is a big financial commitment for us," Tibbitts says. "We're taking this home and homesite off-market for a significant amount of time."

While Beazer's Surprising Performance Rooms in models across the country showcase a cross-section of a wall to provide a small sample of what's behind the walls, the deconstructed model's walls will be open throughout the home. Visitors will be able to scan QR codes to learn more about specific products and features.



ABOVE: Action plan. Dwellings built to the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) standards—such as this one at Beazer's Crosswind Estates community in Henderson, Nevada—must be exceptionally energy efficient, and have better indoor air quality, water efficiency and a renewable energy-ready design. COURTESY OF BEAZER HOMES

LEFT: Buying smart. Beazer Homes expects the Cadence community to resonate with the public, largely thanks to the company's efforts to educate consumers about the financial and environmental benefits of owning one of its houses. CREDIT: SAMANTHA CARLIN

"This is an opportunity to help customers understand how we can make their home more affordable to operate and more comfortable," Anderson says.

Going forward, every home Beazer builds in Las Vegas will meet ZERH requirements, Tibbitts says.

"Depending on the climate zone, the measures we take to get there may be a little different," Tibbitts says. "We're taking what we've learned building sustainable homes in different divisions over the last few years and using that knowledge to go to a new level."

While pricing has yet to be determined for the ZERHs at Cadence, the expectation is that they will be priced competitively for that marketplace and likely to be primarily purchased by first-time move-up buyers, according to Tibbitts.

The VISION House Las Vegas demonstrates that building high performance, healthy, connected, resilient, solar plus storage-powered homes is achievable for every builder, from the smallest custom home builder to large national production builders. **GB**

Who's On Board?

resideo

Whirlpool
CORPORATION

Vestlake
Royal Building Products™

BROAN
NuTone
COME HOME TO FRESH AIR

daltile

MOHAWK
BUILDER • MULTIFAMILY

Organized
Living

sunnova

SPAN

greenfiber
BUILDER'S SANCTUARY

DUPONT

LiftMaster

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Coming February 2025 for Design and Construction Week

VISION House®
LAS VEGAS
Crossing the Rubicon



GREEN BUILDER MEDIA and production giant **BEAZER HOMES** have joined forces to demonstrate what the future of housing will look like.

Follow the project at:

www.greenbuildermedia.com/vision-house-las-vegas

TODAY'S HOMEOWNER



READY AND WAITING

Still about a decade away from prominence, the up-and-coming Generation Z already has its sights set on a sustainability-driven housing market.

BY SARA GUTTERMAN

Builders and manufacturers have spent a lot of time focusing on millennials—with good reason. Millennials have seized the top influencer position in the housing sector, spending more money buying and remodeling homes than any other generation.

However, Gen Zs are emerging. While their homebuying numbers are still fairly low, it's important to watch this generation's purchase drivers, buying patterns, behaviors and preferences as they evolve in their careers, grow their household wealth, and expand their market influence. Soon, they will be buying homes in droves.

PORTRAIT OF A GENERATION

Pew Research Center defines Gen Z as persons born between 1997 and 2012. At 68.6 million strong, their collective spending power is about \$360 billion. It's a pittance compared to the \$2.4 trillion spent

by millennials (1981-1996), but the number of Gen Zs opening their wallets will grow exponentially over the next decade.

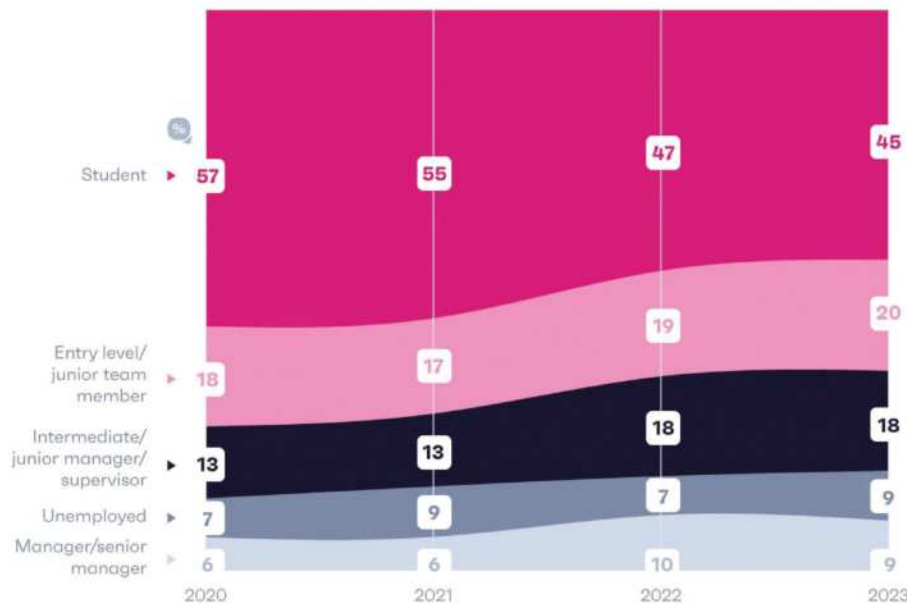
Two crippling recessions and a global pandemic have led Gen Zs to be debt averse and budget conscious. These individuals are considered to be discerning and sensible with respect to spending.

Generally speaking, they've also turned brand loyalty on its head. Many of them don't want to wear fashionable, recognizable brands. In fact, they're considered to be the "anti-brand" generation. While they rely heavily on social media for recommendations, they're more likely to follow the advice of their peers rather than influencers.

SHIFTING DEMOGRAPHICS AND PSYCHOGRAPHICS

According to research firm GWI, the number of Gen Zs that are single, college students, and living with parents is decreasing, whereas the number of Gen Zs that are employed, are parents themselves, and are married is increasing.

Ready to Work



Ready for prime time. Generation Z is stepping out of life and onto the job/careers ladder. As they age and their student status diminishes, the number seeking and finding work has gradually increased.

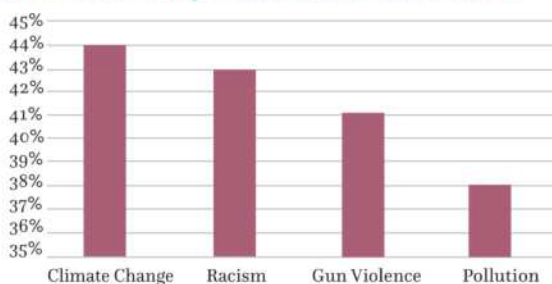
Gen Zs' values are quite different from older generations. As one example, there are currently more Gen Z individuals that are parents than are married, a dynamic that was once considered taboo by older generations such as Traditionalists (a.k.a. The Silent Generation, 1925-1945) and Baby Boomers (1946-1964).

The most-diverse generation in American history, equality is a guiding principle for Gen Zs. Technology has enabled these digital natives to connect to faraway cultures and global issues faster and more often than any generation before them. As a result, they tend to be more open-minded, liberal-leaning, and actively engaged in advocating for social justice and fair treatment for others. This is particularly important because Gen Zs will make up 17 percent of eligible voters in 2024 and 35 percent by 2036.

CLIMATE STANCE

According to Green Builder Media's COGNITION Smart Data, Gen Zs are concerned about climate change, racism, gun violence, and pollution. Eighty-five percent of Gen Zs claim that they have greatly been affected by climate change, and they feel personally responsible for their impact on the environment. COGNITION data also shows that 64 percent of individuals under age 30 report that they feel guilty about their environmental footprint.

What social issues are you most concerned about?



SOURCE: COGNITION SMART DATA

About 61 percent report feelings of sadness, anger, powerlessness and helplessness when it comes to mitigating impacts of climate change, and more than half feel ignored when they try to express their climate anxiety to older generations.

These emotions have contributed to the larger sense of loneliness and isolation that has become pervasive among Gen Zs—to such an extent that a new branch of medicine called ecopsychology has emerged to help these individuals deal with their climate anxiety.

Indeed, the strain of mental health is felt acutely by this young generation. The chaos and confusion of everyday life is taking a toll, according to COGNITION data.

WORK OUTLOOK

Thirty-eight percent of Gen Zs have entered the workforce—a number that will continue to grow rapidly over the next several years (along with Gen Zs' generational wealth).

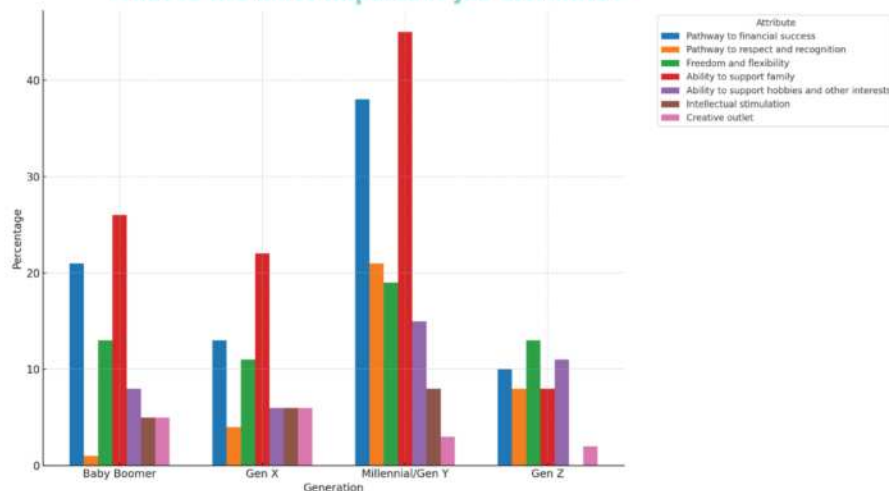
Gen Zs have different workplace demands than their predecessors. Aspects of work that have been considered “nice-to-haves” by older generations are now expected, such as mental health days, remote working capabilities and opportunities for personal learning and advancement.

Diversity and inclusion are of paramount importance to these burgeoning professionals. They seek career options that reflect their values and allow them to work among people from different backgrounds and cultures.

Gen Zs describe themselves as ambitious and career oriented. They are willing to work hard for companies that have missions and values that match their own. With that said, they're more likely than older generations to leave a job that doesn't meet their needs.

COGNITION data shows that individuals in this generation are looking for meaningful work that offers freedom and flexibility, allowing them time to pursue their hobbies and other interests.

What is the most important job attribute?



SOURCE: COGNITION SMART DATA

HOUSING EXPECTATIONS

The American Dream is very much alive within the Gen Z generation. About 80 percent have their sights set on homeownership—and they want to purchase homes quickly. According to Rocket Homes, nearly 45 percent want to own a home within five years, which means that tremendous transition in the housing sector is forthcoming.

Even though desire exists, there are major obstacles to Gen Zs buying homes—starting with affordability, which is particularly acute given that Gen Zs are in the early stages of building household wealth while home prices are at historic highs.

There is also a pricing expectation mismatch: Gen Zs anticipate that homes purchased now will cost somewhere around \$225,000, but the national median average price is closer to \$420,000, according to real estate brokerage firm Redfin.

To get into homes, Gen Zs are becoming crafty—those that are buying homes are doing so in less-expensive secondary and tertiary markets. Some are co-opting funds with friends and family for down payments, and others are getting creative with respect to living scenarios (e.g., with multiple couples living in one house).

SHIFTING VALUATION METRIC

When it comes to housing, Gen Zs are looking for a blend of attainability and sustainability. Affordability is certainly top of mind, but they also want the most-sustainable home possible because it 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.

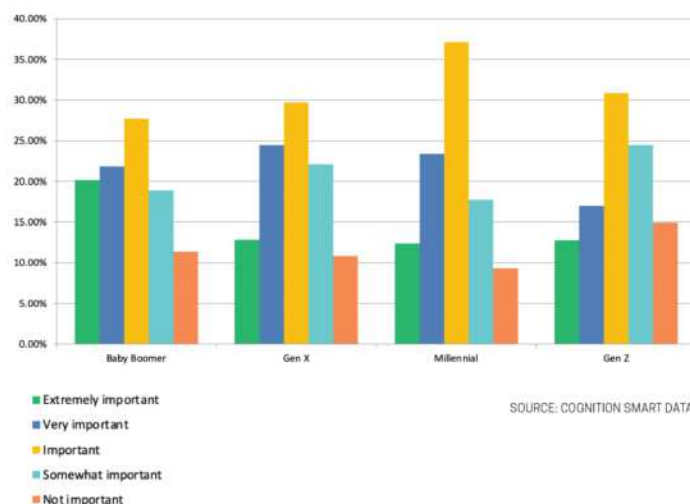
One noticeable change in the mindset of younger generations—millennials and Gen Zs—is the willingness to look at long-term value of homeownership, as opposed to just upfront cost.

COGNITION data shows that Gen Zs 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.

While the desire to own a home is fairly consistent among all generations, Gen Zs are the most likely to consider moving due to climate change, are the most concerned about climate change impacting the value of their homes, and are experiencing the most difficulty getting insurance for their homes.

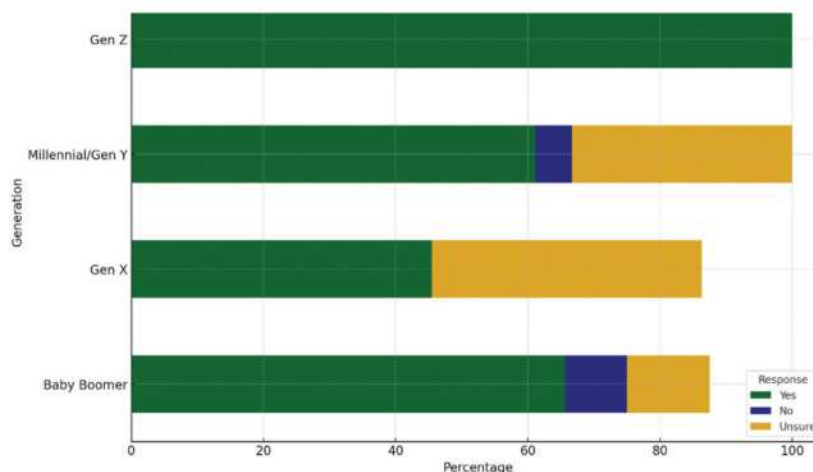
Gen Zs are also most likely to report that living in a net zero carbon home is important, and 100 percent of individuals in this generation claim that they would like to live in an all-electric home, according to COGNITION data.

How important is living in a zero-carbon home?



SOURCE: COGNITION SMART DATA

Would you live in an all-electric home?



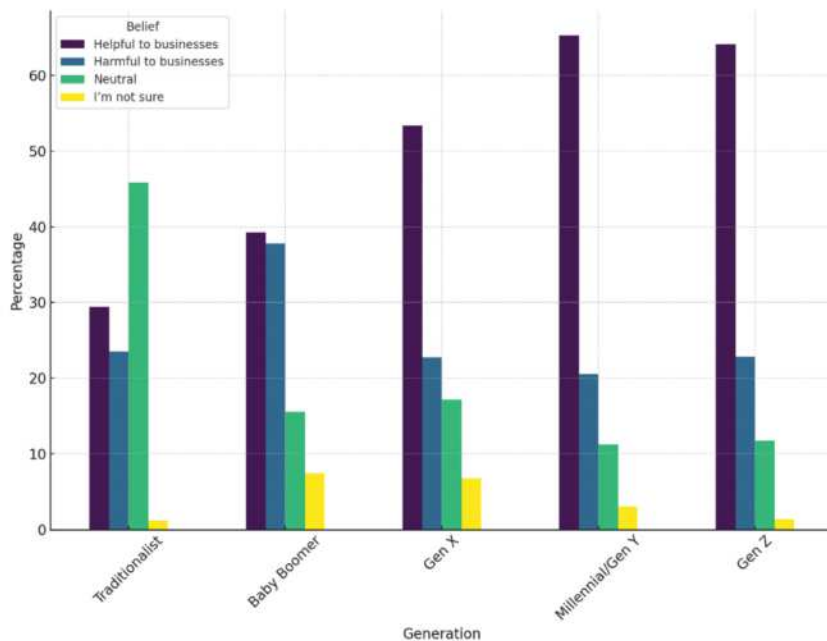
SOURCE: COGNITION SMART DATA

DEMAND FOR DECARBONIZATION

Gen Zs have little ambiguity when it comes to decarbonization and corporate sustainability.

Sixty-five percent believe that decarbonization is helpful to business, resulting in enhanced innovation, greater financial returns, and positive brand equity.

What does decarbonization do for business?



SOURCE: COGNITION SMART DATA

Among these younger individuals, there is a growing awareness of and demand for decarbonization strategies such as carbon sequestration (taking carbon out of the air and storing it), circularity, Life Cycle Assessments, and Environmental Product Declarations.

Beyond decarbonization, Gen Zs are demanding enhanced corporate sustainability strategies. Ninety-three percent believe that companies should take a stand on environmental issues and 78 percent prefer to purchase products from sustainable brands.

Ninety-three percent of Gen Zs have stopped purchasing a product because of a company's sustainability practices. Ninety percent claim that they are more likely to do business with a company with strong environmental, social and governance (ESG) strategies compared to one that does not, and 72 percent believe that companies with strong ESG practices have higher quality products than those without.

A PIVOTAL MOMENT

The market is undeniably transforming as younger generations loudly voice their concerns about the environment and demand climate action.

More than 80 percent of Gen Zs believe that companies play an essential role in solving the climate emergency, and 85 percent want to be engaged with companies to develop better solutions.

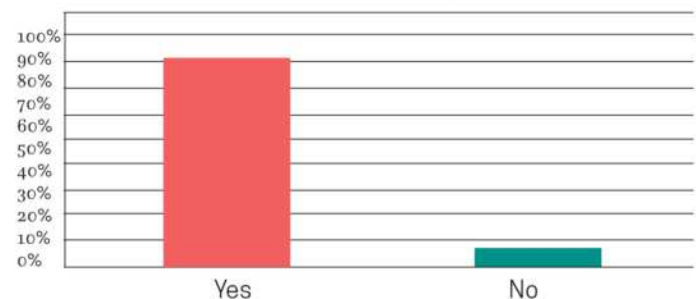
Eighty-two percent say that the more socially and environmentally responsible a company is, the more motivated and loyal a Gen Z will be as an employee and as a customer.

With that said, although demand for sustainability is at an all-time high and growing, there are historically low levels of consumer trust. Seventy-eight percent of Gen Zs believe that it's extremely important or very important for companies to have transparent and ethical business practices, but nearly 70 percent believe that companies greenwash very often or almost always.



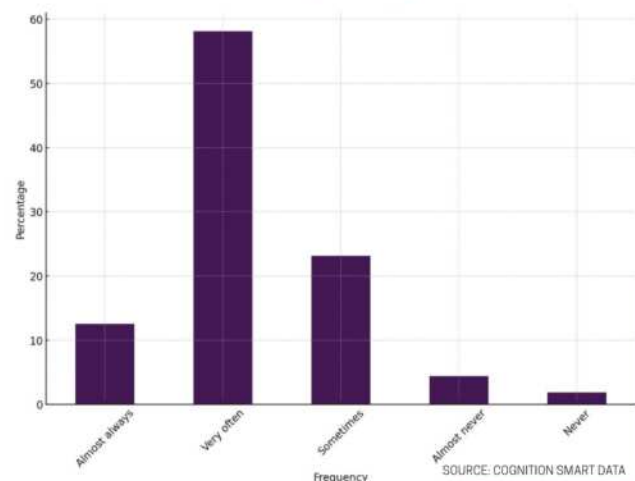
Given these dynamics, it's more important than ever for building professionals and manufacturers to craft authentic, data-supported sustainability strategies. Younger generations have made it clear that they want companies to be relatable, accountable, and transparent. They would rather hear an honest assessment about how a company has stumbled in its pursuit of climate goals than glossy, greenwashed (i.e., fake pro-environment) messaging with fuzzy details and hazy horizons.

Have you stopped buying products from a company because of concerns about its sustainability practices?



SOURCE: COGNITION SMART DATA

How often do companies greenwash?

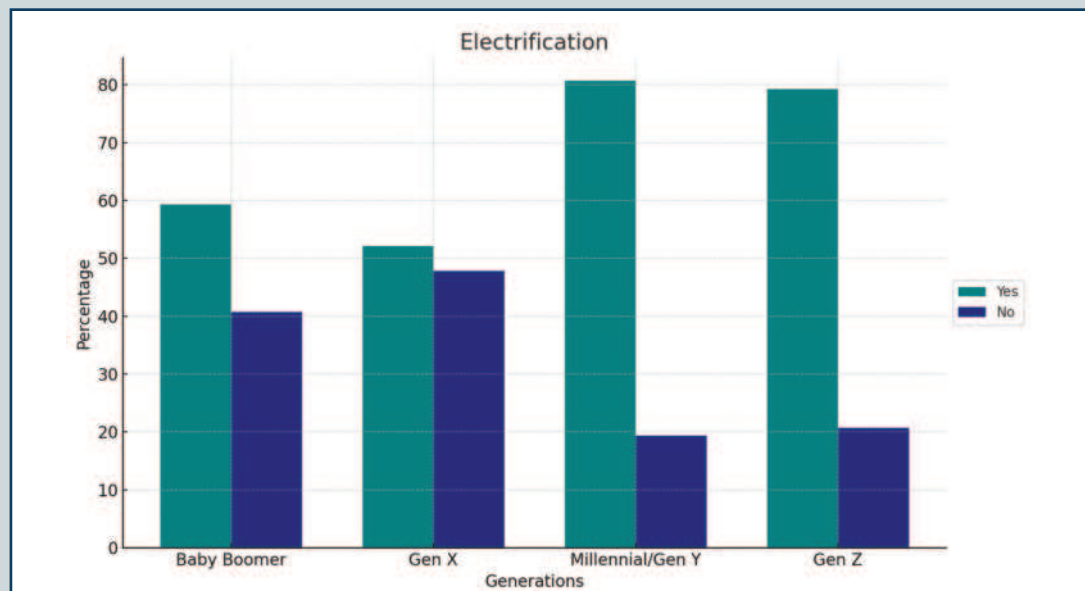
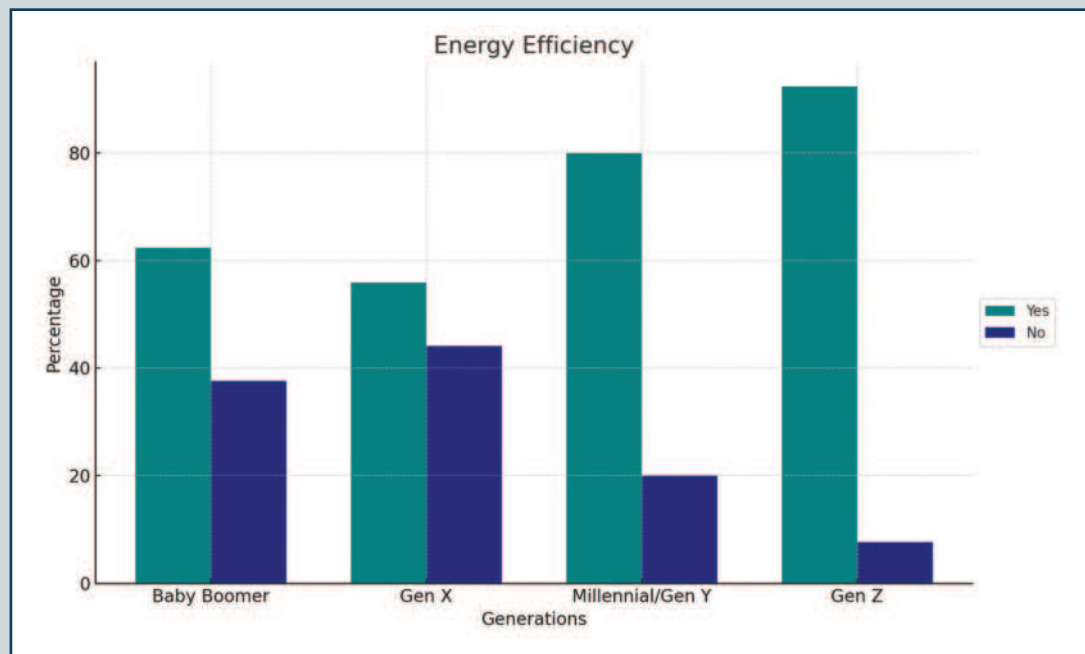


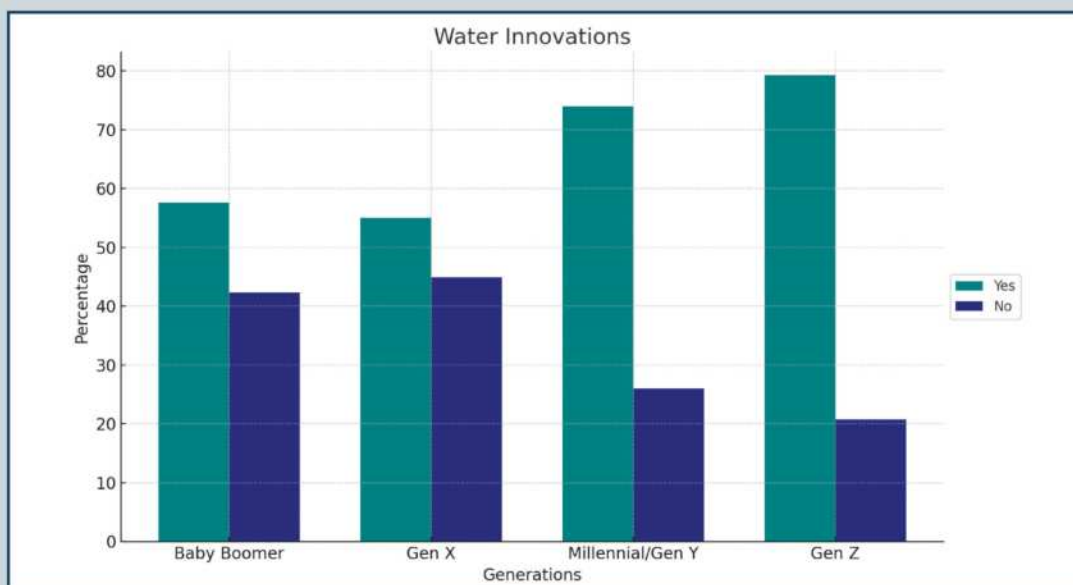
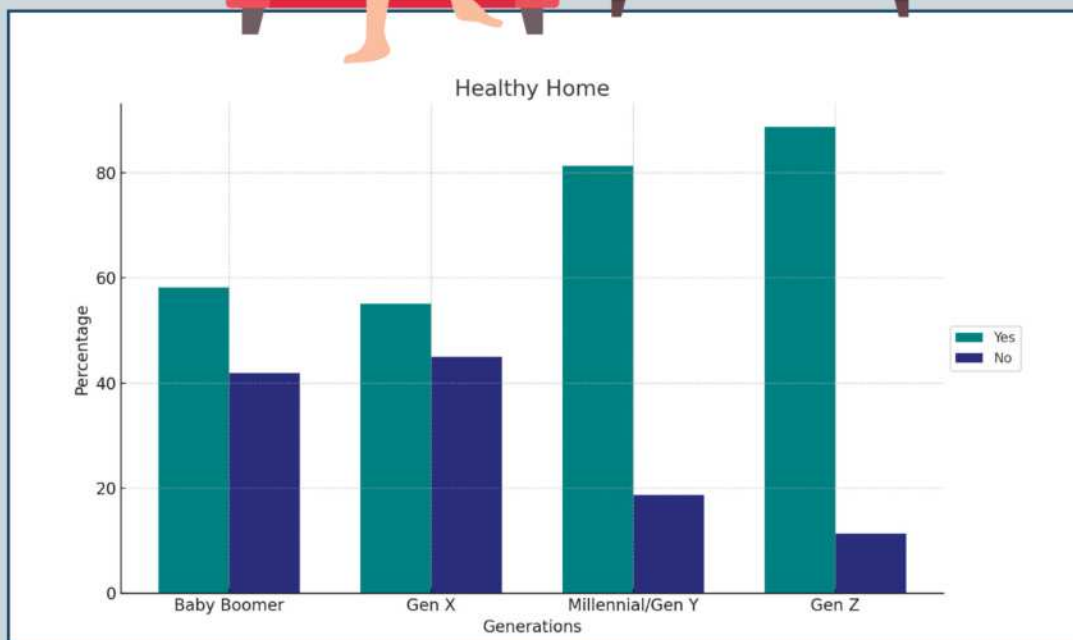
SOURCE: COGNITION SMART DATA

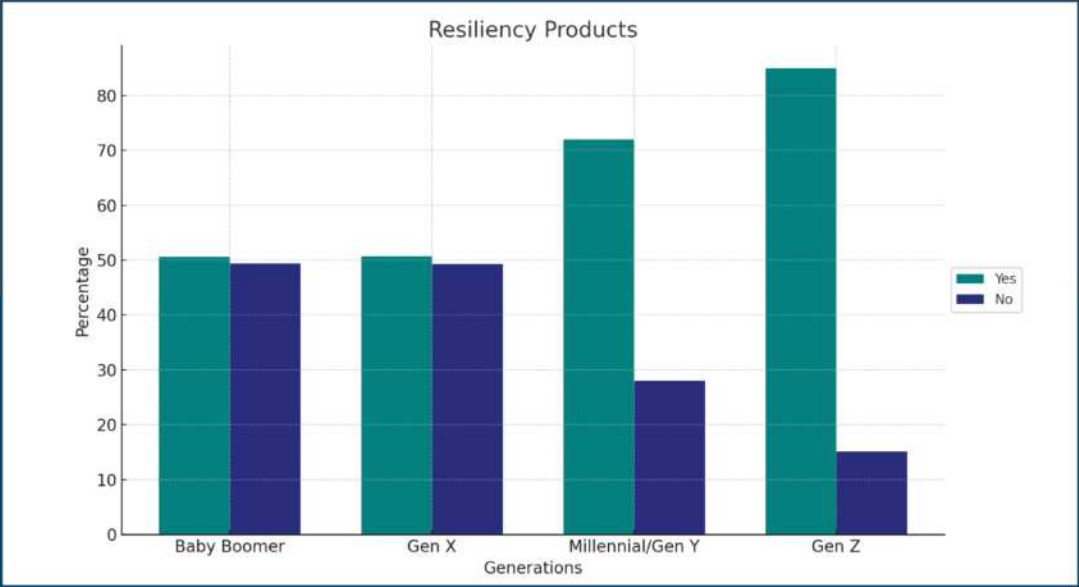
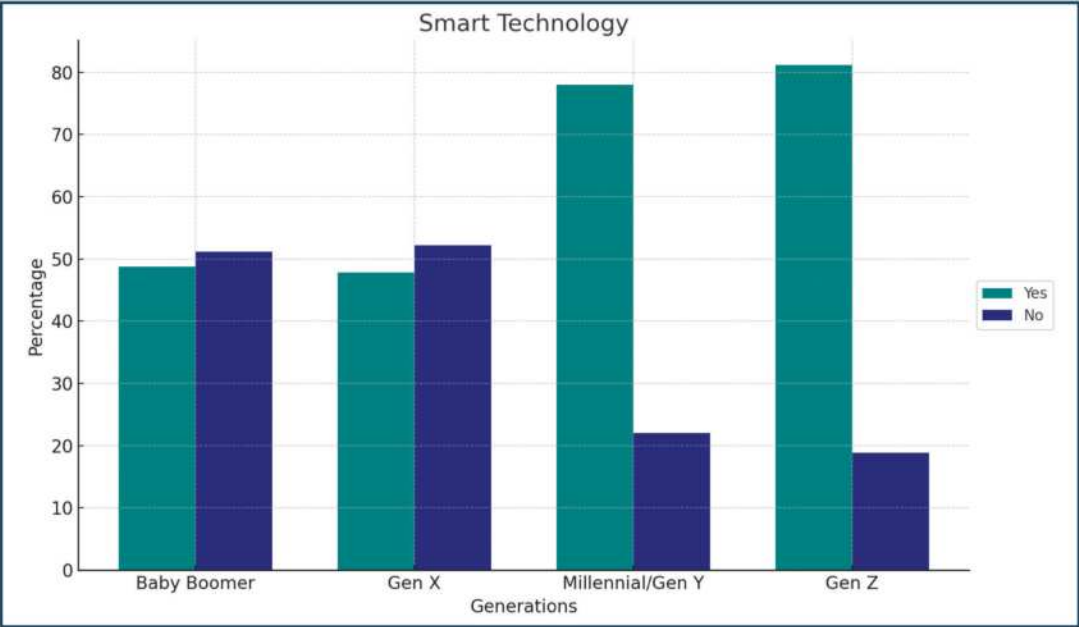
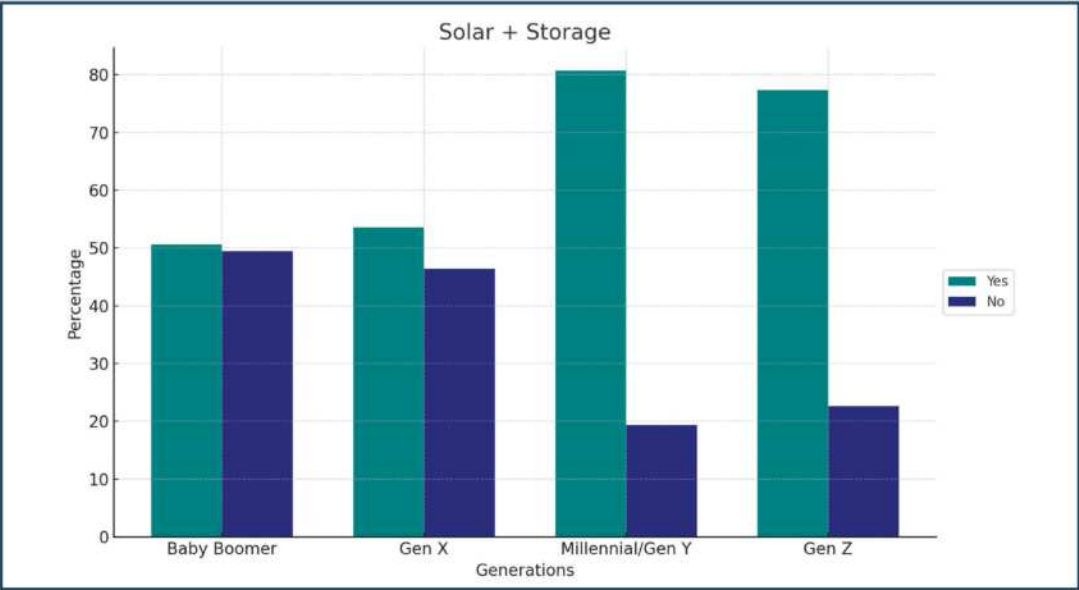


Will **you** pay more for sustainability upgrades if they eventually lower the cost of homeownership?

SOURCE: COGNITION Smart Data







DIGGING DEEPER

Here are a few additional
COGNITION Smart Data insights
into Gen Zs' lifestyle preferences
(derived from recent surveys):



CREDIT: ISTOCK/MONO

SOURCE: COGNITION Smart Data

ECONOMIC OUTLOOK

Given current economic conditions:

- 40 percent have reduced monthly household spending by 11-20 percent
- 39 percent are borrowing money from friends or family
- 50 percent are inclined to make their homes more energy efficient
- 37 percent are having trouble affording home renovations
- 43 percent plan to wait and see what interest rates do for a few months before jumping into the home buying market
- 42 percent believe that the economy is getting better

SUSTAINABLE HOME PRIORITIES

- 94 percent consider having an energy efficient home important
- 60 percent say that investments in energy efficiency upgrades are worth it to achieve long-term cost savings
- 90 percent believe that energy efficiency upgrades increase the value of their homes
- 41 percent plan to install a solar system in the next 12 months
- 38 percent plan to upgrade their appliances in the next 12 months
- 35 percent plan to install a smart thermostat in the next 12 months
- 30 percent would invest in battery storage to achieve long-term energy cost savings
- 40 percent are willing to spend more for net zero carbon homes
- 39 percent state that their area is facing water quality issues, whereas 27 percent are experiencing water shortage/availability issues

LIFESTYLE CONSIDERATIONS

- 41 percent consider themselves to be homebodies, whereas 30 percent consider themselves to be social
- 60 percent mostly cook at home
- 37 percent eat a plant-based diet
- 68 percent own a pet (of those, 37 percent own dogs, 31 percent own cats), and nearly 90 percent of pet owners say that their furry friends help them cope with climate concerns by reducing feelings of loneliness, acting as a calming presence, and encouraging them to spend more time outdoors
- 40 percent have purchased an electric vehicle and another 30 percent say that they plan to buy one in the near future

PURCHASE DRIVERS

- 59 percent have paid more for products made with sustainably harvested materials
- 57 percent have paid more for products made with recycled materials
- 45 percent will pay between 6-15 percent more for a product that uses recycled ocean plastics
- 60 percent say that takeback programs are important, in which manufacturers reclaim products at the end of their useful life for recycling

DEMAND FOR DECARBONIZATION

- Gen Zs have little ambiguity when it comes to decarbonization and corporate sustainability
- 65 percent believe that decarbonization is helpful to business, resulting in enhanced innovation, greater financial returns and positive brand equity

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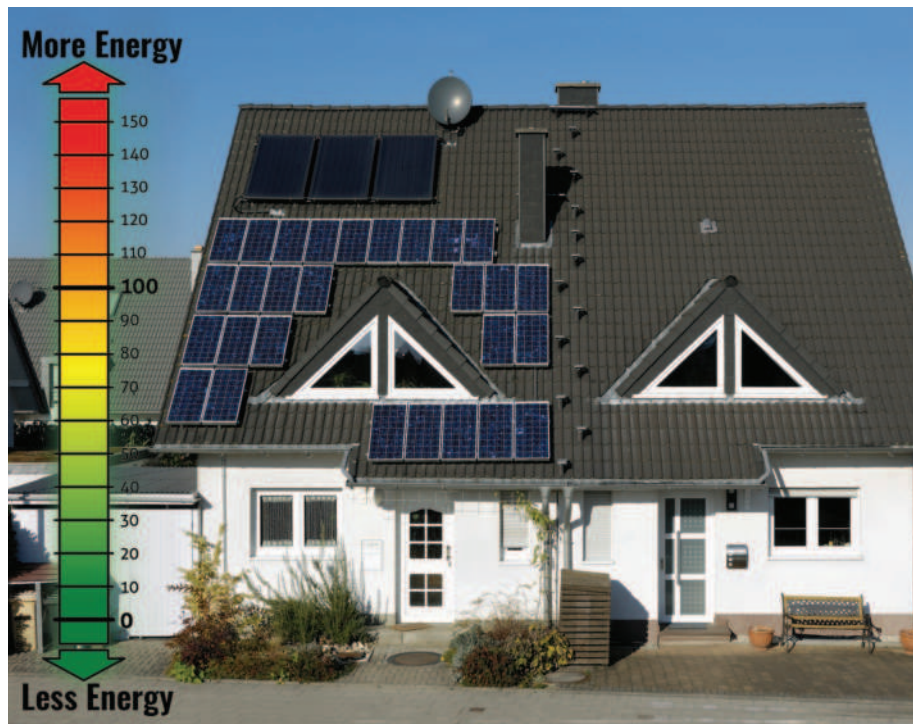
HOUSING 2.0

BEYOND RATINGS BASICS

It's time to rethink home energy rating metrics and inspire action.

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.



Metric minded. The energy efficiency scoring metric creates a contrast between business-as-usual and greater energy efficiency with consumers. CREDIT: ISTOCK/ACILO

The most foundational part of high-performance home programs is the energy efficiency scoring metric. It is a critical tool for creating contrast between business-as-usual and greater energy efficiency with lay consumer audiences. It needs to inspire emotion and action. With this in mind, I'll examine existing metrics for rating new and existing homes.

Home energy ratings were first developed with support by the U.S. Department of Energy (DOE) in the early 1990s, primarily as a tool for measuring the energy efficiency of existing homes. These early rating systems (e.g., Energy Rated Homes of America, Home Energy Rating Organization) provided a numeric score that also prominently featured a consumer-facing five-star rating, much like the peer review metric used pervasively today for thousands of products and services. In other words, these early home energy rating programs were ahead of their time.

In 1995 the Residential Energy Services Network (RESNET) emerged as the predominant Home Energy Rating System (HERS) with critical initial funding by the Environmental Protection Agency (EPA). This was because the EPA made HERS ratings a requirement for its ENERGY STAR Certified Home program and needed a national rating infrastructure. This resulted in a complete shift of focus for home energy ratings from existing to new homes.

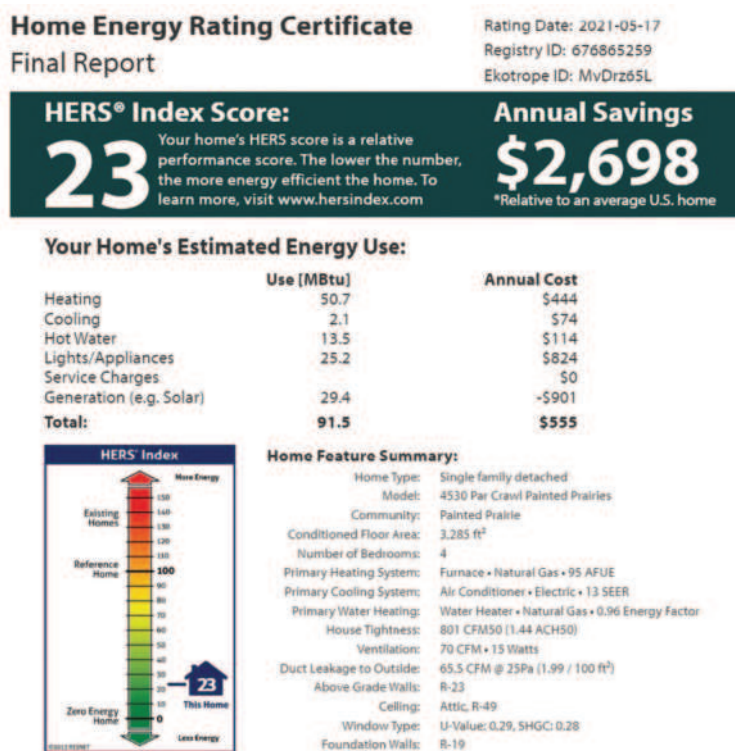
The original RESNET HERS Index score was based on a scale where zero was the least energy efficient home (e.g., effectively an open

tent). A score of 80 was aligned with a code reference home (e.g., the latest Model Energy Code), and scores above 80 would be homes worse than code (e.g., the vast majority of existing homes). However, RESNET embarked on a transformational change to the HERS Index in 2006 that completely flipped the scoring system. This led to the current scale, where a score of zero is a zero-energy home. A score of 100 is the reference home tied to the 2006 International Energy Conservation Code (IECC). Scores above 100 are less efficient than code.

Today, RESNET HERS ratings still calculate home energy savings relative to the 2006 IECC reference home. As the latest codes (e.g., 2015, 2018, and 2021 IECC) have gotten significantly more rigorous, the HERS Index-reported energy savings have become highly overstated for new homes.

A sample RESNET home energy rating certificate shown in Figure 1 reveals the confusion communicating HERS rating results to consumers. The substantial energy savings are cited as “relative to an average U.S. home,” which is highly ambiguous. Is it an average new home? Is it an average existing home? Is it an average for all new and existing homes?

What isn’t ambiguous is the energy savings, noted in a bold, extra-large font. The only assumption I can make is that homebuyers will interpret the savings cited on a customized certificate for their home as the utility bill they should experience—a huge over-promise.



SOURCE: MCSTAIN NEIGHBORHOODS

Figure 1: Sample RESNET Home Energy Rating Certificate

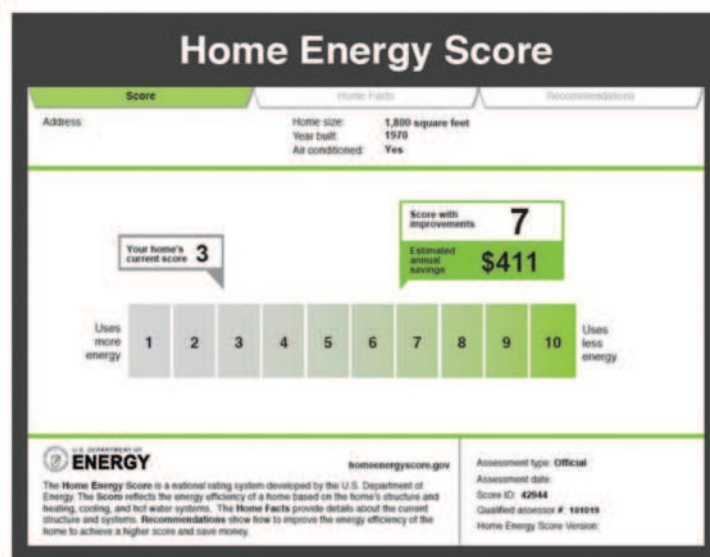
Addressing this problem has proven to be a huge challenge for RESNET, since many versions of the IECC code are adopted by different states and modified with an incredibly complex array of addendums. That said, the RESNET HERS Index has very effectively served its primary purpose by ensuring certified homes meet a consistent energy efficiency threshold. This enables high-performance home labels (e.g., ENERGY STAR, DOE Zero Energy Ready Home [ZERH]) to deliver a consistent brand promise which has been critical to their success. As

a result, the RESNET HERS Index has experienced impressive success with more than 4 million ratings.

In spite of its significant market impact, personal observations from mystery shopping thousands of high-performance homes suggest that the HERS Index itself remains complicated for homebuyers to understand. For instance, it's very difficult to extract emotion for varying high-performance home HERS Index scores: approximately mid-60s for an ENERGY STAR Certified Home Version 3.2, low 50s for a DOE ZERH Version 2, and mid 30s for a Passive House Institute U.S. (PHIUS) home.

Recognizing that the growth of RESNET HERS Index with new homes was not translating to existing homes, DOE was legislatively mandated to fill this gap and launched the Home Energy Score in 2012. Seeking a simpler and lower-cost option, DOE introduced a whole new “1-to-10” rating scale that went in a completely different direction than the RESNET HERS Index. In this rating system, “1” is the most inefficient existing home and a “10” is the most-efficient existing home (see Figure 2).

This new metric entailed huge challenges related to creating a whole new rating infrastructure and getting homeowners engaged and inspired to take action based on rating results. I know from experience with Energy Star that this level of consumer education entails billions of dollars of investment. The latest results from the DOE website suggest the Home Energy Score is struggling to gain traction, with only 175,000 homes rated nationwide. This is in contrast to the millions of new homes scored with RESNET HERS ratings.



SOURCE: U.S. DEPARTMENT OF ENERGY

Figure 2: DOE Home Energy Score system for rating existing homes

WHERE TO GO FROM HERE

This overview of home energy rating metrics suggests two conclusions. First, significant progress has been made developing robust analytical tools with the RESNET HERS Index and Home Energy Score. And second, there is tremendous opportunity to significantly improve these metrics relative to their emotional connection with consumers and impact on decisions purchasing and/or upgrading homes. In particular, two proven behavior changing metrics can be leveraged that have been used globally with a proven track record for extracting emotion and inspiring action: traditional grading schemes and five-star peer review ratings. I'll examine both.

An example applying the traditional grading metric is the Energy Performance Certificate (EPC), which was introduced in 1994 by the European Union. It is used on buildings and products, including all new and existing homes that are for sale or rent in European Union countries. This rating was made mandatory with the Energy Performance of Buildings Directive in 2010. Effectively, it is Europe's ENERGY STAR. The EPC summarizes the energy efficiency score with ratings from "A" to "G," where "A" is very efficient, and "G" is inefficient, and provides recommendations for improving your home's grade (see Figure 3).

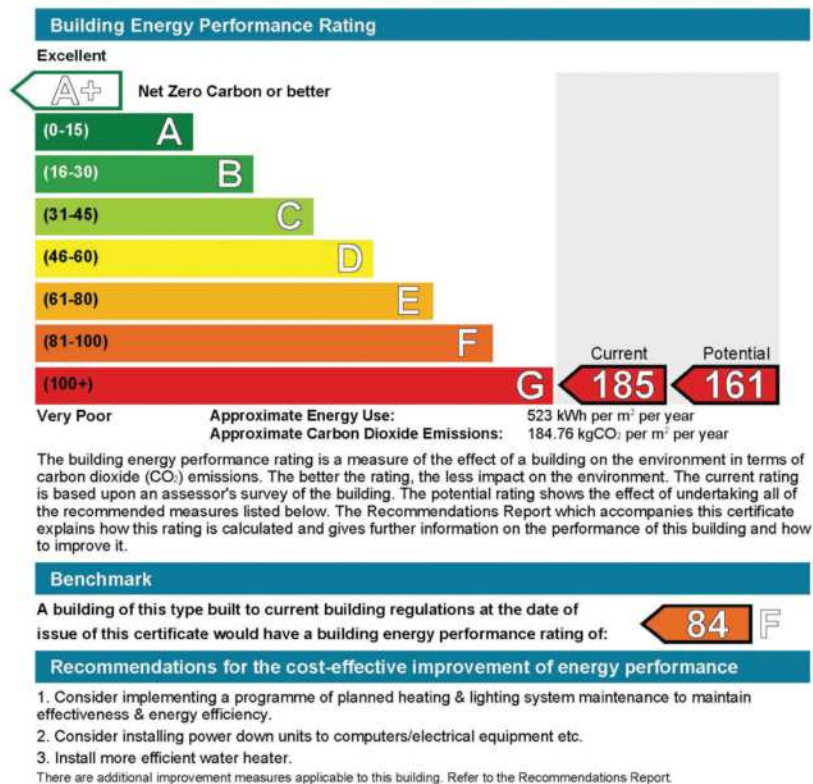


Figure 3: Energy Performance Certification used by European Union

I would personally make a minor revision to the EPC— eliminating the "E" and "G" scores—to more closely align with the something like the traditional "A-through-F" grading scheme used in the U.S. This is because the "A-through-F" scale is an off-the-shelf metric that guarantees extremely high emotion for every individual in the United States who has ever been to school and gotten a grade (i.e., virtually everyone). For free, this rating system would leverage the mortal fear we feel of getting a "D" or "F," euphoria we feel getting an "A," and desire to do

better getting a "C." My personal recommendation is when you are given an invaluable gift for free, take it.

Getting back to the original HERS rating systems supported by DOE, it unintentionally leveraged the one-to-five-star peer review rating metric that eventually became a powerful asset for inspiring behavior change. American consumers are already emotional about peer reviews and make millions of purchase decisions every day based on them. In other words, they come fully trained. I won't even choose a restaurant or hotel that has less than a four-star rating when traveling and that's just for a \$100 meal or \$300 room. It should be expected that five-star ratings should yield substantially greater impact with what is often the largest asset we own, our homes.

This leaves me with a simple but powerful recommendation for our nation's home energy rating systems. Optimize investments to date and build upon excellent progress developing robust analytical tools by augmenting existing rating metrics with a simple, emotional, and action-inspiring summary score. Two options to consider are the "A through F" grading scheme and five-star peer review rating.

We still have formidable challenges ahead moving the nation to zero energy new and existing homes. However, I believe it is a big handicap to rely on performance rating metrics that don't inspire emotion and action with a lay consumer audience. The climate crisis depends on it. **GB**



Charging forward. For decades, energy ratings systems have served a vital purpose in ensuring that homes carefully, efficiently and consistently use electric power.

CREDIT: ISTOCK/OLEKSANDR HRUTS

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

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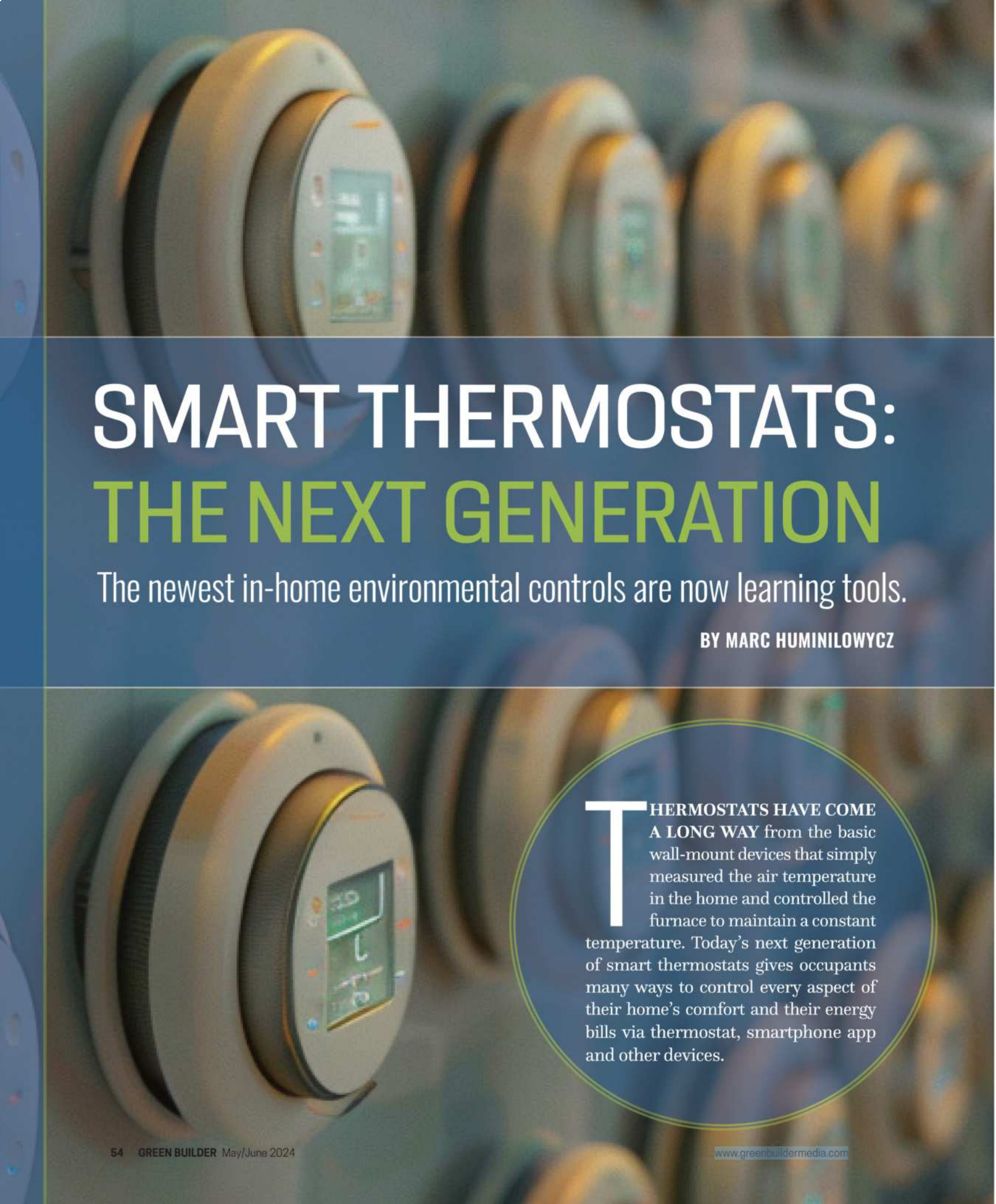
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SMART THERMOSTATS: THE NEXT GENERATION

The newest in-home environmental controls are now learning tools.

BY MARC HUMINILOWYCZ

THERMOSTATS HAVE COME A LONG WAY from the basic wall-mount devices that simply measured the air temperature in the home and controlled the furnace to maintain a constant temperature. Today's next generation of smart thermostats gives occupants many ways to control every aspect of their home's comfort and their energy bills via thermostat, smartphone app and other devices.



HONEYWELL HOME T9 SMART THERMOSTAT WITH SENSOR

T9 smart sensors read temperature and humidity in chosen rooms in the home, viewable on the thermostat touchscreen or in the Residio app. Occupants can set the schedules or allow the sensors to respond to their lifestyle. For multiple rooms, the *T9* creates average temperature, balancing occupants' needs across the entire home.

The unit sends alerts to the app if temperatures fall below a chosen threshold, as well as reminders to change filters.

With location-based "geofencing" or "region monitoring"—which alerts a thermostat when the home's occupants enter or exit a geographical region—and the capability of home and away modes, the *T9* can respond to a family's lifestyle, automatically adjusting the temperature and saving energy. Occupants can track their heating and cooling trends, compare them to energy usage in similar homes in their neighborhood, and receive tips on reducing their energy use to make their home more efficient.

ECOBEE SMART THERMOSTAT

ecobee's **Smart Thermostat** learns occupants' routines and recommends changes to their thermostat schedule, automatically turns down the temperature when nobody is home, and reminds users to change their homes' filters. This thermostat also comes with remote sensors to help manage hot and cold spots in the home, and a built-in indoor air quality (IAQ) monitor that alerts users when IAQ is poor, then offers tips on how to improve it.

The thermostat's *eco+* software automatically heats or cools the home during off-peak hours, when electricity is more affordable and greener. A built-in speaker allows for two-way talk paired with a choice of Apple's *Siri* or Amazon *Alexa*. It works in harmony with leading smart home ecosystems, including Apple HomeKit.

A premium version acts as a home monitoring hub, with built-in smoke detection, sensor technology to identify household safety or operational issues, and freeze detection. It can also be paired with an ecobee *Smart Security* subscription.



EMERSON SENSI

Offering easy installation and straightforward app control, **Sensi** delivers a simple and effective smart thermostat solution without the excessive bells and whistles of some other brands. Compatible with HVAC systems found in most homes and with all smart home platforms, it features geofencing, 7-day flexible scheduling, remote access and in-app system usage.

Sensi also offers smart alerts to help detect extreme temperature and humidity levels in the home; circulating fan control to improve IAQ by helping to regulate temperature and prevent build-up of particles and mold; and helps users find local utility rebates through a rebate finder on its website. It is compatible with Amazon *Alexa*, Google Assistant, Apple *HomeKit* and Samsung *SmartThings*.



GOOGLE NEST LEARNING THERMOSTAT

As its name suggests, this one is known for adjusting the temperature in the home based on occupants' habits and preferences over time. But it does so much more. Easy to control and program with the Google Home app's Quick Schedule (or on the thermostat), it can turn itself down when occupants leave the house to avoid wasting energy, and it is adjustable anytime.

With its Energy History and Home Report features, the [Nest Learning Thermostat](#) helps occupants understand their energy use, looking for more ways to save energy and suggesting tweaks to their home schedule. It monitors the HVAC system to catch issues early and gives reminders of service schedules like when to replace HVAC filters. And best of all, Nest can be easily installed by the homeowner in 30 minutes or less.

HIVE THERMOSTAT

This wireless thermostat, designed for conventional boilers and combi systems (heating and hot water), can be moved around the home to control and set just the right temperature for every room. [Hive Thermostat's](#) Geolocation feature sends instant phone alerts if occupants have gone out and left the heating on, and automatically turns the system on if the temperature drops to avoid freezing pipes. There is also a Holiday Mode that optimizes heating and hot water for when occupants return from vacation.

A subscription to *Hive Heating Plus* offers handy home energy budgeting tools, 24/7 efficiency monitoring, and personalized suggestions for saving energy. Hive also offers a range of integrated, remotely controlled smart home products such as smart plugs, security cameras, an alarm system, leak detectors and electric vehicle (EV) charging ports.



TADO WIRELESS SMART THERMOSTAT V3+

Designed and developed in Germany, Tado claims to save homeowners 28 percent on their home heating bills without compromising on comfort. Its advanced geofencing capability doesn't simply switch heating on and off based on the location of occupants. Users can decide whether and how they want to preheat the home for when they return, and set the temperature when they're not in.

With additional smart thermostats, including easy-to-install wired or wireless units attached to radiators and boilers, occupants can expand their system to individually control the temperature in each room. The [Tado Wireless Smart Thermostat V3+](#) also features Open Window Detection that doesn't require additional sensors on the windows. It is compatible with other smart home products and systems such as Apple HomeKit, Google Home and Amazon Alexa.



UPONOR SMATRIX PULSE CONTROL SYSTEM

This wireless solution is the first in North America to control radiant heating and forced air heating and cooling in multiple zones throughout the home. *Smatrix Pulse* provides a connection to a smart home assistant for voice-activated control, and allows for remote control anywhere via the device app, which can be downloaded from Google Play or the Apple App Store. It is described by the manufacturer as "the ultimate comfort control solution for installers and homeowners" in new construction single-family residences, retrofit and remodel applications.

Smatrix Pulse features innovative auto-balancing technology that eliminates the need for manual balancing, adding efficiencies for installers while providing faster system reaction times and greater energy savings for homeowners.

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Chris Castro, U.S. Department of Energy Chief of Staff at the Office of State and Community Energy Programs, reads Vantage. **Do you?**

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Word- or text-based AI technology helps with creation of reports, information, communications and specifications, as well as the writing of articles and books or reporting on ESG accomplishments.

CREDIT: ISTOCK/OLE CNX

and Tools

New technology will help improve the efficiency and effectiveness of information collection for the building industry.

BY TERRY BEAUBOIS

Whether we are working on a single-family house or something as complex as a new airport, our knowledge of what needs to be done and the tools we use play a crucial role in our success.

Currently, it is estimated that only a very small percentage (5 percent to 10 percent) of the information generated during the planning, design and development of a building is made readily available at the end of the project. These staggeringly low estimates show that very little of the valuable information developed during the course of a building project is being shared with the industry. Therefore, little of it is used to improve the efficiency and effectiveness of the industry on future projects. This can change, however, with the implementation of new technologies of “knowledge management” that are under development.

I’ve been observing the rapid progress of these new technology “tools” being put to use in research labs and in educational settings, as well as what we are beginning to see in the practice of various industries. These tools will eventually help improve the efficiency and effectiveness of the building industry—one of the oldest, largest and most important in existence.

For many people not directly involved with construction, our work seems “magical,” just like a magician who can wave a hand and “make a building appear.” (Granted, it may take a year or more for it to actually appear.) But even a magician has the knowledge and tools to pull off the magic.

So far, the use of these new tools has been applied to medicine, healthcare, automotive and aircraft, and they are continuing to benefit additional industries. The potential for this technology to contribute positively to the building industry is evident.

As these new approaches to “knowledge management” create new tools to be used in various industries, each industry develops specific applications beneficial to that industry.

And this is beginning to happen for the building industry.

THE KNOWLEDGE CYCLE

There are three domains of knowledge use within the building industry:

- Research: Creating new knowledge
- Education: Sharing knowledge
- Practice: Putting knowledge into action

As someone who has been involved in the Research, Education and Practice domains of the AEC (the architecture, engineering, and construction industries), I’ve experienced this directly and can see how the building industry is beginning to explore the integration of current advancing technologies.

Advanced computer tools, which include artificial intelligence (AI), are being integrated into the activities of Research and Education. This will significantly benefit companies involved in practice in the green building industry. With a significant increase in public interest in sustainable, green design and building in the areas of Research and Education, the green building industry is in a good position to take advantage of this potential with thoughtful use of these new technologies.

Knowledge is key. A significant increase in the number of people interested in sustainable, green design and building makes advanced computer tools such as AI increasingly popular and invaluable to the green building industry. CREDIT: TERRY BEAUBOIS VIA MIDJOURNEY



They will increase our ability in the green building industry to provide a higher proportion of the services across our industry.

There are two main types of technology tools that make significant contributions to green building:

First, there is word- or text-based technology to help us with creation of text for reports, information, communications and specifications, as well as the writing of articles and books or reporting on ESG accomplishments. This form of AI is already used daily in many industries. We are also seeing examples of images, voice, music, and videos that are a step up from “text-only” technologies.

Second, but coming along quickly now, is a more complex, advancing technology to address the three-dimensional aspects of the real world, not just the words and images. This technology will include modeling of spaces and 3D objects, along with information about the characteristics that such objects would have in real life: colors, textures and knowledge of those objects’ other attributes, such as the information found in product literature.

When applying this technology to a model of a building, you can click on any object in the model to view information about it. These are called “digital twins” of objects, spaces, and eventually, entire buildings. This technology is currently under development for use in real life architecture/building projects, as well as for use in computer games featuring buildings. The 3D objects will appear in a 3D model exactly where they would occur in the building in real life. This will simplify and unify our use of these new advanced technologies to create digital building models that can be viewed by each member of the building industry team for a project, to explore the information they wish to contribute, view or learn about, for the specific project.

This new technology will truly revolutionize our collaborative work in the building industry and advance green building into 2024 and beyond.



Inside information. More-complex AI technology models and 3D objects address the characteristics that the objects would have in real life.

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Info wonder. New AI-based technology can enable multiple industry experts and stakeholders to contribute or view information about cost and location of a building project.

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THE GREATER BUILDING INDUSTRY

As we know, the actual “building industry” in practice is not restricted to “the AEC” or architecture, engineering and construction. The actual building industry, before the involvement of the AEC, includes businesses, finance and real estate. There are also product manufacturers and material suppliers, and the government review and approval process, and the building owners/homeowners, managers and operators once the AEC work is completed. Large government, corporate and educational projects are well aware of the range of building industry members. In a single-family house project, all of these elements come into play.

In this new digital twin modeling technology for buildings, someone in business or finance would be able to contribute or view information about the cost, and someone in real estate could add or find out the location and site-related information about the building project. Architects, engineers and contractors will create models of buildings that can bring forward the requirements of the spatial relations and adjacencies, provided to the architects by the building client, and show that the sizes of rooms and locations in the model are meeting the client’s “program” of needed spaces and adjacencies of related spaces. Engineering data about the structure, mechanical and electrical equipment can be added and viewed. Complete information about the specific equipment that was selected and approved for use in the building will be accessible by clicking on those elements in the object-model. Product installation instructions will be also viewable in this digital model.

These new models will also eventually serve as the submittal to government reviews and approvals and show what codes and regulations are being met, speeding up reviews and approval processes. All of that data will go along with the model, so that the general contractor

will be able to provide this information to each subcontractor who can then have direct access to the final approved version of the model appropriate to their involvement with the building and the equipment, products and finishes that they need to know about for the particular project.

Any approved changes made during construction can be updated in the model. In the final version, when the project goes through building inspections, the inspector can more easily access and more efficiently check that the proper, approved items are in place.

At the “handover” of a building project to the building owner or homeowner after the completion of construction, the model will include the latest version of all of this information. Data will no longer be and not spread across PDFs in multiple data forms or put into a filing cabinet of product literature and copies of documents. This building model concept will also improve communication about the building to a homeowner or the building operations and building maintenance personnel, and be available to reference for any future remodeling, additions or demolition and recycling of a building. The potential value of this technology to each member of the building industry, across all specialisms, will contribute to the rate of adoption across our industry.

The goal of this technology is to make information on all aspects of a building more efficiently and effectively managed, and to successfully live through the actual life cycle of the planning, financing, design, construction and use of a building—the process that actually already exists currently, but less efficiently and effectively. This can benefit all projects, however simple or complex. These technological applications may be in use as soon as they are available, because of the significant benefits they will bring to the building industry. **GB**

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COVER 4

**COMING NEXT ISSUE****2024 Eco-Leaders**

Green Builder's annual special edition features the "EPD Honor List," sustainably minded companies that are conducting Environmental Product Declarations by rethinking business models, prioritizing resource use, incorporating digital technology, and more.



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FOOL'S GOLD



Ron Jones
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It's fair to say that most people would identify with the early lessons we are taught regarding being resourceful with things, and not being wasteful with materials that have value. Maybe it usually starts with a simple example such as a focus on food—cleaning up one's plate, as it were—and being grateful for what we have. Of course, there is likely a subtle element of leverage that is applied in these scenarios, a promise of dessert, but only if all of the vegetables are consumed first.

There may not be any group of professionals who are more sensitive to the ever-increasing cost of things than those in the building industry. We learned very early on that we needed to be careful and accurate with estimates of how much of any given product or material we would need to complete a project, because the only thing that rivals the fear of coming up short is having a surplus that can't be used.

Back during the more than two decades when we continuously built custom homes for clients, we knew that we must strike a delicate balance; ensuring that we had enough supplies to finish the job without being left with a half carton of this or a partial bucket of that. It seemed like there was often just enough to hang on to, but not for any practical application.

I surmised that I would deal with this conundrum by leasing a 10-by-20-foot self-storage unit where I could not only safely stash some of our bulky construction equipment but also those assorted treasures that were byproducts of almost every description. The storage unit cost only \$100 per month, which seemed reasonable enough until I realized that I was going to need a second one in order to hold everything. "Okay," I said. "It takes what it takes and we'll make up the difference by being super-efficient with leftovers."

I tried not to think about what it was costing me in time and money on each occasion when I would send a member of the crew on the 30-plus mile round trip to pick up a handful of leftover anchor bolts or a box of assorted joist hangers. Before long, we

had enough remnants, trim hardware and special finish items to outfit maybe two dozen custom dog houses. Year after year, as the stockpile grew, it forced out the aforementioned equipment.

Then one day, I was jolted by the reality that 20 years had passed. The arithmetic was brutally simple. Two units at \$100 each, 12 months a year for 20 years. Yep, \$48,000. After thinking about it, I kept asking myself why the monthly rate had never been raised in all that time. I suppose the owner figured it would be more profitable in the long run to just let me cruise along in my state of blissful ignorance than risk losing steady, dependable payments.

Heck, we were very skilled and creative builders. We could have constructed a nice shop building in those days for under \$50,000. Instead, I couldn't even give all that junk away and ultimately had to pay someone \$500 to haul it all off. The man was right when he suggested there is a sucker born every minute.

Well, you can bet I've learned my lesson, though I will confess that I do have one particular fetish that I still indulge in. You see, I have this thing about containers. I especially like metal buckets and sturdy plastic jars. There is hardly a shape or size that I can't find a theoretical use for. As a result, we are never faced with needing to discard any leftover screw, nail, nut, washer, or bolt. Ever!

And we have plenty of safe places for small batteries, short pencils and the dozens of keys that don't seem to fit any of our locks. Best of all, many of the containers fit nicely inside one another like those wooden Russian dolls, so it makes it possible to save multiple sizes inside bigger ones. We practically have our own Fort Knox.

I'm sure you'll agree, this scaled-down version is much more logical and realistic. It saves money and valuable space while preserving the satisfaction of knowing that nothing is going to waste. The only thing I'm still struggling with is figuring out what to keep in those nifty little single-serving jelly jars. **GB**

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A woman with dark hair in a bun, wearing a light blue short-sleeved shirt and blue jeans, is standing in a modern kitchen. She is cooking at a stainless steel range with a pot on the burner. The kitchen features light wood upper cabinets, green lower cabinets, and a white subway tile backsplash. A stainless steel refrigerator is on the right. In the foreground, a white table holds a blue oval dish of chicken wings, a small bowl of cherry tomatoes, and a green tray of vegetables. The text "COUNT ON US MEANS" is overlaid in large yellow letters.

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