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EDITOR'S NOTE

The Inside Scoop

By Matt Power
Editor-in-Chief

The Heat Pump Imperative

The concept of an all-electric home has never made more sense.

IN THE BUILT ENVIRONMENT, improvements in technology now demarcate a clear path toward decarbonization. The timing is urgent. We are, quite literally, experiencing a perfect storm of human-fueled weather pattern disruption, from the inferno of Western wildfires to a record-breaking Atlantic hurricane season. We must rapidly change the source of our energy from fossil fuels to renewables, and the building industry can play a pivotal role.

Why? Because heating and cooling of buildings in the U.S. accounts for about 10 percent of our national greenhouse gas emissions. But only about 1 percent of those buildings have upgraded to electrified heat pump equipment. Of those, an even smaller proportion can claim to operate at net zero, producing enough power onsite (or in leased offsite facilities) with renewable energy to heat or cool the building.

Essential upgrades. Newer heat pumps such as this *XV20i* model from Trane offer 21 SEER efficiency and include variable speed motors. They can operate efficiently in extreme cold and heat.

CREDIT: COMFORT SQUAD HEATING & COOLING

The latest heat pumps use about a third of the energy for heating or cooling of older electric resistance and A/C systems. Major advances over the last couple of years have mitigated two of the major weaknesses of this technology: temperature sensitivity and power "surge" when starting. Many heat pumps can now operate efficiently at extremes of hot and cold temperature. Advances in variable speed motors mean they not only run more quietly, but they also ramp up and down easily, making them more flexible and viable for connection to renewable power, such as solar. This also improves their efficiency and lifespan.

Writing in *Vox* in 2018, David Roberts notes that currently, roughly 37 percent of American homes are electrified. These are mostly in the South, and most use inefficient baseboard heating rather than efficient heat pumps. Some 48 percent of homes use natural gas, which dominates in every region except the South.

So here we are, with millions of homes using outdated, energy guzzling technology, dependent on natural gas or oil. The shift has begun, but we all need to move faster. Every new home should have fossil fuel independence built into its design. Heat pumps offer a giant leap toward that goal.

If I sound evangelical about this technology, it's because unlike fossil fuel appliances, heat pumps offer a rapid pathway to all-renewable energy. I've focused on HVAC because it's the big energy user in our buildings, but other technologies deserve kudos, too. They have made all-electric, net zero living an achievable goal. These include LED lighting, DC-powered bath fans, induction cooktops and water-saving appliances (less hot water means less energy demand). And none of it would work without advanced housewraps and insulating practices. Tight, efficient homes require smaller energy inputs and produce far less greenhouse gas pollution.

It's naïve to suggest that the transition to an all-electric society will be painless and easy. Many codes and regulations are written in such a way that they slow adoption of electric technology or reward fossil fuel dependence. But with the upheavals now occurring, these begin to look like speed bumps, not unbreakable barriers. As politicians try to convince us of the fantasy of a deregulated utopia, we're seeing the truth behind the illusion: pollution, pandemics and economic ruin. The building industry doesn't have to follow this low road to nowhere.

We have the tools, the know-how and the motivation to step forward and make positive change in our industry—one of the few sectors of the U.S. economy that has remained relatively strong throughout this devastating and terribly mismanaged pandemic. Let's go down in the history books for the way builders, architects and developers led the U.S. through one of its toughest periods, by building a fossil fuel-free society for future generations. **GB**

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Extreme Weather Means Costly Future

The physical and financial impacts of wildfires and other climate-related disasters will only get worse in years to come, EDF contends.

WILDFIRES THUS FAR in the United States have destroyed more than 7 million acres and thousands of structures, killed hundreds of people and resulted in billions of dollars in damage—and things are only going to get worse. According to a report released by the Environmental Defense Fund (EDF), global warming has led to the financial cost of wildfires and other weather-related disasters more than quadrupling since 1980, to a 40-year total of $1.7 trillion. Costs have risen from an average of $18 billion per year in the 1980s to $80 billion annually in the 2010s.

At that pace, the economic damage caused by Climate Change will increase by about 1.2 percent for every 1.8 degrees Fahrenheit warming, coming out to $257 billion—only a little more than California's current state budget of $222 billion, the report notes. The damage totals are conservative, as the study only included disasters of $1 billion or more. Fires, floods, drought and tropical storms were the base disasters for the report.

This year, current damage numbers will only go up, as fire season has just begun and winter weather-related flooding is on its way, according to a report by InsideClimate News. "The changes we're seeing are best explained by climate change," says EDF Senior Director Elgie Holstein, a former National Oceanic and Atmospheric Administration (NOAA) official. "All the indicators are moving in the direction of bad news…There's no denying the trends and the fact this becomes more expensive going into the future."

More to come. Millions of acres of land and thousands of homes have been destroyed by wildfires and other climate-induced disasters since 1980—and there's even more to come, according to the Environmental Defense Fund. CREDIT: USDA FOREST SERVICE

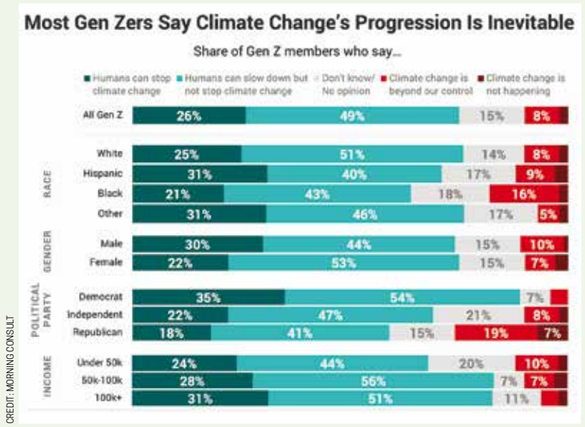
Generation Z to Become 'Generation Green'

For the next decade's workforce, saving the environment and taking Earth-friendly jobs are top priorities.

NINETY-TWO PERCENT OF GENERATION Z members believe Climate Change is inevitable, but 75 percent also believe it can be stopped or at least slowed down, according to a survey by global data tech firm Morning Consult. The poll of 1,000 members of Gen Z between the ages of 13 and 23 also shows that 8 percent of respondents think Climate Change is beyond our control. For 2 percent, Climate Change isn't happening at all.

The up-and-coming group of voters and workforce members are also thinking environmentally when it comes to jobs. Participating in sectors whose emissions contribute to Climate Change holds little appeal. Instead, many respondents with plans to pursue careers in various sectors of the energy industry are considering solar and wind energy, at 50 percent and 43 percent, respectively. Emissions-based industries such as coal and natural gas were last resort, with only 15 percent and 29 percent of interested respondents considering jobs in those respective fields, according to Morning Consult.

For coal and fuel, this finding is troublesome, as it mirrors surveys conducted by those two industries. These energy executives are now extremely concerned about how to attract new talent in the coming decades, Morning Consult notes.



CREDIT: MORNING CONSULT

LEED Has its Project of the Year

Winners list includes entrants from California to Turkey.

PARK MOZAIK A Block, a multi-family affordable apartment building in Ankara, Turkey, is LEED's Residential Project of the Year, the U.S. Green Building Council (USGBC) announced. The 40-unit LEED Gold-certified structure was "designed to support middle-income families and focused on decisions that promote sustainability, health and affordability," according to LEED CEO and President Mahesh Ramanujam. Those features include water-efficient fixtures that reduce water use by more than 40 percent, and a human-centric design that prioritizes health through enhanced ventilation, filtration, source separation and non-emitting materials, he notes.

Other LEED Home Award winners include GPD 346 Highland (Weston, Mass.), GREENLAB (Dallas), and Sikes Residence (Cincinnati) as Outstanding Single Family Projects; 3365 Third Ave. (Bronx, N.Y.), The Arroyo (Santa Monica, Calif.), and Freedom Commons (Syracuse, N.Y.) as Outstanding Affordable Project; and AMLI Residential as Developer of the Year. The full list of 2020 awards recipients and their project profiles may be found at www.usgbc.org.

Northern boom? Despite a pandemic, new home building in Canada is hitting record highs. CREDIT: FATCAMERA/ISTOCK

Canada's Housing Market Turns Red Hot

Defying predictions, 'The Great White North' has its best new homebuilding summer since 2007.

CONSTRUCTION OF NEW HOMES in Canada reached its highest level in more than a decade as the nation's housing market continues to defy forecasts of a slowdown. According to a report by Bloomberg News, housing starts for this past summer topped 650,000, up 6.9 percent from the same period in 2019 and the highest total in any quarter since fall 2007. The increase is largely the result of new construction in Toronto and Vancouver, Bloomberg notes.

The housing market has boomed even as the Canadian economy slowly recovers from the steepest downturn since the Great Depression, according to the Canada Mortgage and Housing Corp. (CMHC). Prices for existing homes in the largest cities are at record highs thanks to strong demand, limited inventory and historically low borrowing costs, CMHC says.

Canada's construction surge follows suit with the United States, which has also suffered through a pandemic-induced economic slowdown but has recently seen its biggest number of new housing starts since 2006, according to the U.S. Census Bureau. **GB**

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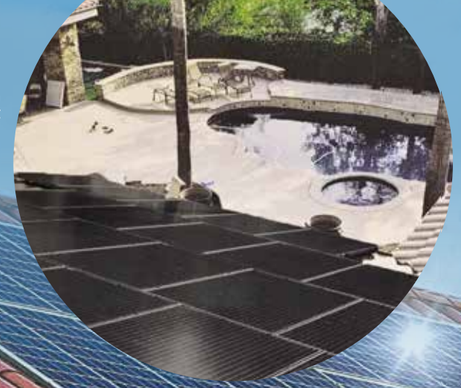
THE ALL-ELECTRIC HOUSE

Super-efficent HVAC, appliances and lighting put a sustainable post-fossil fuel lifestyle within reach.

Optimal Power Generation.

The latest PV panels from Jinko Solar use half-cell technology to increase efficiently and mitigate shading. The company also offers bifacial translucent solar panels (*Swan* series) that create energy from both direct sun and reflected light.



Smart Ventilation.

Sensors activate bath fans, range hoods and more as needed. The Panasonic *FV-WCCS1-W* multi-function sensor is shown.

Advanced Heat Pumps.

Heating and cooling efficiently even at extreme temperatures, new models include variable speed motors that are quiet and renewable power-ready.

Intelligent Electronics.

From TVs to LED lighting, sensors offer a heads up, phone-enabled overview of the house, identifying wasteful patterns to reduce energy load.

Gas-Free Cooking.

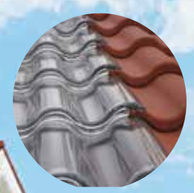
Induction cooktops use only the energy they need to heat cookware. They work with cast iron and offer response times similar to gas tops. Samsumg sells one that creates a gas flame illusion.

Smart Thermostats.

Controls such as this *EcoNet* model from Rheem optimize HVAC efficiency. The company also makes hybrid hot water heaters.

Backup Generator.

For peace of mind, and to reduce total battery storage needed, a propane generator acts as a reliable emergency power source for the all-electric home. Kohler model is shown.

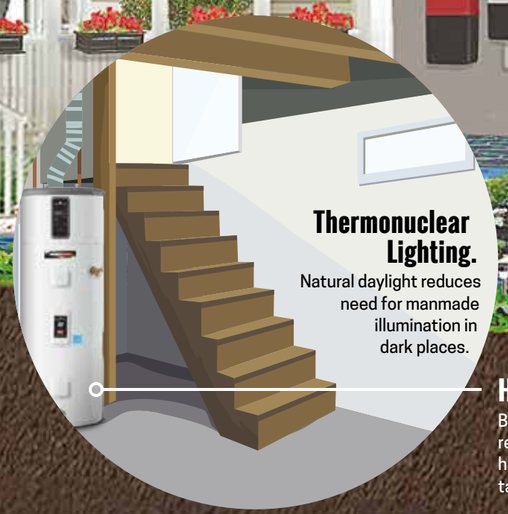


Solar Hot Water Assist.

To reduce household demand for electric hot water, these glass roof tiles from Swedish company Soltech Energy heat the air, which then is used to heat water. We were unable to confirm current availability.

Mobile Grid Backup.

An electric vehicle with quick charging station can double as a large storage battery for the home. Many EV batteries have about a 60 kilowatt hour capacity, four times the capacity of a Tesla *Powerwall* (15 kW hours.).

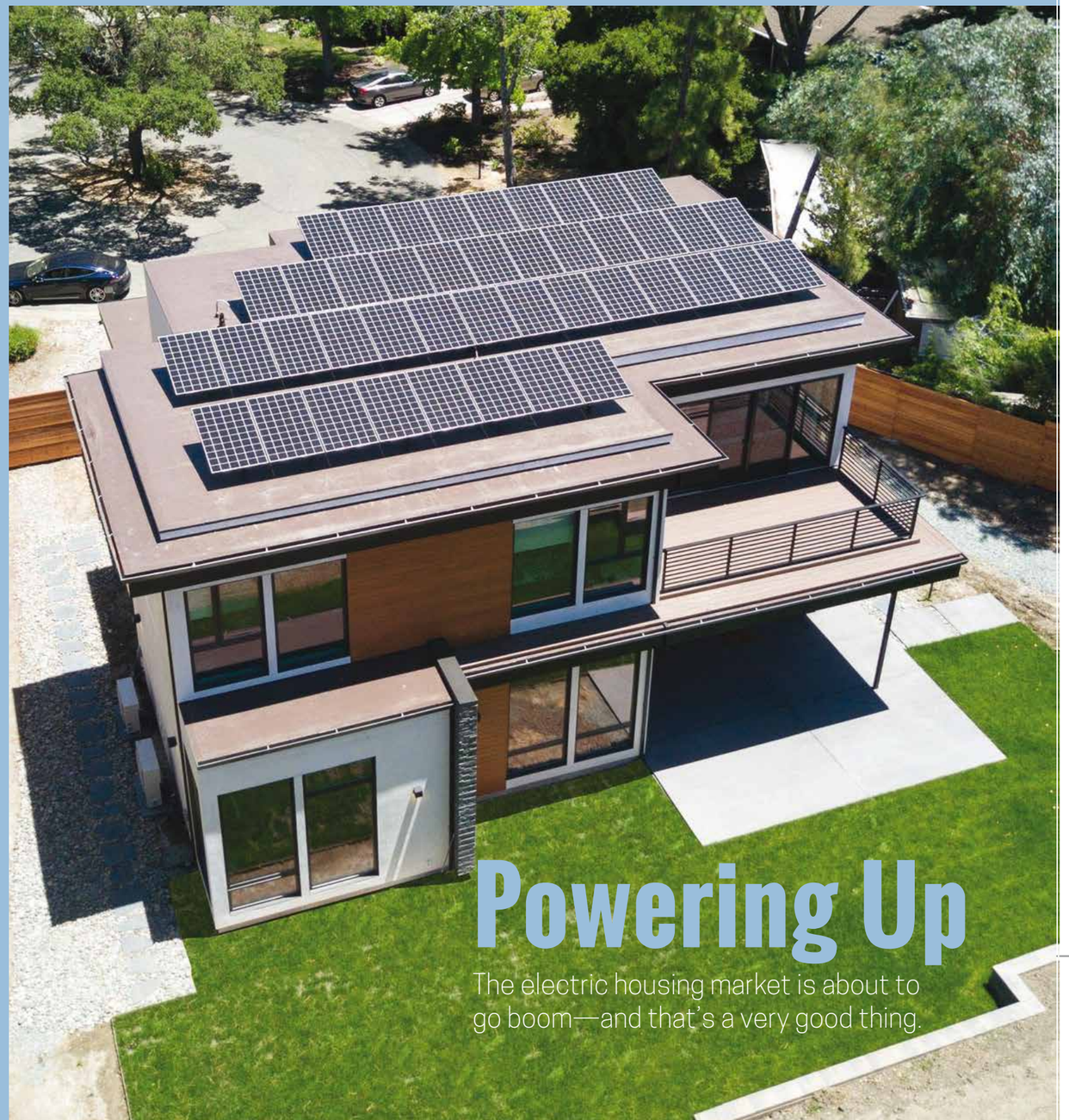


Thermonuclear Lighting.

Natural daylight reduces need for manmade illumination in dark places.

Hybrid Heat Pump Hot Water.

By extracting heat from nearby air, heat pump technology reduces water heating costs annually by about $300 for a household, when compared with standard electric resistance tanks. Bradford White's *AeroTherm* model is shown.



Powering Up

The electric housing market is about to go boom—and that's a very good thing.

BY ALAN NADITZ

ONCE UPON A TIME, Charles Arias thought all the talk about an emerging electric housing market was just that—talk. He says he couldn't envision a time when people would willingly give up all-too-convenient natural gas water heaters or stoves in favor of electric-powered models that, in his opinion, simply didn't perform as well.

Fast-forward five years. He now lives in a Sacramento-area all-electric community and has no complaints. "I admit I was wrong, or at least not well informed about electricity versus gas," he says. "They are, in most instances, on equal par. My utility bill is even a few dollars less each month, which is pretty good, considering this house is about 1,000 square feet bigger than my old one."

Expect that pro-electricity scenario to play out more over the next decade, as people become better aware of the benefits of electric power, according to a report by Boulder, Colorado-based marketing intelligence firm Guidehouse Insights (formerly Navigant Research).

Report co-authors Daniel Talero and Neil Strother say electrification technologies are "rapidly becoming more cost effective and more reliable than fossil fuel systems in a variety of planning scenarios and climatic conditions...although mixed systems predominate, the electrification of all residential energy end uses is desirable for many consumers, and is expected to increase substantially on a 10-year timeline."

The study projects more than a 500 percent increase in revenue—from $2.4 billion in 2020 to $12.9 billion in 2029—for fully electrified home technologies. The report defines a "fully electric home" (FEH) as one where space heating, water heating and cooking are electrified through the use of air source heat pumps (ASHPs), heat pump water heaters (HPWHs), and induction cooking technologies. Insulation and energy management systems (EMS) are not part of the definition, but many FEHs have them, the reports adds.

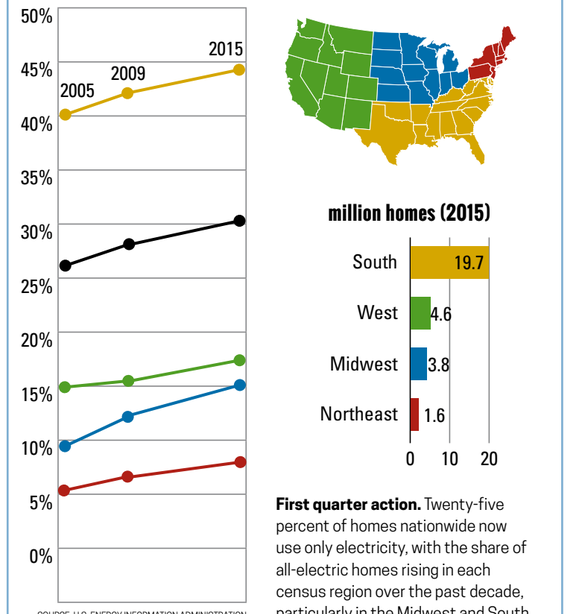
Pushing that growth will be high demand for cost-effective technology such as insulation and heat pump water heaters, rapidly improving cost and performance metrics across climate zones and markets, and high job creation associated with building retrofitting, the study notes.

THE BURNING QUESTION

There's also a reality clause: Approximately 70 million American homes burn natural gas, oil or propane onsite to heat interior space and water. This generates 560 million tons of CO_2 each year—one-tenth of total U.S. emissions, and just under half of all residential end-use energy consumption nationally, according to the U.S. Environmental Protection Agency. "If you think about that, it makes electricity a more-attractive path," Arias says. "As long as you know what you want and what's out there, there appears to be no reason not to at least think about making the conversion, or flat-out buying a house that already says goodbye to [natural] gas."

Watt house. Stanford University Professor Marc Jacobson went all electric with his custom-made home in a successful effort to prove how easy it is to transition off fossil fuels.

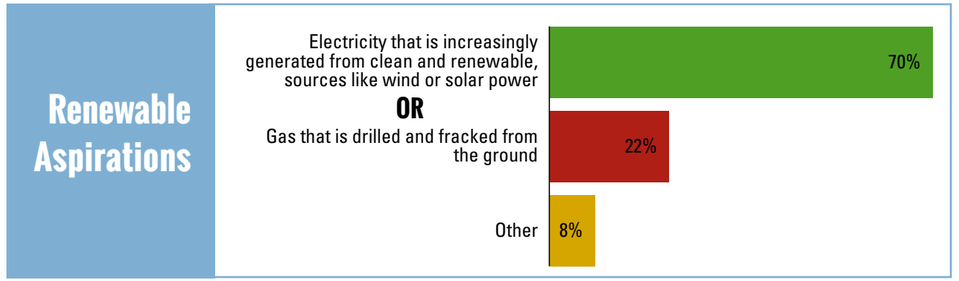
CREDIT: BONE STRUCTURE AND MARC JACOBSON



That may not be so easy. Natural gas remains the least expensive fossil fuel-based energy source and is the preferred heating tool for 48 percent of all U.S. households, according to DOE. There is also a much larger number of older, gas-dependent homes—about 50 million nationwide to nearly 35 million electric-only—and owners are more likely to stick with what's been working for them, the agency notes.

It's primarily a case of money, according to the Rocky Mountain Institute (RMI), which in 2018 released a study on the economics of electrifying home buildings. In general, the study found that the older the home, the more likely it is to function on, and continue to use, gas-powered appliances. "In many scenarios, notably for most new home construction, we find electrification reduces costs over the lifetime of the appliances when compared with fossil fuels," the study notes. "However, for the many existing homes currently heated with natural gas, electrification will increase costs at today's prices, compared to replacing gas furnaces and water heaters with new gas devices."

A 2018 study from the California Building Industry Association (CBIA) found that homes with natural gas appliances could cost up to $7,200 to upgrade wiring and electrical panels for the purchase of new electric appliances, average $877 per household each year in increased energy costs, and result in an overall cost increase of $4.3 billion to $6.1 billion per year.



Planned improvement. By a wide margin, Californians who currently have natural gas-powered appliances at home want their replacements to be renewable energy-driven ones. SOURCE: FM3 RESEARCH

LEAD—AND LEARN—BY EXAMPLE

Education can play a big role in helping people make the switch to electricity, according to Talero. As it stands now, many Americans are not aware of the differences between electricity and natural gas for homes.

A survey by FM_3 Research, conducted in California earlier this year, found that three-quarters of its respondents have natural gas or propane furnaces and cook stoves. But 62 percent of those respondents said they were unfamiliar with devices such as air source heat pumps or heat pump water heaters. And barely over half—53 percent—were even "somewhat familiar" with an induction cook stove.

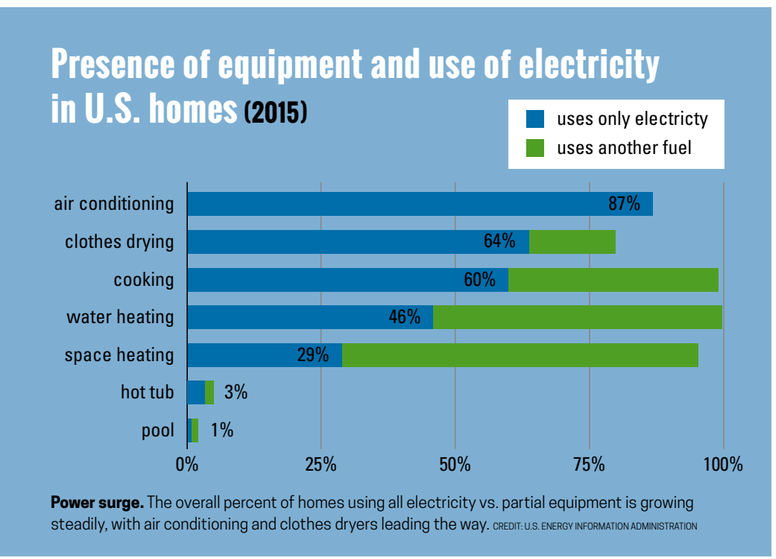
This represents an opportunity, according to Matt Vespa, a staff attorney with Earthjustice, one of several environmental groups to commission the survey. "With more information on the hazards of gas, and increased familiarity with advanced electric appliances—through events like induction stove lending programs, city expos and, probably most importantly, training for contractors who recommend appliances—Californians' demand for this transition will only grow," Vespa says.

Many Californians may be personally unfamiliar with alternatives to their gas appliances, but they strongly support an array of policies that would allow them to power their appliances with renewable electricity, FM_3 Research notes. Seventy percent of the firm's survey respondents said they want their homes' power to be generated by green sources, such as solar and wind.

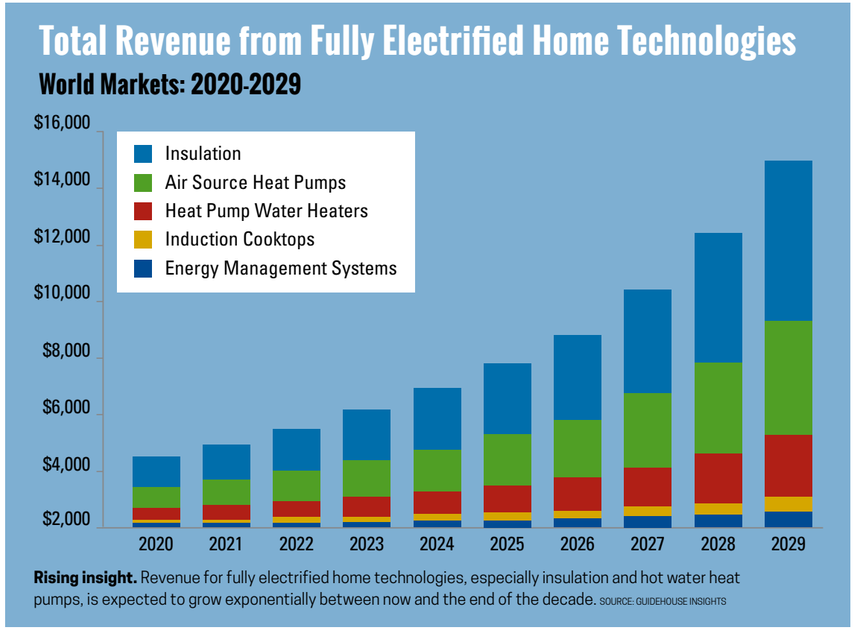
From a marketing standpoint, educating and convincing consumers to opt for electrification means stressing the benefits of having suitable products in the home. "There is a growing consensus that building electrification is the most viable and predictable path to zero-emission buildings," notes Betony Jones, an inclusive economics consultant to the UCLA Luskin Center for Innovation "This consensus is due to the availability of off-the-shelf, highly efficient electric technologies (such as heat pumps) and the continued reduction of emission intensities in the electricity sector."

There's also a wider-ranging marketing point: electrification's overall impact on the environment. According to RMI, there are two good reasons for houses to be all-electric: the health of the home's residents and the health of the planet. As noted earlier, the use of natural gas in homes contributes to the 560 million tons of CO_2 generated each year in the U.S. Gas stoves also emit pollutants such as nitrogen dioxide and carbon monoxide into the home, resulting in asthma and other ailments. Everyday indoor activities, such as the cooking of meals, can enable those invisible pollutants to easily reach levels that would be illegal outdoors, according to Bruce Nilles, RMI's former managing director and current CEO of Energy Innovation, a San Francisco-based environmental policy think tank.

Not only is it safer and healthier to go all electric, but the time is right, RMI adds. "New technologies such as heat pumps and induction stoves are extremely efficient," the institution notes. "And with the price of renewable energy falling, people can affordably run their appliances on clean energy."



Power surge. The overall percent of homes using all electricity vs. partial equipment is growing steadily, with air conditioning and clothes dryers leading the way. CREDIT: U.S. ENERGY INFORMATION ADMINISTRATION



Rising insight. Revenue for fully electrified home technologies, especially insulation and hot water heat pumps, is expected to grow exponentially between now and the end of the decade. SOURCE: GUIDEHOUSE INSIGHTS

As an example, RMI cites Habitat for Humanity's Basalt Vista, an affordable housing community of two- to four-bedroom homes under development in Basalt, Colorado. Each home is equipped with an 11 kilowatt (kW) solar photovoltaic system on the roof, heat pumps, induction stoves, electric vehicle charging stations, LED lighting, and Energy Star-rated appliances.

All residents receive training and a homeowner's manual that explains how to interact with the various new appliances and pieces of equipment. But the manual will have a behavioral aspect, according to Habitat for Humanity Roaring Fork Valley programs coordinator and analyst Bo Blodgett. "We want people to realize that they are part of the net-zero system," he notes, "instead of just thinking about how the system can work for them—or working against it outright."

Of course, the best example of electrification worthiness comes from an "expert." In 2017, Mark Jacobson, a professor of civil and environmental engineering at Stanford University, built a 3,200-square-foot home that showcases everything needed to be net zero. It features a carefully planned daylit design and visible all-electric appliances. There's no gas line; instead, the house uses electricity that powers mini-split ductless heat pumps, an induction cooktop, and a heat recovery ventilation system. And, the home is primarily powered by rooftop solar with backup batteries.

The overall process works so well, Jacobson can sell up to two-thirds of the energy generated each year back to the local utility. But more importantly, the dwelling serves as a model for what can be done when someone wants to divorce themselves from using fossil fuels. On the Silicon Valley Clean Energy website, Jacobson notes that he's spent much of his career working to understand air pollution and Climate Change in order to develop large-scale, clean, renewable energy solutions.

The house, he notes, is a shining example of that goal. "I wanted to practice what I preach," he says. **GB**

Home sweet green home. Basalt Vista, an affordable housing community under development in Colorado, provides residents with a chance to experience the merits of green energy appliances and devices. CREDIT: HABITAT FOR HUMANITY ROARING FORK VALLEY

PV power base. With better technology and a lower price point, photovoltaics have come of age. Today's solar panels are 30 percent more efficient than units built 20 years ago. CREDIT: JOE WACHUNAS

Electrification Accomplished

Converting a fossil fuel-heavy home to an all-electric design takes time, but when it's done, there's financial and environmental satisfaction.

BY JOSEPH WACHUNAS

"HI, I'D LIKE TO CANCEL MY SERVICE."

These seven anticlimactic words in a phone call to our natural gas company marked a momentous achievement for my family—the final black pipe carrying fossil fuels deep from North Dakota Bakken fields into our home has been shut off.

Our middle class family of three, living in a 1980s ranch home, has electrified everything. And in doing so, we've joined a movement—a green energy strategy—with three fundamental tenets:

1. Electricity is the quickest and most-realistic path to CO_2 emission free energy.
2. All household appliances and forms of transportation should be switched to the most-energy efficient electric models available.
3. Energy should be provided through renewables—ideally from local sources—such as solar on rooftops.

Follow these three tenets and you can have your modern comforts "cake" and eat it, too. Enjoy the fruits of technological progress and stop sending greenhouse gases into an ever-warmer atmosphere [over] the next 100 years.

We were already believers in number 1 and it took us six years of lackadaisically working to electrify everything to officially achieve number 2, and we'll check off number 3 later this year.

Electrifying everything has been neither expensive nor difficult. It has basically meant replacing old, inefficient gas appliances at the end of their lives with new, energy-efficient electric ones.

HEAT PUMP

We happened upon this strategy when we bought our house in 2012. Immediately after moving in, we decided to turn the garage into an apartment, which meant replacing a 20-year-old furnace that was taking up valuable real estate.

By removing this old heating system, we explored cleaner alternatives and discovered heat pumps, which would become a fundamental part of our overall electrification strategy, and give us the option of air conditioning in addition to heat.

[Because] heat pumps move hot or cold air rather than create it, they can find heat even in air that feels cold, and lure it in. This makes them extremely efficient—at least four times more so than electric resistance heating and natural gas. Heat pumps run on electricity, but sip it like fine wine rather than chug it like cheap beer. Refrigerators and air conditioners are heat pumps, so the technology is proven and widespread. When heating a space, the direction is reversed to pull the heat into a space rather than out of it.

Our system includes two interior, wall-mounted "heads" that bring in warm (or cool) air captured by a compressor placed outside. Our trusty heat pumps were cost equivalent to a new fossil fuel furnace, and have been keeping us warmed and cooled, with electricity, for over six years.

The heat pumps proved to be a huge success. We knocked out a chunk of our natural gas usage and still had lower-than-average electric bills, despite using electricity to heat our home.

HEAT PUMP WATER HEATER

The next gas user we tackled was the hot water heater. Like our

Hot air affair. An electric heat pump's ability to move hot or cool air from one place to another makes it invaluable in the effort to turn a house fossil-fuel free. CREDIT: JOE WACHUNAS

furnace, this 20-year-old appliance was approaching the end of its life. It was also responsible for a ton of our energy use (18 percent in the average home) and excessive carbon emissions (3,000 pounds per year). While researching electric alternatives, we happily discovered that the heat pumps that were magically heating our home by pulling heat from cold air could also be used to steam our showers.

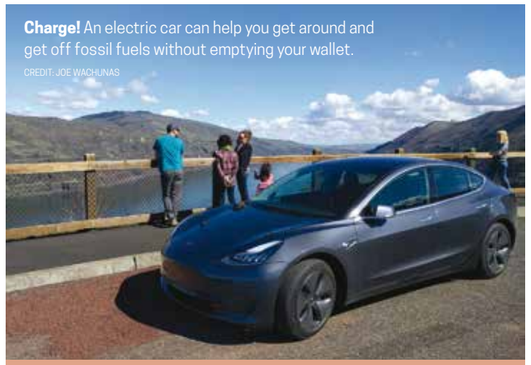
But we had to venture into uncharted territory. Heat pump water heaters were (and still are) new enough that I had a hard time finding a contractor who was familiar with them. I did much of the research myself. We had to become early adopters and embrace a relatively new technology.

In this case, the reward for our risk was huge. This incredible water heater uses a quarter to an eighth of the energy of a "standard" (electric resistance or gas) hot water heater. This translates into savings of $200 to $400 dollars per year. Like the ductless heat pumps on our walls, there is little difference in the initial cost of the technology and we still enjoy all the hot water we want.

While these water heaters may seem too good to be true, I can personally testify to their awesomeness. Beleaguered friends, who I regularly bombard with statistics and tours of my utility closet, ask why they haven't heard of these before.

Heat pump water heaters have the potential to be game changers in our climate crisis, given the large amount of energy and CO_2 emissions they save. I love ours so much that I installed a second one in our garage apartment. This [unit] not only produces hot water for showers but also heats the entire apartment through a hydronic radiant floor heating system.

An electric alternative. A heat pump water heater, such as this *ProTerra* model from Rheem, pulls warmth from the surrounding air and dumps it—at a higher temperature—into a tank to heat water. This makes it two to three times more energy efficient than a conventional electric resistance unit. CREDIT: LIBBY LASSEIGNE/RHEEM MANUFACTURING



Charge! An electric car can help you get around and get off fossil fuels without emptying your wallet.
CREDIT: JOE WACHUNAS

Green Wheels in Motion

WITH OUR ELECTRIFICATION project gaining steam, we were hungry to cut out even more fossil fuels. The obvious next step was transportation. My family is lucky to live in a dense, urban area with amazing options for walking, running, biking, scootering and mass transit. But we also use a car and the cleanest way to fuel it is with electricity.

In 2017, we joined the electric car movement (our first car ever) by buying a used Nissan Leaf with 10,000 miles on it—for only $7,800! I love this car more than I thought I would ever love a car. Not only does its electric motor drive extremely smoothly, but it will virtually never need maintenance and "fueling" it is ridiculously cheap. I spend about 75 cents for a gallon equivalent (30 miles of driving). To drive our average 6,000 miles a year, we pay only $150. Gas, for an equivalent car, would be four to five times that amount. Plus, when I charge my car while the sun is shining, I have an immense and indescribable satisfaction that the solar panels on my roof are fueling my transportation. I am my own oilman, refiner, gas station and energy producer.

INDUCTION STOVE

The next front in the battle to rid the last bastions of fossil fuel energy from our lives took place in the kitchen. Again, we discovered a new(ish), efficient and electric technology—induction cooking.

Induction cooking changes everything in the kitchen. Before, our choices were gas or electric coils. Both are inefficient, but gas had the upper hand due to its cozy flame and ability to quickly control temperatures.

Turns out, induction stovetops match gas in their ability to quickly change and control heat. They also create heat far more quickly and can boil six cups of water in three minutes. The technology creates a magnetic field that directly heats iron in pans, so rather than heating the space under a pan, it heats the pan itself. Induction stoves are also the safest. The cooktop is not hot to the touch unless you put a magnetic pan on it, and the burner turns off automatically after 10 seconds when it doesn't detect a pan. This was a big win for our toddler!

If you're looking to electrify everything, this efficient, safe, responsive cooking technology allows you to leave gas behind and cook food in a cleaner, electric way.

SOLAR PANELS

As we've been electrifying our house, we've also been increasing the energy production on our own roof. It amazes and excites me that I live in a time where this is possible. In decades past, even the most-staunch environmentalist was mostly dependent on large power plants and couldn't imagine being an independent, clean energy producer.

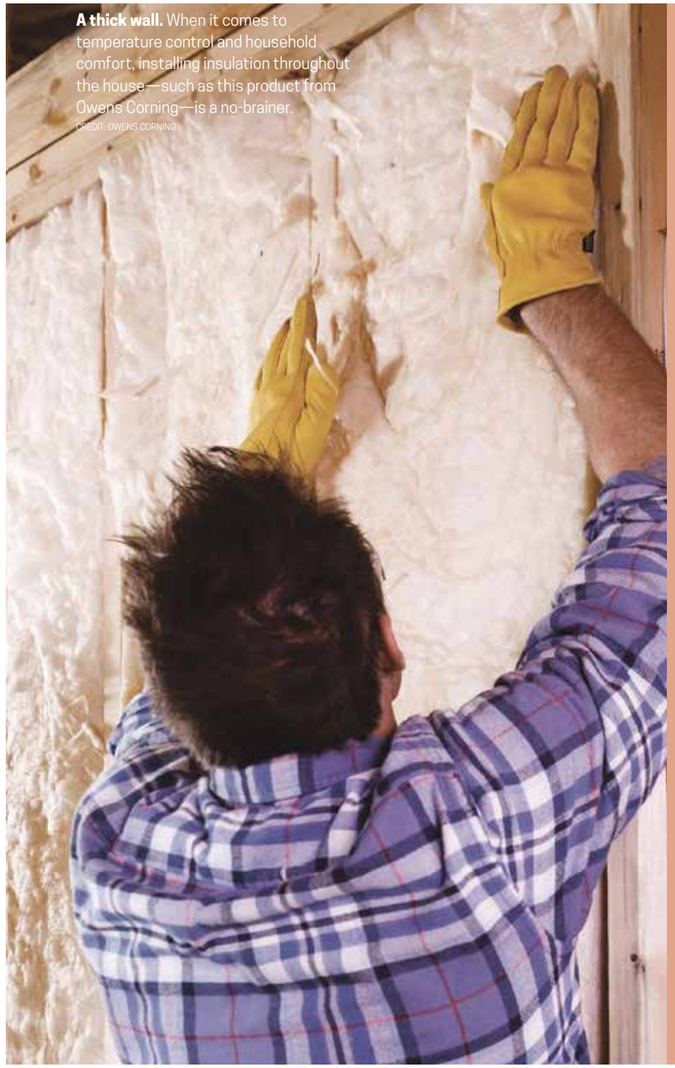
But with solar, I have this option. I can invest in stable, lucrative and local energy production. I can be my own power provider, getting in on action that was once reserved for institutional investors and big corporations.

The financial return on our investment has been amazing. We paid $12,000 down in two separate system leases (7.2 kilowatts [kW] and 28 panels total) and received all that money back in Oregon income tax credits over eight years. We took part in an interesting pricing structure called a "prepaid power purchase agreement." Not only do we get our initial investment back in state tax credits but we also receive free solar power for 20 years, which is about $20,000 in free electricity!

Incentives and price structures change all the time, so I don't think we'll be able to take part in something so lucrative this time, but whatever the cost structure looks like, we'll be thrilled to increase our personal energy generation and have it power our electric home.

Our home will, at long last, be "net zero." We produce more energy than we can consume in the summer and get credit for it in the winter when we aren't producing as much as we need. Over the course of a year, all the electricity we consume will be produced on our property. Our story demonstrates that a normal, middle-class family can achieve a carbon neutral home relatively easily, while saving money and relishing in the satisfaction that we are doing our part to fight climate change through these normally overlooked household systems. **GB**

Joe Wachunas lives in Portland, Oregon, and works for the nonprofit Forth*, which promotes electric transportation. He is also involved with* Electrify Now*, which offers educational resources on electrification.*



A thick wall. When it comes to temperature control and household comfort, installing insulation throughout the house—such as this product from Owens Corning—is a no-brainer.
CREDIT: OWENS CORNING

Making Electricity Truly Efficient

YOU CAN ELECTRIFY EVERYTHING and still squander it away like tokens at Chuck E Cheese. Equally, if not more, important to electrifying our homes are strategies to use energy wisely.

Well before our electrification campaign, we learned to identify the electricity hogs in our home and either not use them or use them as efficiently as possible. We have a whopping six people in three separate units on our property. In addition to our family of three, we have a long-term tenant in our garage rental apartment and [a rental] that accommodates two guests. And still, our house uses only 51 percent of the energy of an average home in the U.S. Per person, we consume only 22 percent.

Our key energy saving strategies:

HANG DRY CLOTHES. Dryers consume too much electricity. As a former Italian exchange student, I noticed that only 3 percent of Italians have clothes dryers. As I follow their lead, [I'm] saving approximately 10-12 percent in annual electricity use by hanging our clothes outdoors in the summer and even indoors in the winter. For those who need a backup plan during winter months, highly efficient heat pump dryers are now available.

USE LOW FLOW SHOWER HEADS. I have a couple great ones that use half the water of an average shower head but still provide a spa-like showering experience. This saves oodles of energy from reduced hot water usage.

INSTALL LEDS AND TURN OFF THE LIGHTS. [This is] the original, and perhaps easiest, of all energy efficiency measures.

Use natural ventilation. Cross breezes in the summer cool our house and we use air conditioning—from the ductless heat pumps—very sparingly.

WASH CLOTHES WITH COLD WATER. Even Consumer Reports says it's not necessary to use hot water.

INSULATE EVERYTHING. Houses that hold heat and cold when they're meant to mean way less energy for space conditioning. We added more attic insulation, air sealed penetrations in walls, and any new construction on our house went way over code with how we insulated.

These strategies may sound insignificant and/or cumbersome, but they are impactful ways to substantially reduce energy consumption and the climate impacts caused by it. Combined with our [other] efficient electric technologies, "Tenet Three"—myself, my wife and our daughter—becomes possible.

Double duty. Solar *Hydropanels* act like solar panels, providing renewable energy off the grid. But they also pull moisture out of the air and produce up to five liters of drinking water per panel each day. COURTESY OF SOURCE

Charging Forward

These new or upcoming tech products may make electrification the greenest way to power up the household.

BY MARC SCHAUS

IF WE WANT OUR SOCIETIES TO APPROACH net-zero carbon emission status, their many features must require less energy. They must integrate more sources of renewable energy systemically. These are largely the needs of developing smarter homes for ourselves, as well: cut energy and resource expenditure needs significantly to become more sustainable.

What kinds of new technologies can help reduce our home energy needs? Generally, insulation to save on heating; air conditioning and shading developments to save on cooling; renewably produced hot water; smart grid-capable appliances; and anything else that will reduce our draw on energy resources.

Now, new insulating materials do not necessarily make for sexy book content. And many are not all that futuristic: techniques like advanced framing, high-performance walls, closed-cell spray foam, rigid foam boards, flooring insulation, and minimizing thermal bridging have gotten us pretty close to the insulation meeting net-zero building standards. But newer materials like nanostructured aerogels are becoming more standard for new homes, vastly reducing heat transfer beyond walls and through the roof.

Newly developed Massachusetts Institute of Technology (MIT) aerogels are actually transparent and applicable for smarter glass insulation, providing another opportunity for advanced insulation (and cost savings). Windows outfitted with greater insulating material will be helpful for colder climates, allowing more sunlight to enter but not exit, like a greenhouse effect. Scientists also envision passive solar collectors with transparent insulation heating hot water pipes or other areas where heat is required all the time, rather than merely lining specific room windows.

Healthy harvest. Michigan State University has been working to finalize a transparent, glass-like solar harvesting system that when applied to windows is capable of producing as much electricity as bigger, bulkier rooftop photovoltaic panels. CREDIT: MSU

NOT YOUR EVERYDAY WINDOW GLASS

Windows have already received a considerable upgrade with energy harvesting tech. Transparent solar cell (TSC) panels have been used in greenhouse roofing and building windows, creating an opportunity for homeowners of the future to generate solar energy from window space. But incredibly, that means new smart glass windows will also have the ability to block selective wavelengths of light from even entering buildings.

Transparent solar-harvesting systems will use molecular designs capable of absorbing only wavelengths of light that we cannot see—like ultraviolet and near-infrared—converting just those wavelengths into energy while allowing us to see the rest of our visible spectrum.

Aside from generating energy, this will allow windows of the future to block out specific wavelengths of light to also bypass some of the heat our homes would otherwise be absorbing, and to potentially bypass the need for blinds on sunny days with electrochromatic shading control.

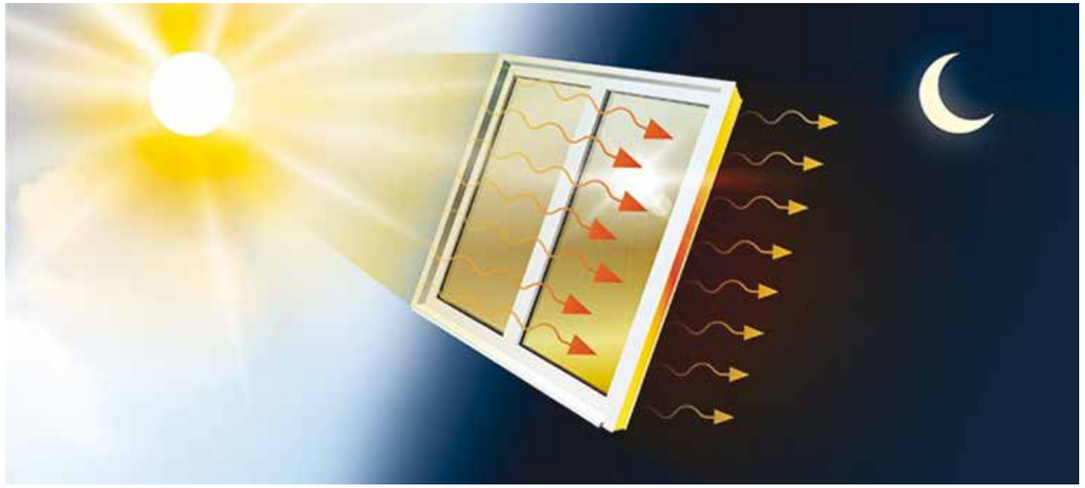
"Chromism" refers to chemical processes that induce a change in color, often with the connotation that the change is reversible. The term electrochromatic, then, refers to an electricity-induced chemical change in color. Within the context of windows, scientists have found that by putting materials with chromatic qualities inside panes of glass, they can alter a number of features with a very small electric input. The result is that smart windows allow for reversible changes in opacity and transparency.

Glass with opacity alteration means a new system of window blinds. The smart glass *TruTint* from Nodis reportedly allows for instantaneous change while achieving up to 10 times lower costs in heat efficiency. The product offers an "infinite" number of tints and infrared control to optimize indoor climate and energy savings, according to suppliers. (Though I suspect the range of options is not literally infinite.)

Newer developments allow for altered reflectivity in response to specific wavelengths of light, implying self-tinting windows for bright days. *Project Drawdown* has estimated that adopting a technology like smart glass into largescale commercial buildings and in residential applications can result in a greenhouse gas reduction of 2.2 gigatons. And the technology is particularly useful if it also saves us money.

According to *Drawdown*, tests of electrochromatic glass in Japan have reduced cooling loads by more than 30 percent on hot days. And while purchase and installation costs may be twice as expensive as normal windows, energy savings make them more than competitive. Some newer models of smart glass may have the ability to harness some energy from the sunlight hitting your windows through TSC tech, resulting in even more savings.

For homeowners who don't want to draw their shades via app,



Making the 'MOST' of sunlight. Scientists from Chalmers University of Technology in Sweden have developed a molecular solar thermal (MOST) window film that can absorb energy from the sun's rays and later emit it as heat for up to eight hours after sunset. CREDIT: YEN STRANDQVIST/CHALMERS

some new smart window models simply use coatings that offer similar—but offline—features like auto-shading. Smart window coatings are essentially filled with very small, water-filled balls that shrink or expand with temperature. One academic team published in the science journal *Joule* revealed that their film of microscopic particles alone could reduce temperature (without a loss of visibility) by as much as nearly 10 degrees Fahrenheit. The coat reportedly reflects up to 70 percent of the sun's heat while letting in visible light, freeing up more of our energy from use on air conditioning.

Some researchers have been hard at work producing a do-it-yourself (DIY) paint-on coating version of the aerogel tech, offering homeowners an energy-efficient window coating at one-tenth the cost of professionally installed retrofits.

HEATING UP TO STAY COOL

We may even be able to capture the thermal energy of incoming sunlight streaming through our windows, and—rather than harnessing the electricity through TSC—use materials similar to the thermal energy "hybrid" panels to retain it. To recap, thermal hybrid panels will soon be capable of placement on rooftops as traditional solar panels are, but they would capture thermal energy for immediate or (through storage) later use.

The device may bridge our much-needed gap in "solar+storage" technology. In terms of window tech, one new film with a uniquely designed molecular chemistry now offers an ability to capture thermal energy from solar rays and distribute it evenly throughout the glass. Materials have a yellowish tint at the start of the day, isomerize and turn transparent in response to solar heat, then reverse over time at night to re-start the cycle.

As long as the sun is shining on the window's film, less heat can penetrate into rooms. But the added bonus is that heat can be stored for much longer periods than just hours, or even days. Researchers envisioned that by using a molecular solar thermal (MOST) storage system, homeowners may be able to store thermal energy for weeks or even months.

RADIANT IDEAS

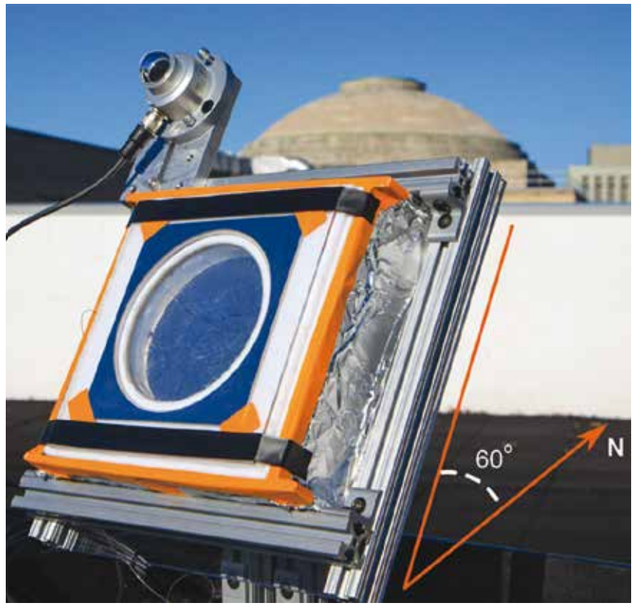
One of the most fascinating new developments in refrigerant technology involves the concept of radiative cooling...yet another interesting take on generating energy from the world around us. But given that the concept implies a sky-facing surface should be cooler than the air around it, does that not also imply a plausible connection for our cooling needs?

Indeed it does. Because heat escapes along a thermal gradient leading out into the cold of space from the surface(s) of our planet, this has led some scientists to conclude that we might build materials to recycle the slight dip in surface-level temperature. And by setting up a specially structured reflective material, scientists were recently able to direct a wavelength of light back out into space that escapes our atmospheric cover more easily—leading to a radiative cooling effect even during the day. As a result, a material able to direct unique wavelengths more readily can become about 5 degrees Celsius cooler than ambient air temperatures.

A similar device was also developed by scientists at the University of Buffalo. It requires no added electricity to function. The system is essentially a low-cost polymer/aluminum film installed inside a box located at the bottom of a solar "shelter." The film performs radiative cooling and keeps ambient air within the shelter cool by re-directing more of the surrounding heat—with a sky-facing design that actively channels thermal radiation more directly from the film into the atmosphere. The device helps to corral and focus directed heat away from ambient surroundings without any use of electricity. According to the team's research, temperature reductions around the enclosed space dropped by about 6°C (11°F) during the day and 11°C (about 20°F) at night.

One geoengineering initiative falling under a category of solar radiation management (SRM) includes painting our rooftops colors that reflect away more sunlight to reduce the amount of heat absorbed. So-called "cool roof" coatings can not only reduce the amount of heat warming up a home, but also slightly reduce the surrounding air temperature—particularly if many homes in an area use them. New research from the Department of Energy's Lawrence Berkeley National Laboratory has shown that widespread adoption of cool roofs can also lower overnight temperatures during hotter evenings as well.

Cool roof materials will definitely benefit from new applications in nano-scale surface material developments. For example, a growing number of nanophotonic materials have been developed, allowing scientists to manipulate the way light encounters materials at the nano scale.



Window dressing. Transparent nanostructured aerogels can reduce heat transfer beyond walls and through the roof. When applied to windows, these aerogels allow more sunlight to enter but not exit, making it ideal for heating homes. CREDIT: STUART DARSCH/MIT

One new development in materials sciences from Berkeley, California-based Cypris Materials involves self-assembling reflective coatings offering tailored optical properties for even more selective wavelength reflection. The company's coatings enable more heat mitigation by reflecting ultraviolet and near-infrared radiation like the models above—but rather than merely applying to windows, Cypris' coatings could be also placed on walls and rooftops to reflect more of the sun's rays with a transparent, colorless coating.

EVER-VITAL, ALWAYS-PRESENT H2O

In terms of saving on resources in homes (simultaneously saving the city at large from shuttling them in), nothing may be more upending than the ability to procure one's own water. And now, tech similar to the devices used by scientists to draw in moisture from ambient air and harness the molecular portions of water can also be used by homeowners—in the form of solar panels able to draw in and sequester water for domestic use.

Tempe, Arizona-based SOURCE Global produces a line of solar *Hydropanels* that not only provide renewable energy off the grid, but also reportedly produce between 2 to 5 liters of drinking water per panel, per day (relative to sunlight and the surrounding humidity, of course—about a half-gallon to 1.3 gallons in conversion).

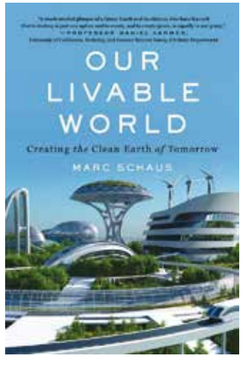
Essentially, *Hydropanels* use solar power to pull in large amounts of air, then collect moisture from that air onto an absorbing material, with solar heat converting it into water [and then] into a 30-liter (7.9 gallon) reservoir, where it is mineralized and kept clean using ozonation. Incredibly, reservoirs can also be run directly to internal faucets.

Engineers with SOURCE have more recently unveiled an additional series of system sensors to fine-tune owners' monitoring of the water reservoir itself. Sensors will allow customers to keep tabs on the water quality in real time and monitor daily reports via the SOURCE app.

Standardized assessment protocols also now exist for gauging the emissions standards for various materials throughout construction. This is especially encouraging because of how complicated it must be. Any one construction project may contain literally thousands of different materials, all with varying carbon emission impacts. Immense tracking applications for materials worldwide have been entered into an Environmental Product Declaration (EPD) increasingly utilized by more construction companies to chart carbon cost for different materials. Anything from insulation and ceiling tiles to metal framing and insulation materials are included.

New tools like EC3 (Embodied Carbon in Construction Calculator) use Microsoft-driven analysis of thousands of EDP items to calculate carbon impacts more quickly. We will explore the concept of "regenerative architecture" as one strategy among many others to sequester more CO2 over the coming years, but for now, yet another avenue exists primarily for cutting emissions while still producing first-class buildings. **GB**

This story was excerpted from *Our Livable World: Creating the Clean Earth of Tomorrow* by Marc Schaus. Content has been edited for length and is being reprinted by permission of the author and the publisher, Diversion Books.



Marc Schaus is a professional research specialist across the sciences for research ventures, craft product manuals, and policymakers. He is the author of Post Secular: Science, Humanism and the Future of Faith, and has written articles that have appeared in Areo Magazine, Free Inquiry Magazine, The Huffington Post, Patheos, and the academic journal Antennae. He currently resides in Ontario, Canada.

DOE Annual Building Science Roundup

A BETTER WAY

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

A virtual winner. Healthy Communities in Williamsburg, Virginia, is among the Grand Winner nominees at the U.S. Department of Energy's 2020 Housing Innovation Awards, which is being held virtually for the first time.
COURTESY OF HEALTHY COMMUNITIES

Zero Energy Ready Home award winners hold an enduring appeal: They're not your run-of-the-mill residential dwellings.

THUS FAR, 2020 HAS CHALLENGED everyone to be better than they were last year. Better at making choices, taking action, and deciding whether to accept the status quo or move on to something new.

In this year's showcase of recent U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) Housing Innovation Awards winners, we feature builders who opted to be better. Their projects tackled long-standing homeowner problems—climate control, high utility costs, durability and the ability to simply keep the lights on during Mother Nature's wrath—and swatted them away for something better.

There were ground rules: The ZERH program requires certification to Energy Star Certified Homes Version 3.0, 3.1 or 3.2, as well as the U.S. Environmental Protection Agency (EPA)'s Indoor airPLUS program, the insulation mandates of International Energy Conservation Code (IECC), and other mandatory requirements of the DOE program.

But in the end, these uniquely planned and carefully crafted projects met their developers' ultimate goal, one that all builders can strive for.

They were made to be better.

THE HIGH LIFE

Building a home against a mountainside required precision and teamwork among builders. But when done, it was precisely what the owner's pocketbook ordered.

PERCHED HIGH ON A mountainside in southwestern Colorado, the Glacier Club Modern Home offered commanding views and incredible challenges for the home builder. Mantell-Hecathorn Builders of Durango, Colorado, was up to the challenge, delivering a home that was architecturally stunning and surpassed the builder's own goals for high performance by winning a Housing Innovation Award from the U.S. Department of Energy (DOE) Zero Energy Ready Home (ZERH) program.

"This was by far the most challenging site and house design in Mantell-Hecathorn Builders' 44 years of building custom homes," says Hunter Mantell-Hecathorn, a principal in the custom home building company started by his parents Greg and Tara in 1975. "If ever there was a home that required constant innovation, this was the home."

Located on a half-acre parcel at 7,600 feet elevation, with a 40-degree rock slope, the site required blasting to nestle and anchor the foundation into the rocky mountainside. The builder also had to contend with heavy snowfalls that could accumulate on and around the house and a fractured rock substrate that allowed subsurface moisture to percolate upward through the rock fissures to the site's surface, especially during spring thaw and heavy summer rains. These issues added to the complexity of site excavation; the builder installed an all-encompassing system of

French drains under and around the home, as well as surface drains, radon trenches and pipes under the lower level.

"The extremely complicated foundation plan required consistent and precise interaction with the surveyor, blasting subcontractor, excavator, concrete subcontractor and engineers," Mantell-Hecathorn says. "The site topography and space constraints required extensive additional effort to simply achieve construction, and provided significant challenges to successful attainment of the DOE ZERH standards."

By all accounts, Mantell-Hecathorn Builders was successful in meeting the challenge, implementing the innovative design by renowned regional architect Jon Pomeroy in a three-level, 4,937-square-foot home that achieved a Home Energy Rating System (HERS) score of 46. A typical code-built home would score an 80 to 100 on the HERS score and a net zero home would score a 0. When the 7.2-kW solar photovoltaic system is included on this house, the HERS score drops to 20, and projected annual energy costs are more than cut in half. That means an annual bill of about $1,000 per year, or less than $85 per month, which is far lower than most homeowners could expect to pay for heating and cooling a home one-third the size.

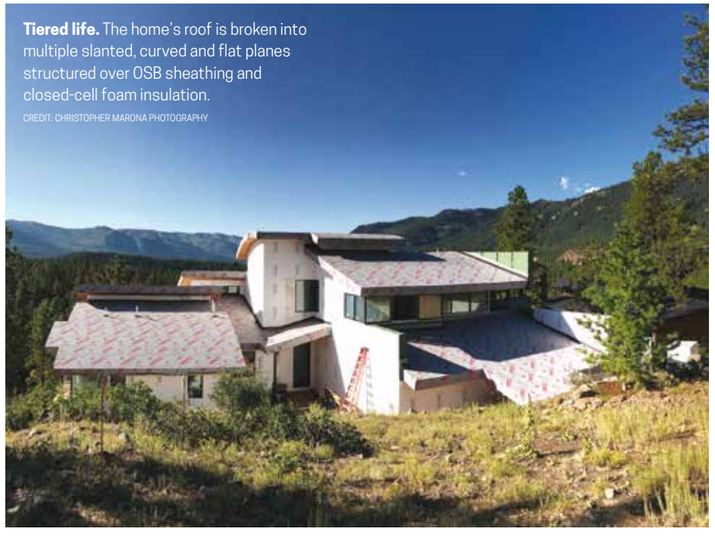
Even without the PV, the annual energy costs are expected to be $2,500, a projected savings of $1,400 over a home just built to the local energy code, which is the 2009 International Energy Conservation Code (IECC).

COST CUTTERS

Building to this level of energy efficiency is nothing new for Mantell-Hecathorn, a long-time ENERGY STAR builder in a state that has no licensing requirement for general contractors, in counties that don't inspect for energy efficiency, and in jurisdictions that until recently hadn't updated their energy code since the 2003 edition. La Plata County, where Durango is located, recently adopted the 2009 IECC and the City of Durango just adopted the 2015 IECC code this year, thanks in part to education by the Mantell-Hecathorns.

Mantell-Hecathorn Builders committed to building all of its homes to the DOE ZERH specification in 2013 when the program started. It has certified 14 homes so far. They are the only builder in southwest Colorado to make this 100 percent commitment. The DOE ZERH program gives builders a road map to build homes that are more energy efficient, comfortable and durable than current code requires, and a third-party verification process helps convey confidence

Hard work. Construction of Glacier Club Modern Home posed a number of challenges, including its high altitude and its location against a highly sloped rocky mountainside.
CREDIT: CHRISTOPHER MARONA PHOTOGRAPHY



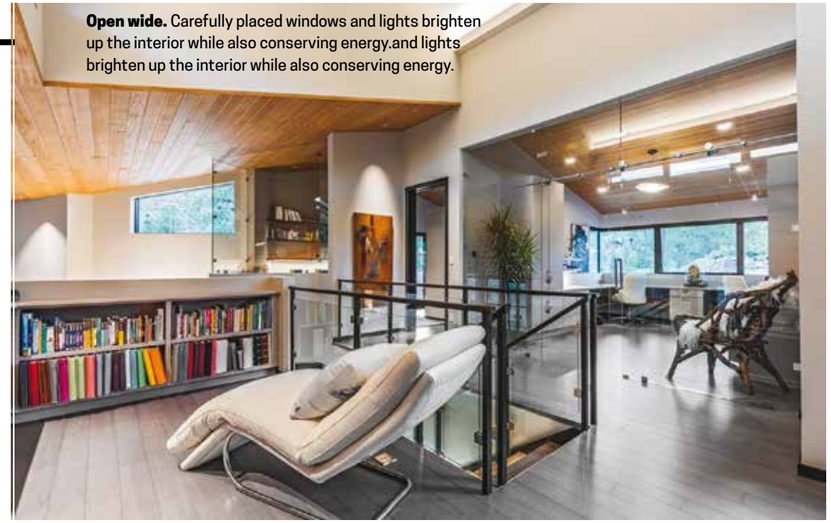
Tiered life. The home's roof is broken into multiple slanted, curved and flat planes structured over OSB sheathing and closed-cell foam insulation.
CREDIT: CHRISTOPHER MARONA PHOTOGRAPHY

Inside views. Energy-saving internal elements include solar-powered LED lighting, heat-absorbing flooring, and heavily insulated walls and ceilings.

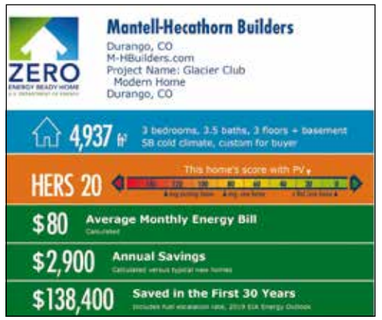
CREDIT: CHRISTOPHER MARONA PHOTOGRAPHY

MANTELL-HECATHORN BUILDERS

Glacier Club Modern Home, 2019



Open wide. Carefully placed windows and lights brighten up the interior while also conserving energy.and lights brighten up the interior while also conserving energy.



confidence to the homeowner that the home will deliver what Mantell-Hecathorn promises.

Greg Mantell-Hecathorn stresses the value of the third-party verification required by the DOE program. It makes it known "that we are providing our clients and the community with homes that provide long-lasting value, greater comfort and performance, and which are tested to meet those high standards for superior quality and energy efficiency," he says. "We believe that the DOE Zero Energy Ready program provides the best verifiable platform for high performance standards, while allowing the flexibility to be adapted to the wide variety of custom homes that we build."

HEADED IN THE RIGHT DIRECTION

On this home, builders took full advantage of the exceptional southern exposure of the site for optimal solar collection and passive solar heating potential. They installed a 7.2-kW array of solar panels on the standing seam metal roof and large amounts of glazing on the south-facing side of the home.

All windows are triple-paned, with an insulation value of U-0.19 (R-5.26). The windows have two low-emissivity coatings to help minimize radiative heat transfer through the glass. The windows are not gas filled due to the high altitude. All windows have aluminum-clad wood frames and most are fixed rather than openable, which provides unobstructed views, better resistance to wind pressures, and more air tightness. The windows have a high solar heat gain coefficient (SHGC) of 0.50 to allow in beneficial solar heat gain in the winter.

Motorized blinds installed on the interior side of the windows can be scheduled to operate automatically to keep out unwanted summer solar sun. Deep overhangs and covered balconies also minimize heat gain from high overhead summer sun. Lighting controls are integrated with the home automation and energy management system.

The standing seam roof cladding covers a roof that is broken into multiple slanted, curved, and flat planes on this modern home. The roof structure consists of 12-inch I joists with no attic space. All of the upper level consists of cathedral ceilings that are insulated with 7 inches of closed-cell foam against the underside of the OSB roof sheathing plus R-19 of fiberglass batt. The sheathing is completely covered with an adhered ice and water barrier underlayment.

The walls consist of 2-by-6 at 24-inch on-center stud-framed walls that are filled with 2.5 inches of closed-cell spray foam, which provides insulation, air sealing, and some structural rigidity to the walls. The remainder of the wall cavity is filled with 3 inches of loose-fill fiberglass. The walls are sheathed with a coated OSB product, then topped with 2 inches of rigid foam. A rainscreen was installed behind the stucco and stone cladding, and ¾-inch furring strips were installed behind wall sections with lapped siding. The walls have a total insulation value of R-38.

In addition to the spray foam layer in the wall, cavities and the underside of the roof deck, sections of the floor that were cantilevered were also insulated from underneath with spray foam. All wood-to-wood seams were sealed with caulk and tape and wood-to-concrete seams were caulked.

The below-grade walls of the basement were poured concrete that was protected on the exterior by a spray-on crystalline waterproofer, 2-inch rigid foam, and a plastic drainage board. The interior walls of the basement level were framed 2-by-4 24-inch on-center stud walls, with 3 inches of closed-cell spray foam, giving the below-grade walls a total insulation value of R-23.

The home achieved an air tightness of 1.5 air changes per hour at 50 Pascals. To provide ventilation, a heat recovery ventilator was installed to bring in fresh air through a MERV 13 filter and to exhaust stale air. The HRV was separately ducted to provide fresh air to every room in the house and to exhaust air from several locations, including the kitchen and bathrooms, which have boost switches to more quickly remove steam.

meets all of the requirements of the EPA Indoor airPLUS including the use of low and no-VOC and formaldehyde-free products. While a beautiful home and low-energy bills are the result, Mantell-Hecathorn's attention to detail and focus on quality construction are what they are most proud of.

"We focus on high performance, not just energy efficiency and lower utility costs, but also building durability, something homeowners can pass down to future generations," says Hunter Mantell-Hecathorn.

IT'S ALL ABOUT TEAMWORK

The company lives up to its motto, "personal attention to detail, one home at a time," limiting projects to two or three per year, so that Hunter or Greg can personally be on site daily to ensure that quality standards are being met by the subcontractors and crews. Mantell-Hecathorn Builders employs five full-time carpenters who receive training, construction documents and daily oversight.

"We don't experience much turnover in our employees, as we always have interesting, challenging, and fun projects to work on," says Hunter Mantell-Hecathorn. "They can feel pride in their work, and we treat them as valued, respected members of our company." The company put effort into finding subcontractors willing to meet their standards. Mantell-Hecathorn meets with subs during budget formation and plan development, provides written scopes of work for each trade detailing construction methods and materials, requests the best crews, and meets regularly with the principals and the onsite supervisors for each subcontractor trade during construction. "Quality construction is something we take a lot of pride in, and our company is known for that dedication," he says.

A 96 percent efficient wall-hung boiler provides domestic hot water to the home and hydronic radiant floor heating to all three floors. Passive solar gain adds to the space heating. Cooling is provided by a SEER 22 heat pump.

Energy Star appliances, LED lighting, and low-flow EPA WaterSense-labeled fixtures add to energy and water savings.

A main-floor master bedroom and elevator are among the aging-in-place features designed into the home. The home

KEY FEATURES

WALLS: 2-by-6 24-inch on center advanced framing, R-38 total: 5/8-inch drywall. In cavity 2.5-inch closed-cell spray foam plus 3-inch loosefill fiberglass. On exterior, coated OSB sheathing, 2-inch rigid foam, rainscreen under stucco or stone, or 3/4-inch furring strips under siding.

ROOF: Shed roof, 5/8-inch coated OSB sheathing, ice-and-water shield, metal roof.

ATTIC: Cathedral ceilings: 3/4-inch tongue-and-groove Douglas Fir, 5/8-inch drywall, 11-7/8-inch I-joists, R-19 batt, 7-inch closed cell spray foam.

FOUNDATION: Insulated basement, R-23 total: 55/8-inch drywall, 2-by-4 studs, 24-inch on center; 3-inch closed-cell spray foam, 8-inch poured concrete, water proofing, 2-inch rigid foam, drainage board.

WINDOWS: Triple-pane, low-e2, aluminum clad wood fixed frames, interior motorized blinds, U=0.19, SHGC=0.50.

AIR SEALING: 1.5 ACH 50.

VENTILATION: HRV, continuous ventilation, boost switches in bathroom, MERV 13 filters.

HVAC: Radiant floor heat from wallhung gas boiler, 96 percent AFUE; 22 SEER AC; passive solar.

HOT WATER: Wall-hung gas-fired boiler, 96 percent AFUE, 80-gallon push button recirculation pump.

LIGHTING: 100 percent LED, integrated lighting controls.

APPLIANCES: ENERGY STAR dishwasher, clothes washer and refrigerator.

SOLAR: 7.2-kW PV system.

WATER CONSERVATION: WaterSense fixtures; drought-resistant landscaping.

ENERGY MANAGEMENT SYSTEM: Smart thermostats, lighting automation, PV tracking.

OTHER: Aging-in-place, all low-to-no-VOC and formaldehyde-free products.

INDESTRUCTIBLE ELEGANCE

This home's disaster-resistant build and green energy source give it the best of both worlds.

OWNERS OF THIS new 2,512-square-foot home in Newburgh, New York, can rest easy, knowing that their home is resistant to hurricanes, earthquakes, wildfires, tornados, blizzards, mold and bugs; and their monthly electric bill will rarely go above $10 a month. All of this only cost about $10,000 more than a home built to just meet code.

Zero Net Now—formerly Greenhill Contracting—of Esopus, N.Y., built the home out of durable, highly efficient, insulated concrete forms (ICFs). They also built it to the exacting specifications of the U.S. Department of Energy's Zero Energy Ready Home (ZERH) program.

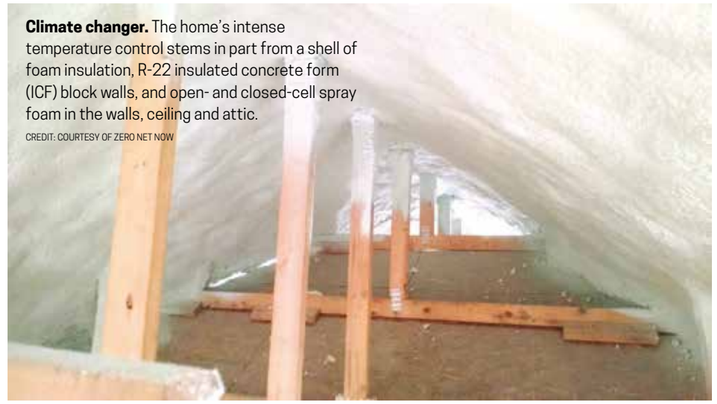
The company constructed its first zero energy home in 2007 and has built 36 zero energy custom homes to date. Zero Net Now, a partner in the DOE ZERH program since its inception in 2013, has committed to certifying all of its homes to the DOE Zero-Energy Home label.

The company routinely achieves among the lowest Home Energy Rating System (HERS) scores in the country. On the HERS index, a typical new home built to code would achieve roughly 80 to 100, while a net zero energy home would score under 10. This is made possible by building a very efficient home, and then adding solar panels that will produce as much energy as the home uses over the course of a year. Zero Net's homes often score below 40 before the addition of the photovoltaic panels.

With this home, Zero Net Now achieved a HERS score of 39 without photovoltaic and minus 5 when the 10.2 kW of solar panels were added.

On-site power. A roof-mounted photovoltaic system offsets electricity usage and cuts energy bills to nearly zero on most months, and leads to a utility bill credit on others.

CREDIT: COURTESY OF ZERO NET NOW



Climate changer. The home's intense temperature control stems in part from a shell of foam insulation, R-22 insulated concrete form (ICF) block walls, and open- and closed-cell spray foam in the walls, ceiling and attic.

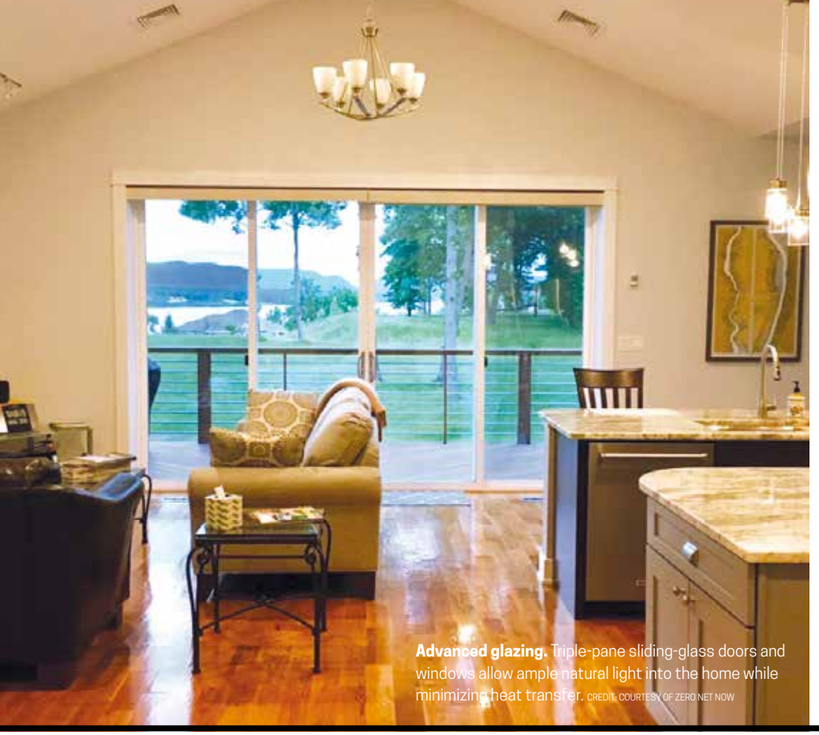
CREDIT: COURTESY OF ZERO NET NOW

BUILDING BLOCKS

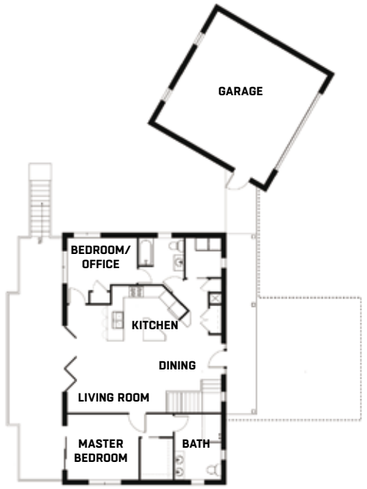
The homes start with the highly insulating properties of insulated concrete forms (ICFs). The 11.25-inch-wide blocks enclose a 6-inch concrete core, with about 2.6 inch of rigid EPS on each side, for a total wall insulation value of R-22.The solid walls are airtight and the continuous foam layers on either side limit thermal bridging or heat transfer through the walls.

The ICF blocks were used in the below-grade basement walls and the above-grade walls, providing a continuous thermal barrier from the footing to the roof line. They also provide R-22 of slab-edge insulation around the basement floor slab.

Before pouring the floor slab, the builder sprayed 4.5 inches (R-29) of closed-cell spray foam directly onto the gravel base, where the



Advanced glazing. Triple-pane sliding-glass doors and windows allow ample natural light into the home while minimizing heat transfer. CREDIT: COURTESY OF ZERO NET NOW



GREENHILL CONTRACTING

Newburgh Custom, 2019

foam serves as a vapor barrier and under-slab insulation.

The ICF blocks are sealed at the seams to provide a continuous air barrier. They also serve as the drainage plane on the exterior side of the walls, so no house wrap is needed. To protect the framing where windows or doors will be installed, an elastomeric waterproofing compound is applied with a caulk gun and putty knife to provide a seamless, jointless flashing layer around the openings. Vinyl siding is used for the exterior cladding. Below-grade portions of the ICF walls are protected with cementitious boards.

"The design and construction utilizes highly durable, moisture-tolerant materials and best practices for water-management so the structures may serve as safe, comfortable homes for many generations to come," says Zero Net Now founder Anthony Aebi. "These reinforced concrete structures are designed to survive severe winds (above 200 miles per hour) and earthquake activity, creating a safe haven for the occupants. These building materials and strategies also create a pest-proof environment."

Aebi constructs a sealed, unvented attic that is insulated on the underside of the roof deck with two types of spray foam. He sprays 10.5 inches (R-46) of open-cell spray foam, followed by 2.5 inches (R-19) of closed-cell foam insulation which completely covers the open-cell spray foam, providing a total attic insulation value of R-65. The closed-cell spray foam also serves as a Class II vapor retarder. The insulated attic serves as a conditioned space for the ducted mini-split HVAC system. Above the roof deck, a self-adhered bitumen membrane is installed at the roof edges and valleys and the roof is covered with enhanced-performance shingles that have a 130 mph wind speed rating and a lifetime warranty.

To allow for an abundance of natural light without sacrificing too much in thermal performance, the builder opted for high-efficiency triple-pane windows. The windows are argon-filled vinyl-framed casement style windows with an insulation value of U-0.18 (R-5.55) and a solar heat gain coefficient (SHGC) of 0.23. Even the sliding doors are triple paned. They have an insulation value of U-0.20 (R-5) and an SHGC of 0.28.

WHERE'S THE AIR?

The home is so airtight that a blower door test of whole-house air leakage showed the home had leakage of only 0.18 air changes per hour at 50 Pascals pressure difference (ACH 50). That level of airtightness (which is typical of Aebi's homes) is far below the 3 ACH 50 required by the 2015 IECC and even well below the 0.60 ACH 50 required in the Passive House Institute U.S. standard.

To provide fresh air for the home, an energy recovery ventilator (ERV) runs 24⅞ at low speed to exhaust air from the bathrooms, kitchen, laundry and attic. The ERV is equipped with CO_2 sensors that will trigger higher levels of ventilation when CO_2 levels exceed 1,000 ppm. The main controller for the HVAC system allows occupants to increase (or decrease) ventilation as desired. Boost-speed controllers are also in each bathroom, and the kitchen for higher-speed exhaust when desired.

Fresh air brought into the home through the supply duct is filtered by a MERV 7 filter as it enters the ERV heat exchanger. Then, it is ducted into the return trunk of the mini-split heat pump prior to the air-handling unit, where it is filtered again via a set of electro-static and MERV 8 media air filters. The redundant air filters, zero-VOC paints and non-combustion HVAC all contribute to indoor air quality.

The home is equipped with a highly efficient ducted mini-split air-source heat pump with Mitsubishi Electric *Hyper-Heating inverter* technology to operate at very low temperatures. It also has a modulating condenser and variable-speed ECM blower. The heat pump and short metal ducts are located in the insulated attic. The heat pump has a heating season performance factor (HSPF) of 9.8, a cooling efficiency of 16 SEER, and an energy efficiency ratio (EER) of 10.3.

Hot water is provided by an air-source heat pump water heater with a 50-gallon tank and an energy factor of 3.53. The water heater is located within the conditioned space of the home and uses a central manifold distribution system with appropriately sized PEX piping (⅜ inches in diameter) that minimizes the volume of water stored in the piping.

Additional energy savings come from the 100 percent LED lighting and ENERGY STAR-rated appliances, including an air-source heat pump clothes dryer. Low-flow EPA WaterSense-labeled plumbing fixtures reduce water usage and water heating demand. Drought-tolerant turf and native plants were planted to eliminate the need for landscape irrigation systems, and 100 percent of stormwater runoff is managed onsite through landscape design.

ROCK SOLID

This energy-efficient ICF house is also disaster resistant. With the footing-to-roofline steel reinforcement, the ICF exterior walls are resistant to earthquakes, tornados and hurricanes. Hurricane clips and closed-cell spray foam in the attic reduce the potential for roof uplift during high winds, and the asphalt shingles are designed to survive 130-mph winds. The ICFs are fire-, moisture- and bug-resistant.

The home's highly insulated enclosure reduces the impacts of power outages. Because of the continuous thermal enclosure, pipes are less likely to freeze and interior temperatures can be maintained for days without power, according to Aebi. "One of our homes was monitored during a four-day period of power outage during severe cold winter weather (outdoor temperatures were between minus 8 degrees Fahrenheit and plus 16 degrees F). The indoor temperature did not drop below 56 degrees F," he says. "This house can serve as a resource on how to provide safe shelter to extended family and friends in the community during severe weather conditions."

Weather warrior. Zero Net Now's project in Newburgh, New York, resists hurricanes, earthquakes, wildfires, tornados, blizzards, mold and bugs—thanks to its all-foam construction.

CREDIT: COURTESY OF ZERO NET NOW

KEY FEATURES

WALLS: ICF, R-22 total: 1/2-inch drywall; 11.25 inches ICF blocks, vinyl siding.

ROOF: Gable roof; 3/4-inch OSB sheathing, self-adhered membrane at valleys and roof edges; underlayment; 130 mph rated asphalt shingles, lifetime warranty.

ATTIC: Unvented attic; R-65 total, 10.5-inch R-46 open-cell spray foam plus 2.5-inch R-19 closed-cell spray foam on underside of roof deck; 16-inch raised heel trusses.

FOUNDATION: R-22 ICF basement walls clad with cementitious boards waterproofed with tar; 4.5-inch R-29 closed-cell spray foam under slab.

WINDOWS: Triple-pane, argon-filled, low-e, vinyl casement frames, U=0.18, SHGC=0.23; triple-pane sliding doors, U=0.20, SHGC=0.28.

AIR SEALING: 0.18 ACH 50.

VENTILATION: ERV with continuous 20 cfm draw from baths and 40 cfm from kitchen plus boost settings; CO_2 sensor also controls boost setting; MERV 7 and 8 filters.

HVAC: Ducted mini-split heat pump, 9.8 HSPF, 16 SEER, 2 air handlers, ducts inside.

HOT WATER: Heat pump water heater, EF 3.53, 50-gal.; central manifold plumbing with PEX.

LIGHTING: 100 percent LED, motion sensors.

APPLIANCES: Energy Star refrigerator, clothes washer, dishwasher, heat pump clothes dryer.

SOLAR: 10.2-kW PV.

WATER CONSERVATION: WaterSense-labeled fixtures, drought-resistant landscaping.

ENERGY MANAGEMENT SYSTEM: Programmable thermostat

OTHER: Wide doors and hallways, zero-VOC paint, low-VOC KCMA cabinets; hurricane clips, disaster-resistant features. Triple-pane sliding-glass doors and windows allow ample natural light into the home while minimizing heat transfer.

SUN SEEKER

This 'Panacea' is a cure-all for a cold climate's high energy costs.

Meet the neighbors—in style. The homes in Thrive Home Builders' "Panacea Collection"—A *Green Builder* Home of the Year winner in 2019—offer many energy saving features.
CREDIT: COURTESY OF THRIVE HOME BUILDERS

WHEN THRIVE HOME Builders hosts "meet your neighbors" parties for owners of the homes in its "Panacea Collection" in Denver, Colorado, the homeowners rave about all the things they love about their new homes: low energy bills, the continuous fresh air, walls that don't shake during 70 mile per hour wind storms, and hot water that doesn't run out, even when a lot of relatives come to visit. They mention how allergy symptoms seem to go away and asthma attacks are far fewer. They also talk about the open, light-filled interiors and the even temperatures.

What they may be less aware of is the advanced technology and building science know-how that went into making these high-performance homes. Their builder, on the other hand, knows all about high efficiency. Thrive Home Builders is a multi-award winning production home builder in the Denver area, which has certified at least 776 homes to the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) Program since 2013. That's more homes than any other home builder in the country, except Mandalay Homes of Prescott, Arizona.

GETTING READY FOR SUN POWER

The DOE program doesn't require solar panels to be installed on the home; it just requires that the home be ready for them. Thrive installed solar panels and battery storage. With the addition of 9.92 kilowatts (kW) of rooftop solar panels and a 7-kW Tesla *Powerwall 2* for storing energy, the Panacea homes achieve an impressive Home Energy Rating System (HERS) score of 8, which is essentially net zero energy performance (meaning a home that produces about as much energy as it uses over the course of the year). For some homeowners, this means the only cost on the electric bill is the monthly service charge.

Even without photovoltaics, the two-story, 5,142 square foot home is so efficient that it would achieve a calculated HERS score of 43, while typical new homes built to code would have HERS scores of about 80 to 100.

To achieve the high energy-efficiency requirements of this cold climate location,

Thrive used WUFI hygrothermic modeling to design a wall that provides a high wall insulation value of R-40 with a low risk of moisture accumulation. Thrive chose double-wall construction consisting of two 2-by-4 24-inch on-center walls with staggered studs. The walls were spaced 2.5 inches apart to provide a 9.5-inch-deep wall cavity that is stuffed with blown fiberglass to provide a thick blanket of thermal protection while acting as a natural sound dampener, ensuring outside noise is kept outside. Crews installed oriented strand board (OSB) sheathing and used a sprayer-applied sealant to seal all seams. Rim joists were air sealed and insulated with spray foam. Textured house wrap provided a drainage plane behind the fiber cement and brick veneer siding.

Thrive employs internal and third-party quality checks on all of its homes, specifically focused on water management, to ensure the wall assembly installation is durable and will remain effective for the life of the home.

UTILITY BILL BARRIERS

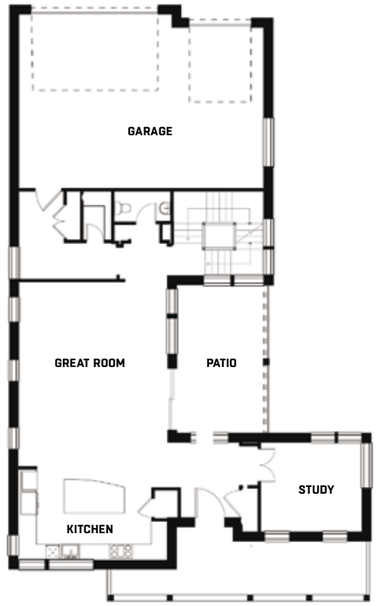
The home's mid-century modern design helps to achieve the utility bill savings, with a broad low-sloped roof that provides plenty of space for PV panels, high windows to bring in daylight, and deep roof overhangs to keep out unwanted summer solar heat gains.

In addition to reducing noise and increasing home comfort, the extra-thick walls accentuate the classic jamb and case trim around the windows, while providing a high level of finish and usable window sills. The ENERGY STAR windows are carefully placed throughout the home to take advantage of natural daylight. The double-pane, argon-filled, vinyl-framed windows, provide an insulating U-factor of 0.25 and a solar heat gain coefficient (SHGC) of 0.20, meaning the windows perform well at preventing solar heat gain.

The home's vented attic was constructed with 14-inch raised-heel trusses to allow space for the full depth of insulation over the top plates. All of the top plates were air sealed with a sprayer-applied sealant, before installing R-50 of blown fiberglass over the ceiling deck. In cathedral ceiling sections, R-49 of batt insulation was installed.

Photo(voltaic) finish. Each home's high-efficiency solar panels give it a HERS score of 8, which is considered net zero energy performance in terms of power usage vs. production.
CREDIT: COURTESY OF THRIVE HOME BUILDERS

Dynamic dual. A double wall-constructed structure that includes blown fiberglass insulation provides a continuous R-41 layer of thermal protection around the home.
CREDIT: COURTESY OF THRIVE HOME BUILDERS



THRIVE HOME BUILDERS

Panacea, 2019

The roof was protected with ice-and-water shield at all valleys, and from the eaves, up 24 inches past the wall line. The deck was covered with a synthetic water-resistant underlayment, and metal drip edge was installed under the asphalt shingles.

A CHANGE IN THE WEATHER

To protect the home from the high winds and heavy snow loads the Denver area is known for, the homes in the Panacea collection were designed to meet a snow load of 30 pounds per square foot (PSF) and wind speeds of up to 115 mph.

The homes in the Panacea Collection have basements with 8-inch concrete slab floors and 8.75-foot-tall basement walls with spray-on damp proofing. Underneath the slab is a 6-mil vapor and radon barrier that is sealed to the foundation with polyurethane sealant. Beneath the barrier is a 4-inch-thick layer of ¾-inch rock over compacted soil. The basement walls have a minimum 3-inch gap from the slab, and are anchored to pressure-treated lumber with 6-inch nails to allow for expansion of the soil without affecting the structure. The walls are insulated with R-15 unfaced fiberglass batts.

Because Denver is in an area with a high radon potential, the builder installed an active radon venting system that consists of a 4-inch perforated plastic pipe, installed along the inside perimeter of the foundation walls to collect soil gases under the slab. These are vented through the roof by a 4-inch stack pipe with an inline exhaust fan.

GETTING THE MOST OUT OF AIR AND WATER

The home's heating and cooling is provided by a very efficient central heat pump with a heating seasonal performance factor (HSPF) of 12.5 and a seasonal energy efficiency ratio (SEER) of 18. A highly efficient 97.4 AFUE gas furnace provides backup heat. All of the mechanical equipment is located in the conditioned basement.

A MERV 16 whole-house air purifier is included in every home for enhanced air filtration. A continually operating energy recovery ventilator (ERV) with a MERV 8 filter on the outside air intake provides clean air, and draws stale air from the home. Smart indoor air quality monitors sense indoor air quality issues.

The HVAC system's mastic-sealed metal supply and return ducts are located completely within the conditioned space of the home. The tightly air-sealed home was tested for overall air leakage and had an air leakage rating of only 1.82 air changes per hour at 50 Pascals pressure difference.

Hot water is supplied by a 0.96 efficiency factor (EF) tankless gas water heater. The water heater is plumbed with a recirculation loop, which uses "intelligent" technology that recognizes usage patterns to have hot water ready for delivery during high use periods, thus reducing wait times and wasted water.

Inside, Environmental Protection Agency (EPA) WaterSense-labeled plumbing fixtures provide water savings, while outside, the homes are landscaped with drought-tolerant, climate-specific plants that are irrigated with ground-level drip irrigation to minimize evaporation and reduce overall water usage.

These features helped the home to achieve a 47 percent reduction in water use and meet all of the requirements for certification to the EPA WaterSense home program.

Energy savers. LED lighting, Energy Star appliances, and EPA WaterSense-labeled fixtures increase overall energy savings, while an active, smart radon sensor helps ensure cleaner indoor air.

CREDIT: COURTESY OF THRIVE HOME BUILDERS

EDUCATION IS KEY

Project specifications, including installation and inspection procedures, and specific scopes of work for each trade, are part of contractual agreements. These include specific requirements related to DOE's ZERH program, Energy Star Version 3, and the EPA's Indoor airPLUS and WaterSense programs. Thrive's internal quality assurance program, FTQ360, assures continuous improvement processes and procedures across all company departments, including construction, purchasing, architecture, warranty, and vendor-partner relations.

Thrive also focuses on educating home buyers on the benefits of zero energy construction. The company has set up building science centers in nearly every community it serves, to explain the energy efficiency and health benefits of its homes. The builder also offers "meet your neighbor" nights, where new homeowners have a chance to learn more about their high-performance homes, while meeting their new neighbors.

Thrive Home Builders also provides homeowners with a one-year limited warranty that includes a 90-day and 11-month warranty review and emergency care as needed.

Customer service coordinators follow up with home buyers at 48 hours, two weeks, 90 days, and 11 months after closing to address any issues. Thrive implemented an online punch list program that provides buyers with an easy way to submit their warranty requests, allowing Thrive to reach out to homeowners with maintenance reminders.

KEY FEATURES

WALLS: Double wall of two 2-by-4, 24-inch on-center advanced framed walls with 2.5-inch gap. R-41 total: 1/2-inch drywall, 9.5-inch blown fiberglass, 7/16-inch OSB sheathing, house wrap, brick veneer and fiber cement siding.

ROOF: Gable roof; 7/16-inch APA-rated sheathing, synthetic underlayment, 40-mil self-adhering bituminous ice-and-water membrane, 30-year asphalt shingles.

ATTIC: Vented attic, R-49 batt in cathedral and R-50 blown fiberglass on flat ceilings, 14-inch raised heel trusses.

FOUNDATION: Insulated basement, 1/2-inch drywall, R-15 fiberglass batt, 8-inch concrete.

WINDOWS: Double-pane, argon-filled, low-e2, vinyl frames, U=0.25, SHGC=0.20.

AIR SEALING: 1.82 ACH 50; flexible top plate drywall gasket; spray foam at rim joists.

VENTILATION: ERV MERV 8 filter, HVAC MERV 16 filter; smart indoor air quality monitors.

HVAC: Central air-source heat pump, 12.5 HSPF, 18 SEER; gas furnace backup, 0.95

AFUE; METAL DUCTS IN CONDITIONED SPACE.

HOT WATER: Gas tankless, .96 EF, pushbutton recirculation pump.

LIGHTING: 100 percent LED, transom windows, daylighting.

APPLIANCES: ENERGY STAR refrigerator, dishwasher, front load washer, clothes washer, bath fans.

SOLAR: 9.92-kW PV system, 7-kW battery.

WATER CONSERVATION: EPA WaterSense fixtures and toilets, drought-resistant landscaping.

ENERGY MANAGEMENT SYSTEM: Smart thermostat, internet-enabled energy monitoring.

OTHER: KCMA cabinets, GREENGUARD gold-certified flooring, paint; active radon system. The exterior wall is a double wall consisting of two 2-by-4, 24-inch on-center advanced-framed walls with a 2.5-inch gap between, creating a 9.5-inch cavity that was densely packed with blown fiberglass to provide a continuous R-41 layer of thermal protection around the home.

A CONTEMPORARY CLASSIC

Middle-class design combines with present-day craftsmanship to form a 'Sanctuary.'

GREEN MARKETING MAY attract home buyers, but quality construction is what makes happy homeowners. The occupants of this award-winning, Charis-built custom home in North Canton, Ohio are so happy with the result, they refer to it as their "Sanctuary."

In this case, a sanctuary's No. 1 criteria is durability. Charis Homes builds with insulated concrete forms (ICFs). The resulting wallsare storm, moisture, fire and bug resistant.. Thanks to a grid of steel rebar that runs vertically and horizontally, walls are rated to withstand winds up to 180 miles per hour.

Durable? Absolutely. But wait—there's more.

A HAPPY HOLDUP

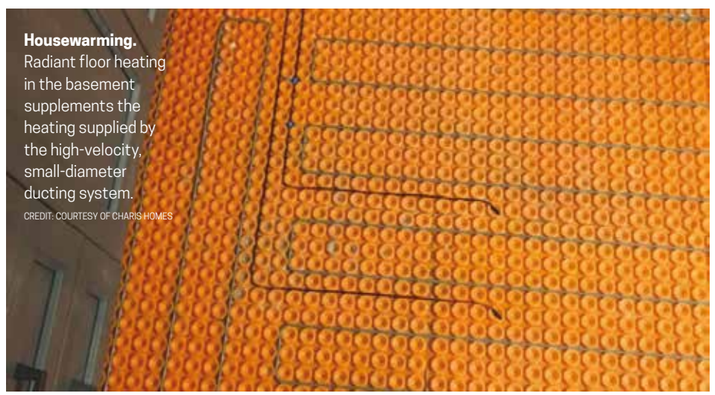
Charis used 11-inch-thick, R-22 ICFs to form the full wall height from footing to roof line for the one-story plus full basement home. The ICF basement walls insulate the sides of the basement slab.

Footers were poured into a stay-in-place form product that has built-in channels to provide interior and exterior drainage of the foundation. The 9-foot-tall basement exterior walls were covered with a dimpled plastic polyethylene membrane that relieves hydrostatic pressure against the wall by providing a pathway for liquid water to flow down to the footing drains.

The first-floor ceiling drywall forms the air barrier between the house and the vented attic. To prevent air leakage, all

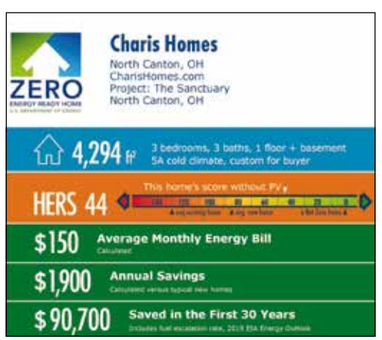
A complete package. Clean air, energy-efficient appliances and a weather-resistant exterior are only a few reasons this home's owners consider it to be their "Sanctuary."
CREDIT: COURTESY OF CHARIS HOMES

Mortar, move over. The Sanctuary's base is comprised of insulated concrete form (ICF) blocks stacked like bricks, reinforced with rebar, and filled with concrete to form a sturdy, nature-resistant structure.
CREDIT: COURTESY OF CHARIS HOMES



Housewarming. Radiant floor heating in the basement supplements the heating supplied by the high-velocity, small-diameter ducting system.
CREDIT: COURTESY OF CHARIS HOMES

Efficiency experts. Double-hung exterior windows and transom windows, LED lights, small-diameter air ducts and energy-saving appliances help make this home ultra-green.
CREDIT: COURTESY OF CHARIS HOMES



drywall-to-top plate seams and joints were sealed with three inches of closed-cell spray foam. Crews carefully sealed around wiring, lighting fixtures, and bath exhaust fan ducts before installing 16 inches of R-50 blown cellulose. For the garage attic, R-20 blown cellulose was installed.

The hip-designed truss roof was sheathed with 7⁄16-inch Oriented Strand Board (OSB) that was fastened with steel plywood clips. A 50-millimeter-thick ice-and-water shield was installed at all valleys and from the eaves up 36 inches past the wall line, then 1.5-inch aluminum drip edge was installed before laying the synthetic water-resistant underlayment, which was topped with 30-year architectural shingles. Soffit vents and a 4-inch continuous ridge vent ventilate the attic.

A gas tankless boiler with an Annual Fuel Utilization Efficiency (AFUE) rating of 95 provides domestic hot water and space heating. The space heating is provided via radiant floor loops beneath the subfloor in the basement and via a coil in the central air handler for the rest of the home. The specially designed indoor fan-coil unit is matched to

CHARIS HOMES

The Sanctuary, 2019

an outdoor condensing unit for a SEER 16.3 heat pump so the air handler can provide heat from the boiler or cooling from the heat pump. This conditioned air is distributed throughout the home via a system of small-diameter ducts. These ducts discharge higher velocity jets of air into each room through multiple small, round supply vents.

The main duct, or plenum, is one-fourth the size of a conventional duct, and the branch ducts use flexible ducting with an inside diameter of only 2 or 2.5 inches, so they easily fit within interior walls and floor joists. This allows more options for keeping the ducts within the conditioned envelope of the home. The branch ducts are factory-insulated and have gasket connections to minimize air and thermal losses. The system provides quiet operation and thorough mixing of air in the rooms for even temperatures.

CLASSIC LOOK, CONTEMPORARY QUALITY

The builder chose to install triple-pane windows that are argon filled and vinyl framed, with a U factor of 0.17 (R-5.9) and a solar heat gain coefficient of 0.21. These windows are easy-to-operate double-hung styles, where both sashes in the frame can be moved up and down, helping to facilitate cross ventilation of the home.

A cove molded sash replicates the look of classic wood windows. The engineered, sloped sills form a negative pressure pocket that keeps sashes securely in place and water flowing away from the home, even during the most adverse weather conditions.

In addition to the double-hung exterior windows, transom windows were installed above interior doorways on the main floor and in the basement, to bring daylight into the interior of the home, reducing the need for artificial lighting during the day. When lighting is needed, all of the fixtures in the home use LED light sources.

This home, with its standard features, achieved a Home Energy Rating System (HERS) index of 44, which is far better than the typical HERS score of 80 to 100 for new homes built to code across the country. Calculated energy cost savings for this home are $1,875 a year. The homeowners report a low $35 per month average electric bill, and describe the home as "quiet, comfortable and dust-free."

And, if homeowners wish to save more money, a smart thermostat includes mobile phone-accessed budget control features that maximize system efficiency and real-time energy tracking. Also, as a requirement for the Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) certification, roof trusses were engineered to support future photovoltaic panels, and an electrical conduit for solar power was run from the attic to the electrical panel.

Indoor air quality is a signature feature for Charis Homes. In 2019, Charis earned its second Leader Award from the U.S. Environmental Protection Agency (EPA)'s Indoor airPLUS program (whose specifications are required to be met to earn a DOE ZERH certification). The builder incorporates several features in the home to support clean indoor air, including installation of an energy recovery ventilator (ERV) that brings filtered fresh air into the home and exhausts stale air while, efficiently recovering heating and cooling energy.

Other features include drywall that absorbs formaldehyde and volatile organic compounds (VOCs), ductwork that is self-cleaning and does not allow condensation to build up within the tubing, zero-VOC paint, formaldehyde-free hardwood and plywood, and water-based wood finishes.

Charis Homes' Marketing Director Emily Meadows says the company uses DOE's ZERH designation as a tool to educate customers as to why building such a home is worth the additional cost. "[In our education center], we visually have a money display showing customers the amount of money a ZERH home saves over the course of a 30-year mortgage," Charis says. "Showing them the data helps to prove the investment is worth it. But our biggest reward is comments from homeowners about how comfortable their home, is and how low their utility bills are." **GB**

KEY FEATURES

WALLS: ICF, 11-inch R-22 total: 2.5-inch EPS, 6 inch steel-reinforced concrete, 2.5-inch EPS, 1/2-inch drywall.

ROOF: Hip roof; engineered 24-inch on-center, 7⁄16-inch OSB sheathing, synthetic felt rain-and-ice guard in valleys and eaves, 4-inch ridge vent, 30-year shingles, 1.5-inch aluminum drip edge, 1-foot overhangs.

ATTIC: Vented attic; 16-inch R-50 blown cellulose, 3-inch R-20 closed-cell spray foam on top plates; R-20 blown cellulose in garage attic.

FOUNDATION: Insulated basement, R-20 total: 11-inch ICFs, waterproof membrane, concrete footers with integral interior and exterior drainage system.

WINDOWS: Triple-pane, argon-filled, vinyl double-hung frames, U=0.17, SHGC=0.21.

AIR SEALING: 1.41 ACH 50.

VENTILATION: ERV, MERV 11 filter.

HVAC: Combined heat and hot water with 0.95 EF gas tankless boiler, hydrocoil and small-diameter high-velocity ducts, and radiant floor heat in basement; 16.3 SEER heat pump AC.

HOT WATER: Combi boiler, 0.95 EF; central manifold with PEX; smart recirculating pump.

LIGHTING: 100 percent LED, motion sensors, transom windows, daylighting.

APPLIANCES: ENERGY STAR refrigerator, dishwasher, microwave drawer.

SOLAR: Solar ready.

WATER CONSERVATION: EPA WaterSense fixtures.

ENERGY MANAGEMENT SYSTEM: Wi-Fi enabled smart thermostat.

OTHER: Electric vehicle charging; zero clearance shower and thresholds; no VOC paints, low-VOC sealants and glues; formaldehyde-free hardwood, plywood, adhesives.

FIRST LOOK

Here are the homes up for top honors at DOE's 2020 Housing Innovation Awards.

BY GREEN BUILDER STAFF

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

This year's awards ceremony will be online and held during the EEBA Virtual High Performance Home Summit, Sept. 29-Oct. 9. The Summit is accessible via the conference app, *Whova*.

Winners have been selected for each of seven main award categories and a Grand Winner will be announced from each one. There will also be a Grand Award for Most Homes Certified.

Winning idea. Dwell Development's Fiona Farmhouse in Seattle is up for the Grand Award in the Custom Homes on Spec category.
CREDIT: COURTESY OF DWELL DEVELOPMENT

Here are the categorical winners:

WINNERS IN AFFORDABLE HOMES (SINGLE FAMILY DETACHED)
- Habitat for Humanity South Sarasota County (FL)
- Hartford Area Habitat for Humanity (CT)
- Pioneer Valley Habitat for Humanity (MA)

WINNERS IN AFFORDABLE HOMES (MULTIFAMILY)
- Housing Authority of the City of San Buenaventura (CA)
- Mutual Housing California (CA)
- United Way of Long Island (NY)

WINNERS IN ATTACHED HOMES
- Alter Eco (PA)
- BrightLeaf Homes (IL)
- Thrive Home Builders (CO)

WINNERS IN CUSTOM HOMES FOR BUYER (> 3000 SQUARE FEET)
- BPC Green Builders (CT)
- Charis Homes (OH)
- Mantell-Hecathorn Builders (CO)
- S.D. Jessup Construction (NC)
- Sustainable 9 Design + Build (MN)
- Zero Net Now (NY)

WINNERS IN CUSTOM HOMES FOR BUYER (< 3000 SQUARE FEET)
- Bellingham Bay Builders (WA)
- Ferrier Custom Homes (TX)
- Leading Force (WA)
- P3 Builder Group (NY)
- TC Legend Homes (WA)

WINNERS IN CUSTOM HOMES ON SPEC
- Amaris Homes (MN)
- C&B Custom Homes (AZ)
- Dwell Development (WA)
- Green Phoenix Development (MA)
- Tim O'Brien Homes (WI)

WINNERS IN PRODUCTION HOMES
- Garbett Homes (UT)
- Healthy Communities (VA)
- Insight Homes (DE)
- Mandalay Homes (AZ)

More about these award-winning homes may be found at the DOE Tour of Zero site.

THE FOREVER HOUSE
Remodeling for Sanctuary

FOR MORE INFORMATION:

Follow the project at www.greenbuildermedia.com/revision-house-scottsdale, where you'll find updated articles, blogs, photos, videos, and performance information.

THE FOREVER HOUSE: REVISION HOUSE SCOTTSDALE

Given that buildings produce approximately 40 percent of global emissions and are responsible for 40 percent of global energy consumption, the path to a sustainable future inevitably involves the retrofitting of our existing built environment.

That's why Green Builder Media has joined forces with internationally renowned building science expert Steve Easley and his wife, Indoor Air Quality expert Susan Raterman, to retrofit a 3,050 square foot house in Scottsdale, Arizona. The goal of the project is to showcase to consumers and building professionals alike how to optimize performance, sustainability, wellness, aesthetics, intelligence, and durability in a remodeling project using the most advanced products, systems and technologies available on the market today.

Uniquely positioned on a lake in McCormick Ranch, the ReVISION House Scottsdale will showcase cost-effective strategies for achieving net zero in a remodeling project using renewable energy, efficient mechanical systems, and advanced smart home technologies. The project will also highlight trending lifestyle issues, such as health and wellness and aging in place strategies and technologies.

The Forever House is designed to be a truly resilient sanctuary home. It will provide everything that the occupants need for peace of mind in a chaotic world, from remote working spaces to workout rooms to onsite power and food production for enhanced self-sufficiency.

The launch of one of our most ambitious ReVISION House remodels ever highlights best practices for ventilation, energy efficiency and beauty, in an age of perilous uncertainty.

THE FOREVER HOUSE

Remodeling for Sanctuary

Before the Hammers Fall

Informed by thermography and decades of building know-how, this remodeling project aims high.

BY MATT POWER, EDITOR-IN-CHIEF

OUR INTEREST IN PARTNERING on a ReVISION House project with building science experts Steve Easley and Susan Raterman of California wasn't because of the location, or the COVID-19 relevance of the indoor air quality (IAQ) story proposed. Rather, we liked the prospect of applying high-tech building science to a home that, on its surface, might not look like it needs a major remodel. But looks, in this home, fade quickly once you get past the drywall. This middle-aged home (it's nearing 50), as you'll learn in this introductory article, leaks energy from its pores. It's a building scientist's dream project–an all-too-common case study in too little insulation, too much air conditioning and not enough quality control during the original build. It's a home that has not held up well with the times.

Fortunately, between them, Easley and Raterman have decades of experience in building science and healthy indoor spaces. They knew what they wanted: an existing house, in a great location, that they could reengineer to avoid unwanted surprises; a resilient sanctuary with a modest energy footprint that accommodated two home offices. They knew this would be a down-to-the-studs remodel that would focus on energy efficiency, IAQ, comfort and long-term durability.

They landed on a lakeside home in Scottsdale, Arizona, built in the 1970s with a great site orientation, but not-so-great performance and design.

The first priority: look behind the walls and ceiling, and identify the home's hidden energy voids and opportunities. Mitigating indoor temperature swings, Easley notes, will impact many decisions. The current house fails that test on many levels. The concrete tiles absorb heat during 110-degree-plus days and reradiate that heat into the poorly insulated attic well into the night, just as electricity rates peak every day. Even at 11 p.m., when the outdoor air temperature is 90 degrees, the garage temperature is still 110 degrees.

In this first installment of The Forever House story, we'll show you just how bad the performance problems in this house are. You'll learn why the couple has decided to completely dismantle the top floor of the home, and "start over" with an adjusted floor plan, new products, new overhangs and a higher standard of building excellence.

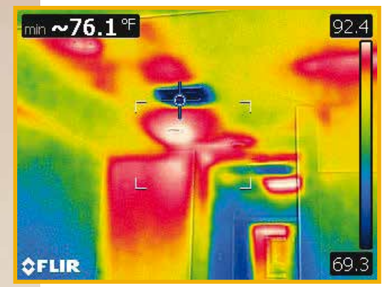
The thermal scans on the following pages tell a more complete story. Note that brighter, warmer colors, such as red, indicate unwanted hot spots. The darker, blue colors indicate cooler surfaces.

A Leaky Legacy

Hidden voids. Looking from the living area into the kitchen area at the north wall, the heat map shows multiple areas of inadequate and missing insulation and uncontrolled thermal transmission.

"You've got multiple insulation voids, warm air infiltration above headers and around sliding doors. It's a mess."

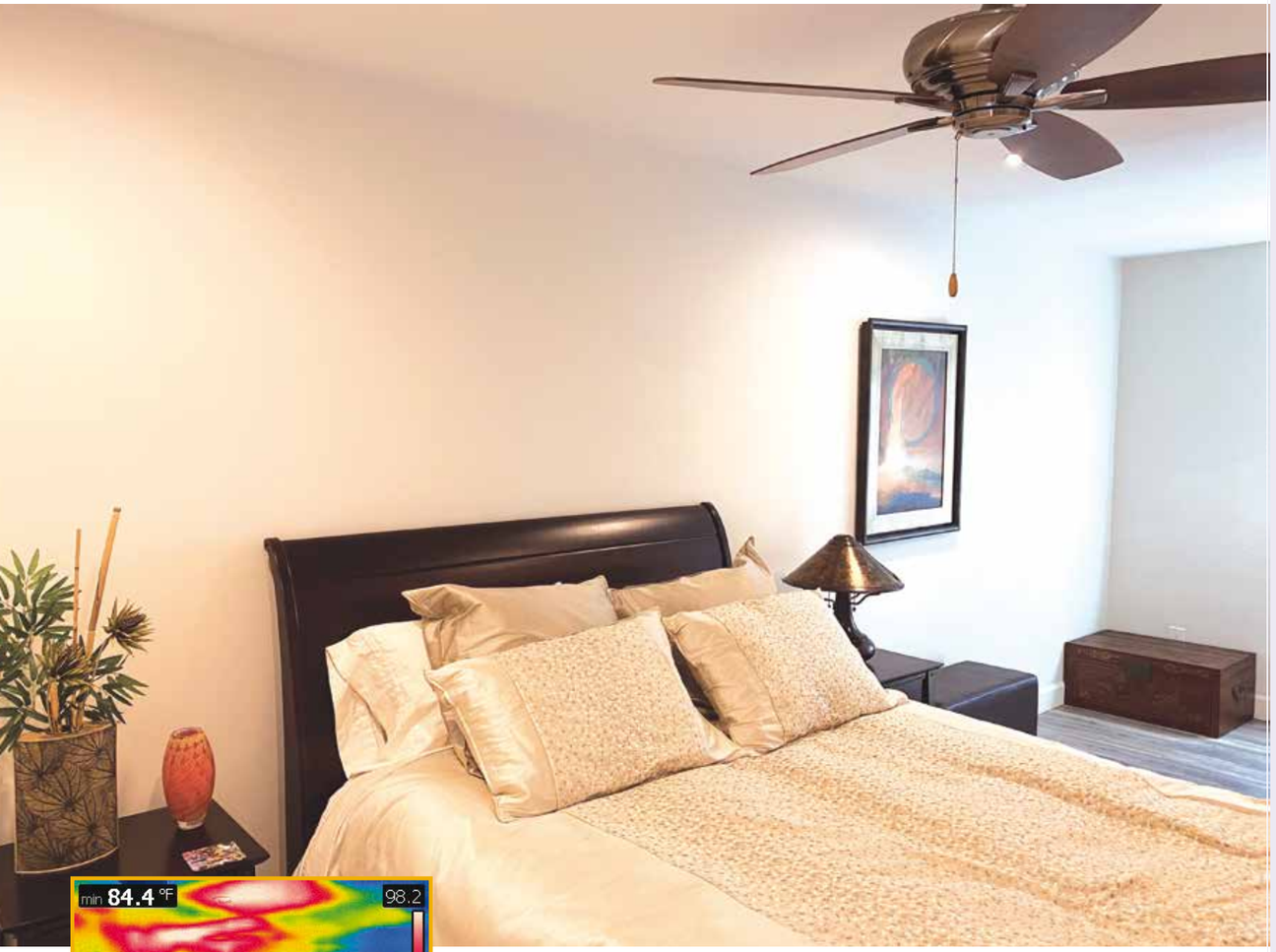
Unconditioned Surrender



Dark secrets. Upstairs, "cool" air coming out of ceiling vents sometimes hits the living space at 76 degrees, when it should be closer to 55 degrees. Note the overheating attic access panel at the far end of the hall.

In the remodel, we'll convert the existing R-19 vented attic to a non-vented attic, with R-49 closed-cell foam, plus a layer of 1-inch *Thermax* on top of the roof deck.

Abuse of Power



Backdraft. The red area at the top of the middle wall and ceiling identifies missing insulation and unwanted air infiltration from HVAC imbalance and leaky ductwork.

"The upstairs HVAC occupies a vented attic. Leaky ducts in the attic cause negative pressures, however, that pull hot air down into wall cavities and increase cooling loads."

Design Disasters

"Upstairs, it's a little bit of a floor plan disaster. The layout is really chopped up. Some of the rooms are just unusable. The total loft area is just 8-by-9 feet, 6 inches."

Golf widow's walk? Although positioned for optimal views, the upper floor loft makes for a cramped office footprint with poorly insulated walls and inefficient glazings.

Reflecting Badly

Crazy cavities. Behind the mirrors in the master bath, cavities run hot, due to missing insulation and poor workmanship.

"You can see why in the end, we decided to take the whole house down to the framing and rebuild. From a systems perspective, it's just terrible. Eight tons of air conditioning for a 3,000-square-foot house. At 110 degrees outdoors, the systems can only bring the house down to about 84 degrees."

MORE INFORMATION

Look for continued, detailed coverage of this project over the next six months. For regular updates, visit our microsite for the project: greenbuildermedia.com/revision-house-scottsdale

INITIAL SPONSORS

WHO'S ON BOARD?

The Forever House will showcase outstanding products and technology from several leading companies. Categories are still open, however, for sustainable products and innovations that will raise the performance bar.

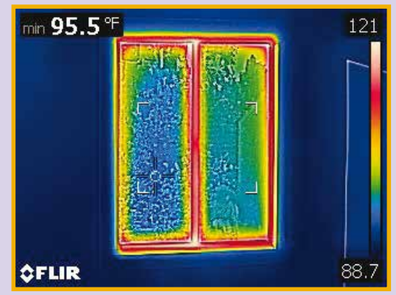
Whirlpool®
DUPONT®
FLOWGUARD GOLD® PIPE & FITTINGS
BlazeMaster® FIRE PROTECTION SYSTEMS
PIONEER LANDSCAPE CENTERS
BROAN NuTone COME HOME TO FRESH AIR
MITSUBISHI ELECTRIC
MSI Making Dream Surfaces Attainable
BELGARD PAVES THE WAY

MEET THE INFLUENCERS

Steve Easley, Msc, is an internationally recognized construction consultant specializing in solving building science related problems and educating building industry professionals and their trade partners.

Susan Raterman, CIH, is the founder and president of The Raterman Group, Ltd., an experienced consultant in the critical areas of air quality, mold mitigation, environmental hazards and industrial hygiene in the Scottsdale, Arizona area.

WINDOWS: Past Their Prime



Old school. The original, single-pane aluminum window frames leak energy badly, but will be replaced with frames with thermal breaks in the remodel. Easley is looking at several brands, including one that makes thermally broken aluminum windows.

"Non-thermally broken bronze glass aluminum windows were almost universal in the 1970s when this home was constructed," Easley explains. "But obviously they offer almost no defense against the heat.

"We've measured the indoor surface temperature of the glass in this home at 95 degrees," he adds. "So, say you have a sliding glass door with a glass area of 40 square feet. If the window faces the sun, the amount of energy that strikes the glass is 250 [British thermal units] per square foot. That's 10,000 BTUs per hour of heat gain. Now, consider that a ton of air conditioning equals out about 12,000 BTUs per hour. Your AC's cooling power is barely keeping up with the heat gain from one sliding glass door." **GB**

Top to bottom, inside and out

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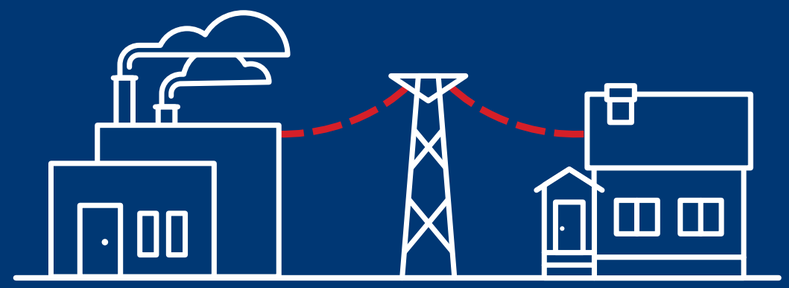
IT TAKES 3X THE ENERGY
TO GET ELECTRICITY TO A HOME



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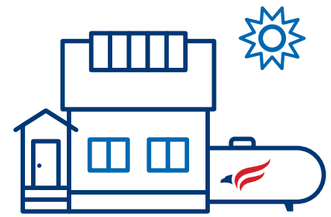

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SOARING DEMAND MEETS LIMITED SUPPLY

Material Shortages Point to Alternative Products

As supply shortages impact lumber, hardware and other goods, high-performance alternatives can solve some problems, but not all.

ICFs rising. As lumber prices and construction demand skyrocket, Insulated Concrete Forms (ICFs) look increasingly attractive from a cost and skilled labor perspective. CREDIT: AMVIC

BY MATT POWER

IN THE SECOND QUARTER OF THIS YEAR, Home Depot, according to a presentation by company CEO Craig Menear, reported double-digit customer traffic increases over the previous year, and 23 percent higher spending. Lowes reported similar, record-breaking earnings.

But all is not well in the building supply universe, at least for the professionals who rely on the same short list of products, year after year. In the new normal of topsy-turvy supply chains, prices and availability of goods whave become unpredictable. For small companies, especially, staying solvent may mean looking beyond the normal comfort zone, at products and systems that are well established and less volatile.

LUMBER INDEPENDENCE?

The long isolation of quarantine at home, coupled with the initial flood of stimulus money, created a burst of remodeling activity—especially outdoor decks and patios.

In Pittsburgh, for example, the Post-Gazette reported in July on big price hikes for pressure treated lumber, aluminum decking and the related hardware. "Anything deck-related is up 50 percent," says Robb Ciotti, general manager of South Side-based Allegheny Millwork and Lumber. "The prices are rising so quickly, some people feel like you're price gouging."

But it's not just decks feeling the lumber pinch. It's dimensional framing, the predominant framing choice for new construction.

New data from the NAHB finds that since mid-April 2020, the composite price of lumber, per Random Lengths, has soared more than 170 percent. This surge is adding approximately $16,000 to the price of a new single-family home and more than $6,000 to the average new apartment.

The NAHB blames the lack of adequate lumber supply on Canadian tariffs, and the fact that the mills guessed poorly about the impact of the pandemic. The owners reduced hours and staff, only to be swamped with surging business.

But for makers of other structural systems, this might be a game-changing moment. Insulated concrete forms (ICFs), for example, have not seen significant price hikes, which means they're vastly more affordable than lumber framing. In normal times, ICFs cost about 15 percent more than 2-by-6 wood framing, according to Amvic, an ICF manufacturer. But with lumber at 170 percent of normal cost, that figure now seems irrelevant.

Of course, ICFs depend on the availability of concrete for their assembly. To date, shortages of cement (the key component of concrete) appear to be localized, and prices went up only about 20 percent over 2019. The supply is something to watch however, as much or our cement comes from India and China. The fact that China tamed the coronavirus quickly may, despite our government's anti-Chinese rhetoric, be helping the U.S. building industry keep moving.

Where's the middle mud? Supplies of fast- and slow-curing joint compound were in ample supply at this box store, but the medium-fast, 45-minute hot mud was almost depleted.

MEANING IN THE MISSING

The first products to run out may reveal what experienced pros use most.

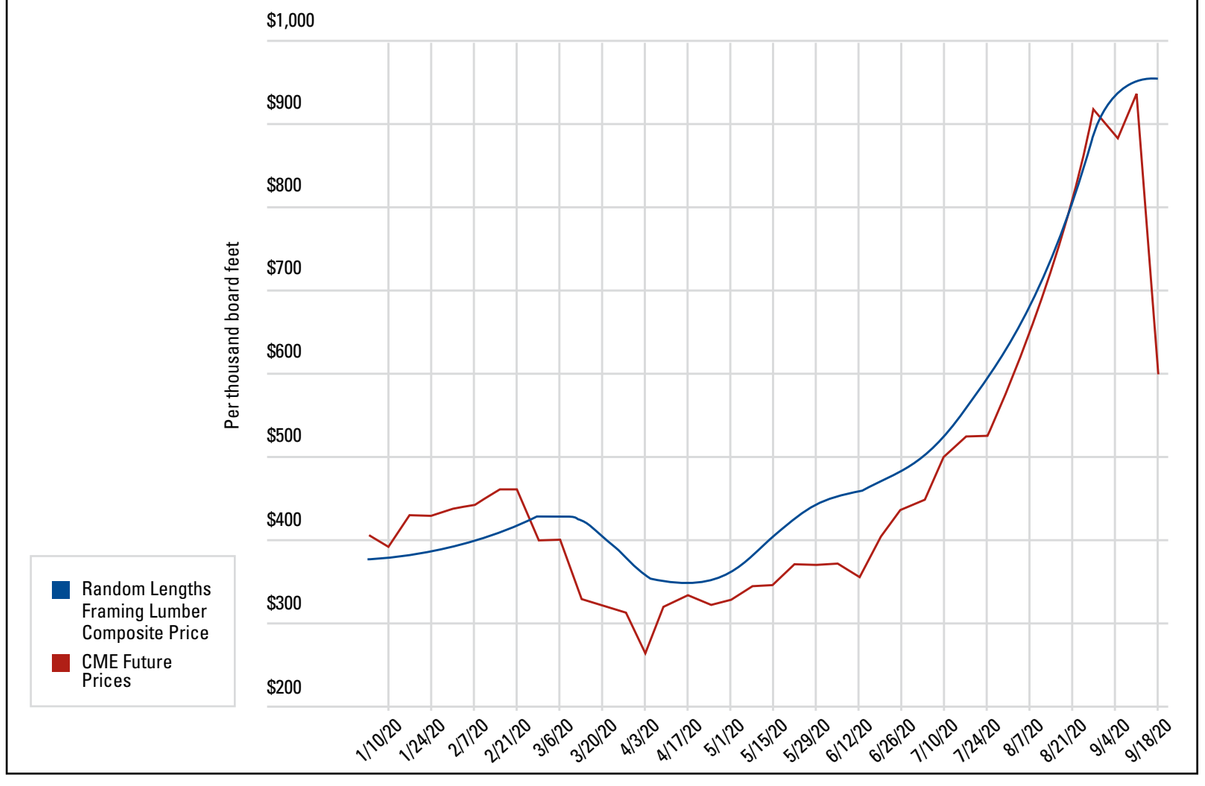
THIS IS A ripe time for product behavior researchers to gain some insights into who's buying what and why, simply by visiting the nearest building product box store. For example, one Home Depot had plenty of 20-minute and 210-minute joint compound (often called "hot mud" by the trades) available, but was notably short on 45-minute bags. This suggests a prosumer or trade buyer. Most won't use 20-minute hot mud for anything except hole patching. It's too unforgiving. And in most cases, a 210-minute drying time doesn't make sense for a pro. Say he or she takes all morning to mud a couple of rooms with the stuff. It will still take almost four hours to dry, so sanding or a second coat can't happen until the next day anyway.

Other alternatives to lumber include factory-built panels and structural insulated panels (SIPs). The labor savings are clear. But these products depend on panels made with oriented strand board (OSB), which has jumped in cost by more than 100 percent in the U.S. One variable is whether the SIP or panel manufacturer was able to stockpile the material in advance of market pressures.

But it's not just the pandemic that has squeezed OSB supplies. It's also Climate Change. For example, Norbord temporarily stopped production of OSB at one of its large plants in British Columbia because it could not obtain enough raw materials. The company blamed wildfires and severe weather conditions during the 2019-2020 winter.

Irreplaceable? Gaps on shelves in the hardware section seem to be increasing, particularly among "staple" products such as standard door hinges—many of which are produced internationally. Will domestic manufacturers rise to replace them? If so, when, and at what cost?

SOARING LUMBER PRICES PUSH THE ENVELOPE



COLLATERAL DAMAGE

The higher cost of materials alone, according to some small contractors, may not be a deal-breaker for clients. But their vulnerability is more complex. When key materials run short, there's no safety net to keep jobs in play. Their limited access to capital, along with municipal delays, compounds the damage.

"It's more about 'can we get the materials?' than cost hikes," notes Jon Stansel, of CJ's Custom Carpentry in Oxford, Maine. "We have to provide a lot more time than normal to submit drawings and get permits now, too."

That permitting lag can make or break small building firms who lack the capital to pre-purchase materials and stockpile them. Portland, Maine, for example, has a disclaimer on its permitting and inspections website:

"Due to an increase in development activity, we are experiencing high application volumes, causing longer than normal review times."

Not knowing whether a job can commence in two weeks or two months means waiting to take a deposit, waiting to purchase materials, risking a major price spike *after* the contractor has already given the client a good faith estimate based on stable prices. Clients may refuse to pay the new price, or simply halt the work.

"It's hard to stay ahead of it," Stansel says. When someone cancels a project in this environment, "that's the kind of email I hate," he adds, "but it's understandable."

TROUBLING TRENDS

Not every building material can simply be replaced with one that's equivalent (or better). Some can't be replaced at all. For example, take a look at appliances–especially refrigerators and freezers.

Back in July, the *Mercury News* interviewed Martin Hartunian, CEO of ABC Warehouse. He said that the wire harnesses, switches, electrical components and dials "are things that are manufactured overseas or in Mexico, which has slowed the production process down." He added that GE, Whirlpool, LG and Samsung do have some assembly of appliances in the U.S., "but with COVID-19, they've had to rework their production lines, which has led to a drop in yield."

A new report from NPR in early September suggests that appliances are still in short supply all over the U.S. Some resellers report that they've had freezers back-ordered since March that have still not been delivered. Demand is way up, but shipments of appliances dropped by about 7 percent in the first months of the pandemic, as production slowed in response to the coronavirus.

Among most dealers in appliances, the assumption is that "as factories ramp back up," availability will increase, and supply will catch up with demand. But with COVID-19 infections back on the rise in about half of the U.S., along with major surges in manysupplier countries (including Mexico), how confident can we be that supply will rise to meet demand?

And it's not just appliances in doubt, as we cruise into what health experts predict will be a winter more challenging than any faced in the U.S. in decades. There is still money to spend on remodeling and new homes. Orders are strong and demand is high. For the moment, most contractors seem able to adjust and keep working. ICFs can readily replace 2-by-6 framing. Metal or clay or concrete tiles offer upgraded roofing, if asphalt prices go even higher. Substitutions, so far, have actually led to efficiency upgrades in some cases.

But we are dependent on foreign imports of materials including steel and cement. For example, we import about 25 percent of our steel from Brazil, Mexico and Russia, countries hit hard by the pandemic—and getting worse.

Perhaps even more troubling is the "death by a thousand cuts" scenario. If building material suppliers continue to see supplies of hinges, fasteners and the myriad small parts of a house dry up, how long can the boom continue? The next few months will tell whether our complex, global web of building products can survive the combination of a pandemic, hostility toward trading partners and Climate Change, or if the U.S. homebuilding industry grinds to a crushing stop. **GB**

HIGH-TECH WALL APPROACH REDUCES LUMBER

By engineering walls to take advantage of spray foam's strength, manufacturers offer a hybrid that saves lumber and panels.

The BASF *HP+ Wall* system promises a strong wall with fewer dimensional feet of lumber, and up to 90 percent less exterior structural sheathing. According to the manufacturer, a 200 linear foot exterior wall could eliminate 50 sheets or more of sheathing.

Framing upgrade. The *HP+ Wall* starts with 1-½ inches of closed cell spray foam *(BASF WALLTITE)*, which is sprayed on to *Neopor Graphite GPS* exterior insulated sheathing.
CREDIT: COURTESY OF BASF

More Power, Please

A file folder full of green energy bills await state and local lawmakers when they return to office next year.

BY MIKE COLLIGNON

WITH COMMUNITIES increasingly turning toward alternative energy sources to power their homes and businesses, state and local governments have been working on bills designed to make it easier to move away from fossil fuels. Here are several pieces of legislation in the works.

A new 'Leaf' line. Charging an electric vehicle at home will be safer for Maryland residents if legislation on charging station installs passes the State senate. CREDIT: NCDOT COMMUNICATIONS/FLICKR

MARYLAND

Before adjournment, the Maryland state legislature was working on HB 111, a bill which includes a blend of regulation and incentives.

First, it looks to prevent condominiums or homeowner associations from prohibiting or unreasonably restricting the installation of electric vehicle (EV) charging equipment by unit owners. There are a few specific rules that would have to be followed, such as requiring the building owner to hire a licensed contractor for installation and pay for separately metered electricity. The installation cannot unreasonably impede the normal use of an area outside the unit owner's parking space, and must comply with building codes, safety standards and architectural standards. It also calls for the unit owner to reimburse the HOA for any insurance premium increases attributed to the EV charging equipment.

Secondly, the bill would establish an EV infrastructure grant program for individuals, businesses, state and local government entities, retail station dealers and condominiums to install charging equipment. The grant would cover "the costs of acquiring and installing qualified electric vehicle charging equipment."[1] It is a fairly generous grant program, with the funding capped at 40 percent of the costs or $700 for individuals, whichever is lower. For businesses, the same percentage applies, but the dollar option goes up to $4,000. Finally, for a retail service station dealer or condominium association, the grant can equal 40 percent or $5,000, whichever is lower.

The bill overwhelmingly passed the House (124-14) and was sent to the Senate, where it was referred to the Judicial Proceedings Committee for review.

COLORADO

Summit County, as well as the towns of Frisco, Breckenridge and Dillon, have adopted the Summit County Sustainable Building Code. This means that all new residential construction must comply with the U.S. Department of Energy (DOE)'s Zero Energy Ready Home program. This program applies to R-2 and R-3 occupancies, as well as R-4 occupancies of four stories or less. Additions to the code include commercial buildings, multifamily and single-family homes becoming electric vehicle (EV)-ready.

The new EV charging requirements incorporate the technical specifications from the 2021 IECC. All new one- and two-family homes must be equipped with one EV-ready parking space that supports a Level 2 charger. Larger parking lots serving multifamily residential and commercial buildings will provide EV charging stations for at least 5 percent of parking spaces and EV-capable infrastructure for 50 percent of the remaining spaces.

The new code includes more than just the usual energy efficiency upgrades. More water-efficient plumbing fixtures (toilets, faucets, sinks, clothes washers and dishwashers) are also required.

MASSACHUSETTS

In mid-April, the Massachusetts Department of Energy Resources unveiled emergency revisions that doubled the capacity of the Solar Massachusetts Renewable Target Program, known as SMART. This should provide a boost to the state's solar industry, which saw new solar installations drop 50 percent in 2019.

The program's ceiling, which was raised from 1.6 gigawatts (GW) to 3.2 GW, was not the only change made by program administrators. Massachusetts administers the SMART program in 200 megawatt (MW) "blocks," although financial incentives fade as more projects get rewarded. A new requirement calls for 5 percent of each program "block" be set aside for community solar projects that serve low-income customers.

Within the same 200 MW block, there needs to be 20 percent (40 MW) allocated to projects between 25 kilowatts (kW) and 500 kW.

To receive the incentives needed to help guarantee a project's completion, community solar projects and shared solar projects serving low-income customers now face a minimum 90 percent subscription rate for bill credits. There is now an energy storage requirement for projects larger than 500 kW.

Finally, there are a couple of site-based facets in the program now. There are incentives to encourage projects that include pollinator habitats, and the criteria was made easier to co-locate projects with certain types of farmland. The State also decreased the amount of incentives for projects on undeveloped land. This was added to boost brownfield development. GB

Reference items:

1. swenergy.org/news/regional?Year=2020#1716
2. greentechmedia.com/articles/read/massachusetts-releases-emergency-update-to-smart-program

Mike Collignon is the executive director and co-founder of the Green Builder® Coalition.

AD INDEX

COMING NEXT ISSUE

GREEN BUILDER®

The State of Green Building 2021

Green Builder takes its second annual look at homebuying trends, market shifts and data-based forecasts for the construction industry.

FROM THE TAILGATE

New Offerings for the Sustainable Minded

By Ron Jones

Sticks and Stones

IN A MOST IRONIC TWIST, it seems that the recent explosion in the price of softwood lumber may be the factor that, once and for all, tips the U.S. housing industry over the brink and into the 21st century—the straw that broke the camel's back, as it were. The ridiculously outdated practice of stick framing the vast majority of new homes in this country could finally be circling the drain to oblivion, where it would join the horse and buggy, along with the phone booth.

Imagine the panic of the industry dinosaurs and their special interest advocacy organizations as they are forced to awaken to the realization that the price crutch they've been hobbling on all these decades is being pulled out from under them, and that they are in danger, at long last, of being dragged kicking and screaming into the age of advanced building science, innovative building systems and technology.

As they scramble from one federal agency to another, attempting to preserve whatever is left of the status quo in order to prop up their profit-driven, lowest-common-denominator business model, they remain blind to the opportunity to truly make a claim that is currently false: American housing is the envy of the world.

As hard as it is to imagine, there are still many parts of the world where people are forced to use any materials available to piece together basic shelter. Mud, sticks, rocks or whatever they can lay their hands on become components in their desperate attempts to provide even the most primitive protection from the elements.

Shamefully, right here in our own country, there are pockets of populations who still survive without electricity, running water or basic sanitation. The industry has turned a blind eye to these unfortunate folks. It considers them little more than outliers to be kept in the shadows when celebrations of success and prosperity are offered up as the image builders want to share with the world.

Frankly, in spite of all the great home building and home builders out there, the standard of the industry remains an embarrassment in many cases. Too many homes are still built to the absolute minimum allowable requirements, and with materials and methodologies that belong to a previous century. It can be attributed to price-centric business models, fear of change or just plain laziness. Whatever the case, the home buyer and renter are entitled to our best efforts.

I'm hopeful that the lumber price crisis forces the industry to raise the floor and the standard of living along the way. Maybe more builders will finally see the need to re-examine their way of doing things and embrace the opportunities to explore all the resources available to us, paving the way to a better-built environment for everyone.

Fortunately, there is a growing number of builders who don't need an external crisis like the price of lumber to compel them to look for better solutions. They are already producing superior results and continually seek ways to improve every aspect of their work. Here's hoping they will lead us into a new day for the building industry, one we can all be proud to be part of. **GB**

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