

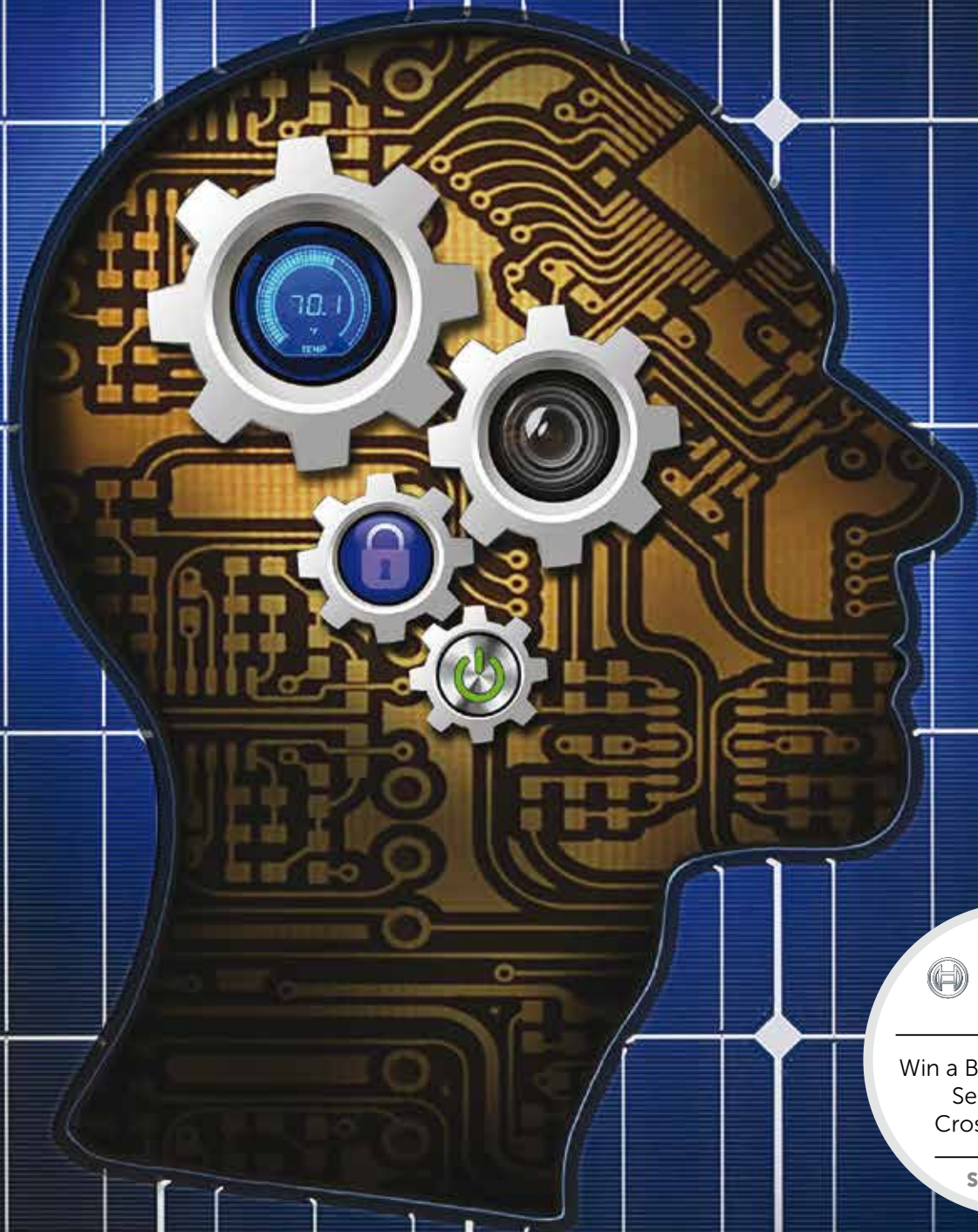
Award-Winning Coverage of Sustainable Construction, Products and Lifestyles

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January/February 2017 / www.greenbuildermedia.com

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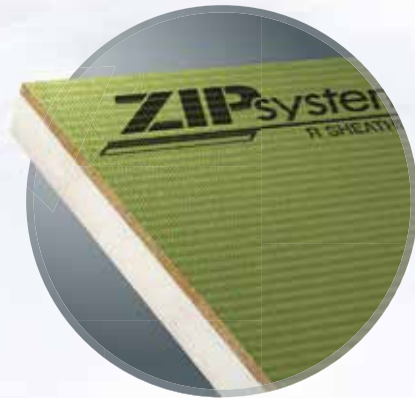
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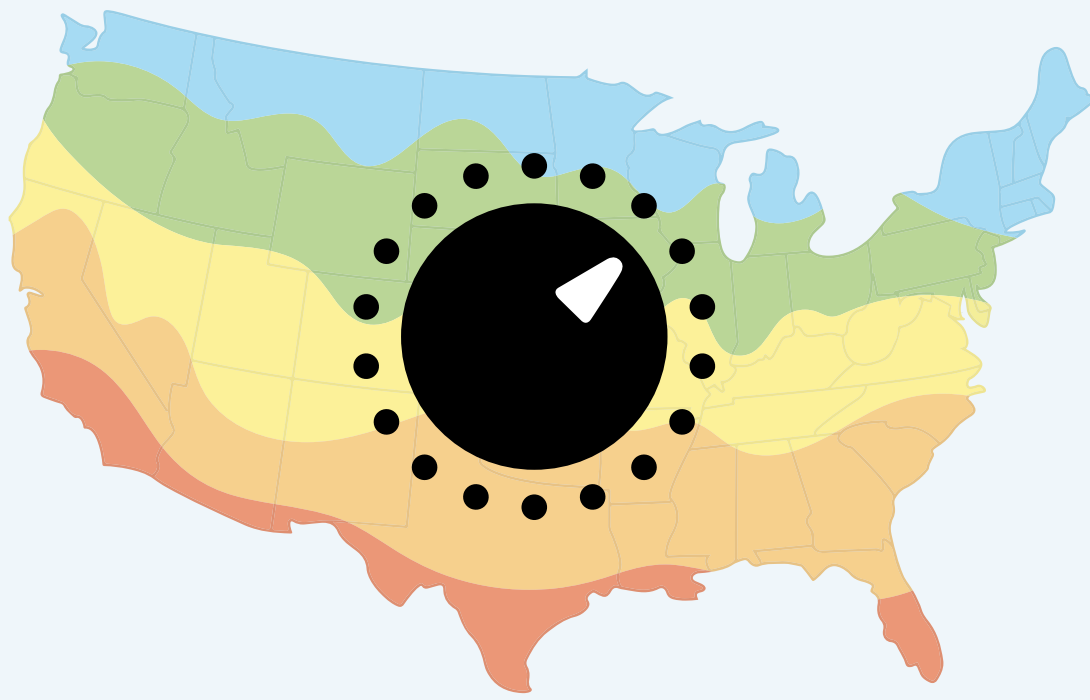
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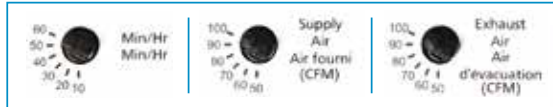
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EDITOR'S NOTE

The Inside Scoop

By Matt Power
Editor-in-Chief

The 71 Percent Solution

If you think America is destined for a return to blackened skies and foul waters, you haven't read the fine print. Progress is here to stay.

BY MATT POWER

THIS MORNING, A NEW SURVEY (<http://bit.ly/2hkMCYn>) of U.S. attitudes arrived on my desktop from the *ReportLinker.com* search engine. The survey found that more than three-fourths of U.S. citizens agree that human activity is the main cause of climate change. Just as importantly, more than two-thirds are worried about air pollution and water pollution. Many other environmental issues also concern them.

But how is this possible, given the latest election's outcome? It's really very simple. About 42 percent of eligible citizens did not vote in the most recent national election. Of the 58 percent who did, just under half chose the candidate who believes that climate change is a hoax. In other words, 71 percent



of the country did not necessarily agree with the premise that global warming is a vast conspiracy, or that the coal industry should be revitalized.

Now, I'm not endorsing the other candidate, either. She had connections to fracking and big banks that would have deeply compromised her ability to do the system-changing work that's needed.

Let's focus on the present. A minority group with strong anti-regulatory leanings will be running the Federal Government. Will they set back progress on some issues? Probably. But many of their views are far more extreme than where the 71 percent want to go. Rhetoric is one thing. Policy is another. It's doubtful

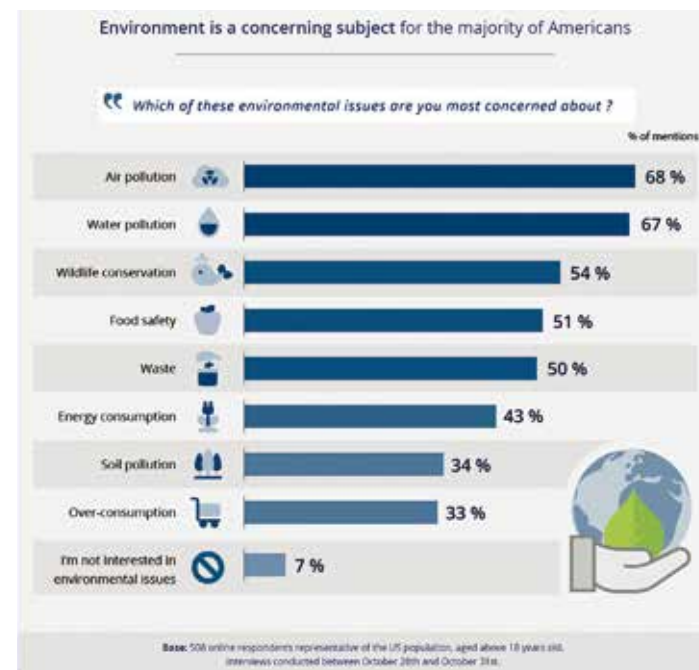
that any American would welcome back air pollution and water pollution—or the disappearance of half of Florida to rising sea levels.

The economic future of this country lies in green technology. It's simply our best hope to maintain any semblance of our current way of life. A massive transformation is already underway.

Here's an example: employment in solar power doubled over the past five years. According to *CNN*, the solar industry workforce is "bigger than that of oil and gas construction, and nearly three times the size of the entire coal mining workforce." At the same time, technologies such as wi-fi controls, Big Data, electric vehicles, whole-house batteries and heat pumps offer us the imminent promise of a cleaner, leaner lifestyle.

Almost all of this technology converges in the modern home. It's become so easy to achieve net-zero energy use in new construction now that there's almost no excuse not to hit that target. Mini splits, solar and smart controls are a perfect trifecta. These systems also make homes better able to buffer the uncertainties of troubled times.

As builders, architects and manufacturers, now is the time to stay on course and continue to reduce your impact on the planet through greener, cleaner technology. You don't need big government to re-define whether we should do what's right for future generations. By designing homes and products to be less expensive to operate and less reliant on fossil fuels, you'll be acting in the interests of the 71 percent—as well as that of every other American. **GB**



THIS MONTH'S GIVEAWAY

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Major U.S. Firms Urge Trump to Take Climate Change Seriously

Big Business demands he keep an open mind, keep U.S. in Paris Agreement

PRESIDENT-ELECT DONALD TRUMP recently told Fox News Sunday that he still doesn't believe in global warming. But he won't completely deny it, either. "Nobody really knows," he said. "It's not something that's so hard and fast."

According to the *Washington Post*, Trump is a longtime critic of the global warming theory, often calling it a hoax. But his bigger concern, he says, is the way environmental regulation is "undercutting America's global competitiveness." He cites how other countries, such as China and Mexico, are quickly able to open new factories because they are not subject to the same restrictions as U.S. businesses.

During the presidential campaign, he threatened to pull the U.S. out of the Paris climate agreement

it entered into in 2015. Now, he is "studying" whether the United States should withdraw from the global warming agreement, the *Post* reported.

That's a partial victory for Big Business, which a week earlier sent a letter to Trump and other world leaders demanding that he keep the U.S. in, out of concern for the environment and "American prosperity." More than 300 companies signed the letter, including Nike, Starbucks, eBay, HP, Kellogg, Hilton and General Mills.



Nations united. World leaders were all smiles at the 2015 United Nations Climate Change Conference in Paris.

How Homebuilders Can Overcome a Low-Water World

Next Generation Water Summit tackles need to do more with less.

WHEN THE NEXT GENERATION WATER SUMMIT kicks off next June, the goal is clear: Get participants to discuss how they will be able build more homes when there's less water available.

The national event, set for June 4-6 in Santa Fe, N.M., is designed to "bring together a broad range of stakeholders to develop strategies that integrate a variety of interests and develop real solutions," according to Kim Shanahan, executive officer of the Santa Fe Area Home Builders Association.

Summit officials note that water scarcity is "emerging as a critical

challenge to the western United States," with the potential to halt construction in the west and bring economic development to a standstill.

Three tracks will focus on emerging policy development, building design and construction, and water conservation tools and technologies, respectively.

Sessions at the summit include "How to Build to Net Zero Water," "Alternative Water Treatment Options," "Stormwater Harvesting in Western States," "Plants for a Changing Climate" and more.

For more information, contact Next Generation Water chairpersons Mike Collignon (mcollignon@greenbuildercoalition.org) or Glenn Schiffbauer (glennschiffbauer@gmail.com).



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Corporate America Still Investing in Sustainability

But the gap is growing between those that do and don't embrace green thinking.

INVOLVEMENT BY TOP U.S. companies in sustainability is continuing to grow, with many reporting strong business benefits, according to a study by construction analyst Dodge Data & Analytics (www.construction.com). However, the study also reveals a gap between the majority of committed companies and a minority of companies that do not see the business value of sustainability investments.

According to Dodge, the number of companies in favor of green investments rose from 15 percent in 2006 to 41 percent in 2015. But the number that considers such involvement a waste of resources increased from 17 percent to 21 percent during that same period.



CREDIT: RUBBER DRAGON

The "green gap" corresponds closely to the respondents' perceptions of the benefits of investing in sustainability, the report notes. It's also likely that those not in favor of investments lack a person or team on staff dedicated to sustainability efforts.

The study, *Corporate Sustainability Reaches Middle Age: A Review of Key Trends and Insights from 9 Years of Research*, is available for free at Dodge's products site (<http://bit.ly/2gTNzTx>).



CREDIT: U.S. FISH AND WILDLIFE SERVICE

Not-so-Fantastic Plastic Killing Ocean's Islands

Birds, fish and ultimately people may fall victim to microplastics.

IF THE CONSTRUCTION industry needed more incentive to keep using sustainable products among its building materials, all it needs to do is read *CNN's* report on "Plastic Island" (<http://cnn.it/2gJyR2i>). The story details the devastating impact of plastic waste upon famed Midway Atoll in the North Pacific Ocean.

"Standing on the island's remote shoreline brings a calm and humility—until you look down at your feet," the story notes. "On the beach lies a motorcycle helmet, a mannequin's head, an umbrella handle and a flip-flop. They didn't fall from a plane or off a ship, and there aren't any civilians living here who could have left them behind."

Instead, they were washed in with the tide from thousands of miles away, some of the pieces ending up in the bellies of albatrosses who lack the sense not to eat them. They can't digest the plastic and they die. The same goes for fish swimming in the dispersal zone of 5 trillion fragments of such waste, some so small that the naked eye can't see them. Many also absorb PCBs and other toxins.

And what happens to birds and fish will, according to the report, eventually happen to humans.

Changing the world's dependence on plastic isn't likely to happen. But, the story's authors offer a glimmer of hope. "Remember smoking? We don't do that as much anymore."

Renewal Energy Group Aims for 'NetZeroPlus' Label

A new marketing plan is underway for Canada's International Ground Source Heat Association.

IN AN EFFORT to reduce confusion and stand apart from other "net-zero energy"-related industries, the Canadian chapter of the International Ground Source Heat Pump Association (IGSHPA) is relabeling itself as "NetZeroPlus" and will promote its energy and environmental contributions, not its technology.

According to IGSHPA-Canada Executive Director Bill Eggertson, the industry has suffered from marketing confusion by using technology terms such as "geothermal," "earth energy," "GeoExchange" or "ground source heat pump." He says the new focus will allow the industry to work with other stakeholders to boost a building's performance beyond NetZeroPlus by increasing efficiency in plug load.

A NetZeroPlus heat pump produces twice as much renewable energy as a whole house will consume for all end uses, surpassing the definition for "net-zero energy," Eggertson notes. With more than 120,000 such systems nationwide, IGSHPA is actually one of Canada's largest producers of renewable energy.

Eggertson says the association has developed social media tools to explain how energy is produced and consumed, including a three-minute video that illustrates the vision of transitioning Canada into a NetZeroPlus nation. The site is <http://NetZeroPlus.ca>.



Atlanta Awaits 2017 IECA Region One Conference

Weather Channel's Cantore and EPA's Zeller will open and close the February event.

WEATHER CHANNEL METEOROLOGIST Jim Cantore and Environmental Protection Agency (EPA) Senior Project Manager Craig Zeller are the respective opening and closing keynote speakers at Environmental Connection 2017, the International Erosion Control Association (IECA) Region One's annual conference in Atlanta, Feb. 21-24.

Cantore, a frequent contributor to NBC News, will discuss changes in weather patterns, predictions for the future and how these changes



Craig Zeller



Jim Cantore

will affect the environmental industry over the next 50 years. He will lend insight on how the industry can prepare for the future in weather.

Zeller's closing keynote presentation will cover his experience as the EPA's on-site coordinator for the cleanup and recovery efforts of the Tennessee Valley Authority (TVA) Kingston Fossil Plant environmental disaster in Roane County, Tenn., on Dec. 22, 2008. The failure of an ash dike at the TVA facility caused a catastrophe where approximately 5.4 million cubic yards of coal ash was released over 300 acres, choking the adjacent Emory River, disrupting electrical power, rupturing a natural gas line and water line, and covering a railway and local roadways.

For more information, visit www.ieca.org.

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TABLE OF CONTENTS

PAGE 25

HERE'S A SAMPLE OF WHAT'S INSIDE

“Are (local politicians) beholden to coal, oil or other fossil fuel interests? This is all too common. In other words, despite best efforts to get off fossil fuels, you remain at the mercy of fossilized thinking.”

PAGE 47

ON THE COVER

SMART + SOLAR

Artist: Kip Ayers

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FEATURES

SMART + SOLAR	15
Smart Home Evolution: Connected and Solar	16
As smart and solar technology continue to change, homeowners face exciting times ahead.	
Passive Plus	18
Stone Fruit Farm's smart and solar bells and whistles reduce its ecological footprint even more.	
Up in the Air	24
Lubberland's Edge is a showcase of smart air management.	
Everybody Wins	28
McKnight Lane, the nation's first net-zero affordable housing neighborhood, powers up.	
SMART + SOLAR PRODUCT SHOWCASE	32
Key smart and solar items used by builders in 2016 as they went for the magic number of net zero.	
THE ARC HOUSE: SMART + SOLAR = TOTAL CONTROL	36
How The Arc House integrates renewable energy with connected technology.	

DEPARTMENTS

EDITOR'S NOTE	02
GREEN BUILDING NEWS	06
DESIGN IDEAS	42
BUILDING SCIENCE	46
ENERGY SOLUTIONS	50
CODE ARENA	52
SAVING WATER	58
TAILGATE	64



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WITH ALL OF THE POLITICAL CLAMOR GOING ON NATIONALLY, it's easy to get distracted from the steady progress toward sustainability that's happening in the building industry. The convergence of rapidly dropping renewable energy prices and integrated controls has made building to net-zero standards easier than ever before in human history.

In this issue, we'll give you many examples of progressive projects, from The Arc House's smart thermostats, to air management and moisture monitoring tools in the Lubberland's Edge and Stone Fruit Farm developments.

We'll also bring you up to speed on the status of net metering, and show how mini split heat pumps and home battery systems can work together in new homes. You'll also get a look at some of the best smart and solar products available in 2017.

Smart Home Evolution: Connected and Solar

As solar and smart technology continue to change, homeowners face exciting times ahead.

BY SARA GUTTERMAN

THE SOLAR AND SMART home technology categories are growing at meteoric rates. To date, the sectors have remained relatively independent, but their convergence will soon offer a game-changing level of control, independence and peace of mind to homeowners.

The global solar industry, expected to reach \$345 billion by 2020, and the global smart home market, expected to hit \$59 billion that same year, are arguably the building industry's fastest-growing sectors.

One of the main drivers for this meteoric growth is the unprecedented transition from a high-consumption and low-automation market to the opposite: one of low consumption and high automation. This transition is fundamentally altering the performance of our built environment and the way that we interact with it.

COMFORT LEVEL

It's easy to see why smart home and solar technologies appeal to homeowners. Smart home technologies that learn our behaviors, upgrade themselves seamlessly and take the human error out of home performance make our lives more efficient, convenient and sustainable. Advanced solar power systems enable us to generate, store and monitor our own power (and in some states, profit from that generation by selling power back to the grid via net metering). They also allow us to become more independent and self-sufficient.

Convergence of these sectors is expected to completely transform the homeowner experience. Smart home and solar share the same



ultimate goal: to provide homeowners with a greater level of control over their homes. And as technologies in both categories become mainstream and affordable, it's clear that they will not remain stand-alone islands. Rather, they will sync as a part of an integrated ecosystem that empowers homeowners to optimize performance of their homes, resulting in enhanced security, cost savings and peace of mind.

WHY GET STARTED?

When it comes to purchasing enabling technologies (smart home products or solar), homeowners take the leap for a variety of reasons. Solar now provides a cost-effective way for homeowners to reduce their dependency on utilities and play a role in helping to meet our

“From a business perspective, solar and smart home technology companies have a watershed opportunity to leverage each other’s successes, creating partnerships that expand their marketing and branding power.”



global sustainability goals. In regards to smart home technologies, studies show that most homeowners are initially interested in security (locks and cameras) and energy management (thermostats and monitoring technology).

Regardless of the hook, once a homeowner becomes familiar with the benefits of enabling technologies, they generally want more. Studies show that almost half of all Americans own smart home technology or plan to invest this year, and once a homeowner purchases one smart home product, they're 93 percent more likely to purchase additional ones. They want to learn more about the larger ecosystem and immediately begin searching all options.

GETTING INTEGRATED

From a business perspective, solar and smart home technology companies have a watershed opportunity to leverage each other's successes, creating partnerships that expand their marketing and branding power. Already, there is technological and marketing integration within the smart home tech space. For example:

- SMA America (www.sma-america.com) is offering a whole-home integrated system that connects smart and solar technologies.
- SunPower (<https://us.sunpower.com>) has teamed up with ecobee (www.ecobee.com) to create streamlined energy production, storage and monitoring capacities.
- SolarCity (www.solarcity.com) and Tesla (www.tesla.com) have partnered with Nest (<https://nest.com>) to allow homeowners to produce and store their own energy, and leverage the “Works with Nest” (<https://nest.com/works-with-nest>) program to interconnect a wide range of products and systems. These include Whirlpool appliances, where if Nest detects that a homeowner is away from home, it will tell the appliances to run on longer, more efficient cycles; and Rachio smart irrigation controllers, where Nest smoke detectors turn on the sprinkler system to wet the home's exterior in the event of a fire.

Utilities and the regulatory environment are also entering the picture. Factors such as rate restructuring, time-of-use pricing, fees on net metering, and residential demand charges are shaping the landscape of the solar industry and will soon impact smart home technology. With utilities concerned about grid reliability, resiliency and cost shifting, solar will soon be required to connect with smart home technology as an effective load management strategy.

KINGS OF INDUSTRY

As solar and smart home technology converge, expect to see a rush of service providers offering personalized settings and customized energy packages that suit homeowners' lifestyles, preferences, and work and travel schedules.

The ocean of opportunity invites new players like metadata behemoths Google, Apple and Amazon into the space, giants that have a long history of disrupting industries. This begs the question: Who will win this mad dash? Will it be the tech goliaths, disrupting yet another business sector with their innovative, artificial intelligence-based solutions like Google Home (<https://madeby.google.com/home>) and Amazon Alexa (<http://amzn.to/2gAyTc5>)? Or will the solution come from partnerships developed by the solar players and the smart home tech companies themselves?

The solar and smart home tech companies may have the foresight to claim their fair share of the evolving market. But don't discount the data behemoths when it comes making a play for the larger space of integrated enabling technologies. They have certainly have proven time and again that they have the creative capability and business flexibility to transform the homeowner experience.

Regardless of the ultimate winner, it's clear that smart doesn't just mean connected anymore. Smart technologies represent a much broader ecosystem of enabling technologies that bring a new level of control, security and cost savings. Watch as the solar and smart home sectors converge to empower homeowners to live more independently, resiliently and sustainably. **GB**

Passive Plus

SMART PLUS SOLAR

BY LARRY LINDNER

BUILDING A HOME up to standards required to be deemed “passive” might make some builders cringe. But when the Valle Group (www.vallegroup.com) received such a request, it was almost par for the course. The Cape Cod, Mass.-based builder specializes in carefully planned, energy-efficient homes.

Mike Katon, Valle Group’s senior project manager, says the company had already built a passive house, and thus knew about items such as super-thick insulation and the membranes required to keep a building airtight, as well as the risk of a seemingly minor occurrence like a nail puncture in the home’s wall cavity.

The learning curve for building a passive house was “probably not as steep for us as it would be for some builders,” he admits. The bigger challenge was what homeowner Hank Keating wanted the Valle Group to do with it.

“(Keating) had some very unique ideas for his one-of-a-kind home,” Katon says. Those included a lengthy solar-warmed corridor

This unique home’s smart and solar bells and whistles reduce its ecological footprint even more.



No dryers allowed. A solar corridor that links separate sections of the house doubles as the clothes-drying room.

(LEFT) Follow the sun. Stone Fruit Farm’s north-south positioning enables its solar array to operate at top efficiency.

PHOTO CREDIT: JON MOORE

PHOTO CREDIT: JESSICA DELANEY

to connect separate parts of the house, an on-demand, near-instant water heating system, and energy-saving fireplaces that help control how long the home retains heat.

Mission accomplished. Keating's home, Stone Fruit Farm in Westport, Mass., won a 2016 Silver Prism Award from the Builders and Remodelers Association of Greater Boston for Best Passive Home. No surprise about the kudos: Last Valentine's Day weekend, when the nighttime temperature plummeted to -5, the house never dipped below 63 degrees—without any energy usage. (During that same weekend, the daytime indoor temperature ranged from 68 degrees to 72 degrees.)

DRY LIKE THE SUN

As proposed, Stone Fruit Farm would include numerous planet-saving facets. One of the more striking ones is a solar corridor that would link the 1,800-square-foot main house to its neighboring guest suite, barn, woodshop, root cellar, garage and greenhouse.

Key elements of the corridor included a wall of south-facing windows to collect sunlight, and a concrete block in the interior to absorb the heat. That's because the corridor had to double as the clothes dryer. According to Keating, who is also his home's architect, you're allowed to have a dryer in a passive house. But clothes dryers are "wicked energy hogs" that on average account for 12 percent of a home's energy bill, he says.

"One of the sad things in our country is that in the last 50 years, we've moved away from drying our clothes outside, even in the summertime, when it's easy to do," Keating says. "If everybody could dry outside when convenient, we could save millions of BTUs."

That's why this house lacks an electric dryer hookup, which would also have required a special plug and circuit breaker, Keating adds.

Not putting something in was easy enough. What made the 120-foot solar corridor "a little bit of a head scratcher" was that its location was going to be on an incline in land that couldn't be regraded without "creating major headaches as far as retainage," Katon says.



PHOTO CREDIT: JESSICA DELANEY

Root bound. Builders used the classic bank vault as a model when designing a temperature controlled, three-chamber root cellar.

For that reason, "we had to understand how the concrete base (and) how all that glass was going to climb the hill, rather than use the typical builder's approach: adjust the land to allow the structure to be straight, square and level."

The key was just to let the slab slowly but surely make its way up the slope. This would let the property dictate how the house would sit, Katon says. It turned out to be a "simple and graceful solution." He credits Keating with sensitivity to the land in his design.



PHOTO CREDIT: JON MOORE

Let's rock. Stone Fruit Farm's rocky exterior is positioned to absorb the sun's rays and heat the inside of the house.



PHOTO CREDIT: JESSICA DELANEY

Waste not. A push-button, temperature monitoring control sends only hot water through the pipes, preventing the gallons of waste that occurs when water is gradually heated in a conventional system.

CELLAR DWELLERS

Building the root cellar—something considered critical by Keating and his wife, because they farm their eight acres organically—also presented challenges. The difficulty wasn't that the cellar had to have three chambers to allow for differences in temperature and humidity required for the storage of different types of crops, thereby dispensing with the energy penalty necessary for storing large amounts of food via refrigeration and freezing. It was getting past basic structural constraints.

"We went back and looked at how bank vaults are constructed,"

"Water as a resource is becoming increasingly scarce... (yet) we waste billions of gallons waiting for hot water to get to the spigot."

—Hank Keating, owner/architect, Stone Fruit Farm

Katon says. "Go out west to old buildings—the vaults are always the last thing standing."

The work included pouring a stand-alone concrete ceiling. "We had a guy come in and form up the foundation walls to the root cellar," he explains. "We also instructed him to allow the reinforcement rods to come out of the tops of all the foundations for about five feet."

A contractor then came in, and with a special tool bent the rods at 90-degree angles. Perpendicular to those rods, more steel rods were laid, and they were then all tied together. "This is done in building bridges," Katon says, "but in this case, it was working upside down."

The builders then put plywood under what Katon calls the "steel cage" of rods and put a perimeter frame around the top—similar to the sides of a sandbox. After that prep work, a cement truck came and poured. After 30 days of curing, the crew removed the plywood underneath the new ceiling, waterproofed the cellar and backfilled it. That part of the project "had its daily challenges for the month or so it took us to put it together," Katon relates, "but it came out right."

IN HOT WATER

Other resource-saving elements presented fewer conundrums. For instance, Keating wanted a system where you didn't have to turn on the faucet and wait for the water to get hot as it spilled down

But Does It Work?

YES, YOU CAN build a smart, passive home. But how do you really know it's working—not just keeping in heat and keeping out cold air, but also keeping out moisture?

To find out, architect/homeowner Hank Keating had an OmniSense (www.omnisense.com) monitoring system installed in every plane of the building—all four sides, and along the long ends of the north- and south-facing roofs.

Each plane contains three sensors: one against the inside of the outside sheathing, one on the wood stud that supports the sheathing, and the third on the inner stud. All sensors collect in real time the temperature of the sheathing or wood, the relative humidity, absolute humidity, dew point and wood moisture content of the material, or WME.

Monitoring moisture is important. "There's a great deal of discussion in the passive house community about whether we are running the risk of creating wall sections with super-insulation that could present mold problems over time," Keating says. "I believe the wall system I've designed is bullet-proof, but this way I will be able to check what's happening. Each system has a battery in it that will allow it to operate for seven years."

Years of monitoring is necessary, because it can take years for a moisture pattern to develop within walls. In summer, things dry out more than in winter, so there are cycles. But over five-plus years, the cycles build on each other, and things that are a concern will reveal themselves. "It's a great big science experiment," Keating comments.

To access what the monitoring system is recording, OmniSense's data acquisition G-3 Gateway series (<http://bit.ly/2hblXgG>) is installed in Stone Fruit Farm's mechanical room. From there, the information gets routed to an OmniSense data cloud. When Keating wants to see what's happening—by making a printout of the last 24 hours, the week, the month, or from the beginning—he can log on to his account at OmniSense and look at the numbers. "It's a very strong, very technical tool that allows me to evaluate how the walls are functioning," he says.

The home also has an OmniSense sensor outside to constantly monitor external temperature and humidity. There is also one in the kitchen to monitor interior conditions in the living spaces. Again, the data goes to a central data collector, and from there to OmniSense's cloud-based service for Keating to check and compare numbers.



On wetness watch. With OmniSense's G-3 Gateway unit, Stone Fruit Farm's owners can track how efficient their smart home's insulation is at keeping moisture out.

CREDIT: OMNISENSE LLC

EMERGENCY HEAT

There are two flue-less ethanol alcohol fireplaces, too—one in the living room and one in the master bedroom. They don't just allow the homeowners to cozy up to the warm glow of a flame, they come to the rescue in the wake of a prolonged power outage. "Let's say there's a terrible winter storm with the power out for an extended period," Keating says. "After a day or two, the average American house is freezing inside. The pipes burst, and the residents have to leave. That house is not resilient. In a passive house like this, the insulation level is so high that it would take several days to lose enough heat to make a difference."

On top of that, these fireplaces will more than meet peak heating loads, Keating notes. "It could be zero outside for five days, and they would do a good job of heating the house," he says. "(All) while putting out roughly half the BTUs of a wood stove."

Furthermore, the lack of a flue for each fireplace means no noxious gasses need to be vented out. It also means no hot air is being sucked out through a chimney.

ALL TOGETHER NOW

Katon says that to pull all the energy-saving parts of the design together, the Valle Group had to get sub-contractors "who would be thoughtful—not just try to bang out their part of the job and move on to the next project."

Stone Fruit Farm required a complete team approach within a whole different atmosphere, Katon adds. "Everybody had to be in constant communication about how it was all going to work; how one system was going to affect another," he says. "It was important that the subs talked to each other, not just to the GC or the architect. We all had to be on our game on a daily basis."

While the project manager considers Stone Fruit Farm a success, it was also a part of an ongoing learning experience. "As we go through these houses that are at this point one-of-a-kind, as we get more used to these practices as builders, we're going to get a lot better at this," Katon says. "Some days we tried things and failed. But it's going to become typical. If it's something you're passionate about, you've got to go through these building pains and get on with constructing these types of houses." **GB**

Larry Lindner is a New York Times bestselling writer who has had a long-running, widely syndicated column in the Washington Post and a monthly column in the Boston Globe. He has also penned articles for publications ranging from Condé Nast Traveler to Design New England, the Los Angeles Times, and O, the Oprah Magazine.

PHOTO CREDIT: JESSICA DELANEY



Flame on. Flue-less, ethanol alcohol fireplaces keep hot air from being sucked out through the chimney.

the drain. "In the U.S. and globally, water as a resource is becoming increasingly scarce," he says. "There are regions of the world that are turning into desert because of a lack of water; where farming is dead because of it. We waste billions of gallons waiting for hot water to get to the spigot."

The solution was a button that, when pressed, sends the cold water sitting in the pipes not down the drain but back to the hot water tank, where it gets recycled. Meanwhile, water that has already been heated by the tank comes out through the line. As it gets very close to the sink or tub, a light goes off to tell you the faucet is ready. Thus, when you turn it on, the water is hot from the get-go; none is lost waiting for it to heat up.

Building the system was "just a question of understanding pumps and demands," Katon says. "The plumber was crystal clear on that."

SITING FOR OPTIMAL SUN

One smart element stemmed from the way—and where—the house was built. The long end of the house faces north and south rather than east and west. Keating explains that this ended up as a temperature

control mechanism, albeit a natural one. Because sunlight coming in from the east has such a long angle, it can shoot through the entire house and overheat it. Compensating would have meant extremely long overhangs from the roof. But by making the south side the front of the house, the overhangs don't have to be as long to control how much sun—and heat—comes in.

Installing solar panels on the south-facing side of the roof—two photovoltaic arrays for generating electricity and three for heating water—also didn't create special challenges. But they help the house go from using the small amount of energy allowed in a passive build to a net energy *gain*, reducing carbon emissions by that much more than a traditional build. That was important to homeowner Keating. "To the extent that we can make electricity without impacting the carbon footprint, we are helping not only the overall environment but also human health in the here and now," he says. "The solar panels are another demonstration of the kind of technology we can be installing to further reduce a negative from the point of view of climate change and people's immediate well-being."

UP IN THE AIR

Lubberland's Edge home showcases smart air management.

BY SARAH LOZANOVA

WHEN NORBERT AND Robin Wesely designed their retirement dream home in southeastern New Hampshire, they were inspired by the concept of dynamic energy efficiency: living in a net-zero home that generates as much energy as it consumes. This would make planning for rising energy costs on a fixed income much simpler.

It's been a year since this 1,900-square-foot test house for innovative Zehnder America (<http://zehnderamerica.com>) was completed. Since then, Norbert and Robin have enjoyed exceptional comfort and

indoor air quality in their modern, light-filled home, Lubberland's Edge.

"It's a really special home that integrates numerous innovative technologies," explains Norbert. "There isn't another project with an equal combination of features in our area."

BY THE LIGHT OF THE DAY

Lubberland's Edge has a solar orientation to take advantage of winter sunlight, which gradually provides heat throughout the day. Even on overcast winter days, light fills the home. A vaulted ceiling in the living room, 11-foot ceilings on the first and second floor, and exceptional wilderness views give the space an expansive, open feel.

The home was designed by Kaplan Thompson Architects (www.kaplanthompson.com) and built by FUTURO Construction (<http://futuroconstruction.com>) to the Passive House standard, a rigorous certification for homes that use 90 percent less energy for heating and cooling than a code-built home. What costs other people \$1 in power is a mere 10 cents for the Weselys.



Free flow. Zehnder's energy recovery ventilator sends a constant supply of filtered air throughout the house while eliminating air pollutants.

PHOTO BY CHRIS SMITH, C.A. SMITH PHOTOGRAPHY



PHOTO BY CHRIS SMITH, C.A. SMITH PHOTOGRAPHY

The great outdoors. Lubberland's Edge in Newmarket, N.H., is a state-of-the-art custom home that uses smart air monitoring and solar power to cut energy costs to one-tenth of normal.

Drawing on innovative new technologies and a passive solar design, the home generates as much energy as it consumes. The home's 7.5-kW roof-mounted solar system covers all energy needs, including space heating and cooling, cooking, laundry and hot water heating. No fossil fuels are consumed; the house is exclusively powered by clean solar energy.

"It's a really special home that integrates numerous innovative technologies. There isn't another project with an equal combination of features in our area."

— Norbert Wesely, Lubberland's Edge owner

ALL THE PIECES

Four energy-efficient and smart Zehnder systems are used to ensure comfort throughout the year while promoting indoor air quality:

The *ComfoFond L eco* (<http://bit.ly/2fBgw4>) geothermal system uses ground temperatures to preheat the incoming air throughout the winter, and pre-cool and dehumidify it during the summer. The geothermal energy also keeps electricity costs extremely low.

When summer temperatures become too high, the control unit turns on the Zehnder *ComfoCool*, (<http://bit.ly/2foLhza>) a low-noise, low-energy heat pump cooling system.

Bathrooms feature electric Zehnder towel-warmer radiators, which create an instant heat zone that warms the rooms as well as the towels.

A Zehnder *ComfoAir 550* energy recovery ventilator (ERV) (<http://bit.ly/2gvQ26e>) provides exceptional home ventilation, bringing in a constant supply of fresh, filtered air while removing indoor air pollutants, excess moisture and odors. This also helps promote occupant health by preventing mold growth during wet seasons, and reducing humidity that can drive up internal temperatures during summer.

On edge. A SolarEdge smart meter helps manage Zehnder's low-energy heat pump cooling system.



PHOTO BY NORBERT WESELY



PHOTO BY CHRIS SMITH, C.A. SMITH PHOTOGRAPHY

No smoking. The home's kitchen exhaust hood works with the ERV system to ensure that cooking fumes are quickly removed.

The ERV recycles heat in the winter and helps minimize the need for air conditioning in the summer. The whole-house ventilation system supplies air to the bedrooms, living room, pantry and office. Stale air is removed from the bathrooms, kitchen and mudroom.

"The level of indoor comfort and air quality is mind boggling," says Norbert. "It doesn't matter what is going on outside, the indoor climate is always ideal."

The kitchen exhaust hood works with the ERV system to ensure that cooking fumes are quickly removed at the source to promote indoor air quality. Particles from cooking are a common source of indoor air pollution and can be problematic in virtually airtight houses without adequate home ventilation.

Also, there are numerous, additional energy-efficient features in the home, including a heat pump water heater, LED lights, a ventless clothes dryer with a heat pump and an induction range. A polished

concrete floor on the first floor provides thermal mass, helping to maintain even indoor temperatures. Triple-pane windows and doors, and generous amounts of insulation reduce the heating and cooling load.

Although there is a wood-burning stove in the living room, the couple have only used it a handful of times—for ambiance—throughout their first winter in the home.

The Weselys have found Lubberland's Edge extremely comfortable, as well as energy efficient. It's two benefits in one: Their new house fits their financial goals and protects the environment. gb

Sarah Lozanova is a freelance energy and environmental writer based in Belfast Cohousing & Ecovillage. She holds an MBA in Sustainable Management from Presidio Graduate School in Alameda, Calif. More information may be found at www.sarahlozanova.com.



PHOTO BY CHRIS SMITH, C.A. SMITH PHOTOGRAPHY

Hot zone. Lubberland's Edge bathrooms include solar-derived electric towel warmers that double as room heaters.



Heaven cent. Residents of McKnight Lane Affordable Housing Development receive free electricity, thanks to each home's solar array and battery storage system.

CREDIT: CATHEDRAL SQUARE

EVERYBODY WINS

The McKnight Lane project is the first in the nation to feature net-zero affordable housing for lower-income families.

BY ALAN NADITZ

BEING LOW INCOME does not mean having to live below safety standards—especially when you're talking about living through the frigid winters of Waltham, Vermont.

That's why a team consisting of a smart-home builder, an architect, an energy storage system maker, Vermont's electric utility, and local nonprofit and government agencies decided to play it "smart" and create the nation's first net-zero affordable rental home community for low-income tenants.

At a modest \$3.7 million, the McKnight Lane Affordable Housing Development (<http://bit.ly/2htVQ4A>) also rid the community of a longtime eyesore: a defunct mobile home park that had turned into a brownfield following an oil spill.

In that way, the project was as good to the environment as it should be to the residents of the 14 new solar energy-efficient mobile homes,

according to Cindy Reid, director of development at Cathedral Square (www.cathedralsquare.org), one of McKnight Lane's developers. "This project's benefits are multiple and long lasting," she says. "Fourteen new affordable homes help to address the area's need for affordable housing, the site is clean and no longer a brownfield, and the homes are net-zero energy and have resiliency."

The modular homes, designed by Shelburne, Vt.-based Pill-Maharam Architects (www.pillmaharam.com) and built by Wilder, Vt.-based VERMOD (<http://vermodhomes.com>), each have a roof-mounted, 6-kWh AC solar array and Sonnen (<http://bit.ly/2gBXqQa>) *sonnenBatterie* smart energy storage battery system for backup power. This is a crucial item during the winter, when storms can turn the lights off for hours, according to Clean Energy Group (CEG) (www.cleanenergygroup.org) Project Director Todd Olinsky-Paul. CEG, based in Montpelier, Vt., is one of McKnight Lane's project coordinators.

During a power outage, the system automatically disconnects the home from local utility Green Mountain Power's (www.greenmountainpower.com) grid and switches to the solar backup batteries. These can power the home's essential elements—such as appliances, ventilation, and the heating and cooling systems—for about six hours at night and continuously during the day, as the solar panel replenish the batteries.

"This nice thing is the homes are all-electric, so all of their

appliances can still function when regular power is down," Olinsky-Paul says. "Of course, if they get carried away, the battery won't last as long as it could. But if people are conservative, they'll do alright."

Once grid power has been restored, the system's automatic transfer switch reconnects the home to the utility grid in about five minutes.

Combined, the energy efficiency, solar PV and battery storage systems bring economic and energy security benefits to tenants, developers note. Meanwhile, Green Mountain Power can manage peak energy demand and reduce cost for all customers.

Solar PV-battery storage systems—a.k.a. solar + storage—are relatively new, and offered by companies such as Sonnen and Tesla (www.tesla.com/energy). But most customers tend to be from wealthier households. The systems haven't made their way to lower-income families, who in many cases need the product even more, according to CEG President Lew Milford.

"There's a lot more attention paid to housing for people with low to moderate income in cities," Olinsky-Paul says. "For those in the rural areas, it's a lot tougher. It's important that people who are underserved—who typically don't get new technologies until they trickle down through the wealthier classes—get those benefits now."

EXTRA PERKS

In addition to the solar array and battery, each home has numerous energy-saving amenities that make the solar + solar system even more efficient. These include triple-pane windows, Energy Star appliances, extra insulation and cold-climate heat pumps, according to Chris Faulk, Cathedral Square's director of media communications.



CREDIT: CLEAN ENERGY GROUP

Saved for a rainy day. Each modular home's solar array charges up a *sonnenBatterie* smart energy storage system, in case the local grid goes down.



CREDIT: VERMOD HOMES

Green team. McKnight Lane's grand opening in Waltham, Vt., drew dozens of clean energy enthusiasts and project-related groups.

Group Effort

THE MCKNIGHT LANE HOUSING DEVELOPMENT resulted from collaboration by numerous organizations, including:

- Project developers Addison County Community Trust and Cathedral Square, architect Pill-Maharam Architects, general contractor Champlain Construction, and builder VERMOD Homes.
- Project funding contributors Vermont Housing Finance Agency, Vermont Housing and Conservation Board, Vermont Community Development Program, HOME Investment Partnership, People's United Bank, VLITE, Clean Energy Development Fund, Vermont Community Loan Fund, Vermont Department of Environmental Conservation, Agency of Commerce and Community Development.
- Additional funding by the City of Vergennes, National Association of Realtors, Efficiency Vermont, the Town of Waltham and the City of Vergennes.
- Solar battery storage system funding by Green Mountain Power, Sonnen, Efficiency Vermont, High Meadows Fund, the Vermont Community Foundation Sustainable Future Fund through Clean Energy Group, and the Clean Energy States Alliance.
- Inspiration by former ACCT Executive Director Terry McKnight, who died in November 2014. The project was named after him in honor of his desire to transform the old mobile park into something modern that residents would be proud to call home.

GOOD BONES

Even the home's construction upon a solid foundation acts as an insulator, preventing energy from leaking out through the floor, Faulk adds.

Simplified use by tenants is a key element. Each home's solar + storage system is automated—residents don't have to handle a thing—and Green Mountain Power, Sonnen and project co-developer Addison County Community Trust (AACT) (www.addisontrust.org) monitor all functions. The system automatically shuts down if any serious system errors occur.

More important, from the tenant's point of view, is the lower utility bill. The energy savings will mean a smaller portion of the family budget will go toward keeping the lights on, according to ACCT Executive Director Elise Shanbacher.

"Nearly half of Addison County renters are burdened by their housing costs, paying more than a third of their incomes in rent and utilities," Shanbacher says. "Not only is McKnight Lane affordable to low-income Vermonters, the net-zero homes (and their) resilient energy storage systems ensure residents won't have to choose between purchasing groceries or paying their fuel bill to stay warm this winter."

The Sonnen batteries are "prepared to weather storms and outages for years to come," Shanbacher adds.

Sonnen CEO Christoph Ostermann says the company's goal is to provide everyone with clean, affordable and reliable energy. "Projects like the McKnight Lane development enable us to bring new technologies like solar + storage to lower-income communities,



CREDIT: CLEAN ENERGY GROUP

Resilient Features

- McKnight Lane is the first resilient zero-energy modular housing development for a rural, low-income community.
- Each of the 14 modular homes has a 6-kWh/4-kW AC smart solar energy storage system.
- Smart energy storage systems will work in conjunction with a 6-kW rooftop solar PV system to provide resilient power to tenants.
- Each energy storage systems is able to automatically disconnect from the grid and enable power from the solar panels to provide resilient, reliable and clean electricity to tenants during a grid outage.
- Electricity cost savings to McKnight Lane homes are expected to be 100 percent, making them net zero.

providing cost savings and peace of mind for these homeowners," he says. "It (stimulates) the local utility grid and contributes to greater clean energy equity."

In addition to providing McKnight Lane residents with resilient power, the McKnight Lane project will demonstrate how solar energy storage systems can improve the grid's safety, reliability and performance while delivering cost savings to its customers, Sonnen notes.

CEG and the Clean Energy States Alliance (CESA) (www.cesa.org) will work with Sonnen and Green Mountain Power to collect performance data on the energy storage systems and provide system optimization analysis. Once the data is in, CEG and CESA will work with stakeholders to implement similar projects in Vermont and throughout the Northeast. VERMOD and Efficiency Vermont (www.efficiencyvermont.com), one of the project's stakeholders, have already identified at least two other such locales.

"We'd like to be able to use this as a replicable model," Olinsky-Paul says. "There are lots of places in the rural Northeast that are just falling to pieces. It's not a quick process, but something like this can go a long way toward helping a lot of people." **GB**



CREDIT: CLEAN ENERGY GROUP



CREDIT: CLEAN ENERGY GROUP

Power aids. Each home includes energy-saving features such as triple-pane windows (above) and a solid foundation (below). These help keep the solar + storage system running at peak efficiency.

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SMART+PLUS SOLAR PRODUCTS TO WATCH

The universe of 'smart' products that enhance the performance of green energy keeps getting longer. Here are some of the brands leading in this new frontier.

BY MATT POWER, EDITOR-IN-CHIEF

Adara Residential Battery System

Adara, a manufacturer of commercial battery storage systems, just introduced a powerful option for solar PV homes. The company's *JuiceBox* system is an 8.6-kWh lithium-ion energy storage, with a continuous power rating of 5 kW, and 172 amp hours of storage capacity. The battery can charge quickly up to 80 amps. To optimize battery lifespan, the system incorporates a smart charging system. It

constantly monitors the state of the battery, the PV output and building load from the inverter. It then determines the mode of operation, based on customer bill rates and other priorities. This balances the rate of charge and discharge, operating temperature, depth of discharge and number of cycles.

Neil Maguire, CEO of Adara, notes that Tesla's

Powerwall 2 is not yet in the field, whereas the *JuiceBox* is ready to ship. "Another main technical performance characteristic is the switch-over time when the grid goes down," he adds. "Our system is eight milliseconds, so all devices in the house stay booted up. The Tesla and Sonnen systems go through a two-second shutdown, so the house and all appliances go off, then reboot."

Adara expects to launch a new product with 20 kWh capacity early in 2017.

www.adarapower.com



Enphase D/C to A/C Microinverter

Enphase takes a smart approach to product design. Unlike Samsung's troubled *SmartThings* line, for example, many Enphase gadgets produce their own power through kinetic or solar energy. This not only avoids hassles for homeowners, it keeps battery waste out of landfills.

So it's no surprise that Enphase offers clever solar innovations. The compact *S280 Microinverter*, for example, retails for about \$150. It's a plug-and-play option that boosts solar panel efficiency by converting power from D/C to A/C at each module. Advocates of this inverter approach say it boosts the overall cost per watt output, and makes installation and replacement easier. One drawback is that if you have a product failure, you need to climb on the roof to fix it, instead of accessing a centralized location.

The Enphase *S280* is designed for high-powered, 60-cell modules. It integrates seamlessly with the Enphase *Envoy-S* communications gateway and Enphase *Enlighten* monitoring and analysis software. In other words, it can be updated remotely as needed. It also works with most battery storage systems.

<https://enphase.com/en-us>



smartflower Self-Contained Solar Power

Smartflower had a successful launch in Europe, and will be available in the U.S. in the first quarter of 2017, with an SRP of \$17,840. This cleverly designed unit automatically fans out its solar petals at sunrise to face the sun, then follows it at a 90-degree angle all day, using GPS-based dual-axis tracking (not unlike a flower). It then closes up as the sun sets.

This close tracking allows *smartflower* to produce up to 40 percent more output than static solar arrays, making it the equivalent of a 4- to 5-kW rooftop system. The efficiency of *smartflower* improves even more, because the panels are self-cleaning. Every time they unfurl or close, tiny brushes on the back of each panel brush dust, dirt and snow off the one underneath it. Each "petal" is also rear-ventilated, so hot air won't accumulate within the system. This keeps the petals cool enough to deliver up to 10 percent more output than other panels.

In winds higher than 40 mph, the petals automatically fold in and stow away, leaving a fully shuttered unit that will withstand hurricane level conditions. Lastly, *smartflower* units with storage provide remote monitoring, allowing the owner to access by any smart device at any time of day a wealth of data about the unit's power generation and use.

<https://www.smartflower.com/en>

www.greenbuildermedia.com

SMA Inverters and Smart Controls

The SMA Smart Home is an energy-efficient solution for whole-house energy management that will result in net-zero independence from utilities. It also helps reduce peak power demand, thus eliminating potential demand charges for homeowners, depending on their utility rate structure. An SMA Smart Home can operate connected to the grid and off-grid.

Key components of the SMA Smart Home include a *Sunny Boy* storage battery inverter, a *Sunny Boy* PV inverter and a high-voltage battery. Together, these elements function as the "brain" of the system, ensuring simple and reliable operation.

A PV system, tied to a *Sunny Boy-US* PV inverter, will charge the high-voltage battery during the day so that it can be discharged in the evening, when electricity rates are often higher. The inverter constantly fine-tunes the flow of energy and information, to optimize how power is used in an intelligent home.

SMA's *Sunny Portal* (shown) allows for easy monitoring and management of the entire Smart Home system via web or smartphone. This scalable software not only manages data, but allows for quick diagnosis of any potential issues.

www.sma-america.com



amazon echo

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Echo and Alexa: The Perfect Couple?

What makes *Echo* noteworthy in the world of Smart Plus Solar is that it takes voice commands to a new level. The unit has seven microphones and beamforming technology that allow it to distinguish human voices from across the room—even while music is playing. Those voices are then interpreted by *Alexa* programming.

Along with this listening ability, *Echo* also functions as an expertly tuned speaker that can fill any room with 360-degree immersive sound.

Today, there are tens of thousands of developers building *Alexa* skills, and over 4,000 *Alexa* skills now available to customers; they can play games, pay bills online or find music. But beyond these daily tasks, new skills will likely include energy management, including integration with smart meters.

Bob Shively, president of Enerdynamics, notes that voice commands with an integrated device such as *Echo* are likely to become the standard for controlling the intelligent home of the future. “Amazon’s *Alexa* personal assistant,” he notes, “accessed through the home *Echo* speaker, can already perform voice-activated functions such as adjusting thermostats and lighting levels, controlling switches and querying security systems to see whether a window is open.”

Although there are no dedicated solar power management apps for *Alexa* at present, some are already in the works. And with phone control of the *Echo* already possible through the *Roger* app, *Echo* and its voice-linked abilities will continue into the arena of home energy saving. The *Echo* is on sale for just \$139 retail at the time of this writing, and with the Amazon *Echo Dot*, you can add *Alexa* controls to multiple rooms.

<http://amzn.to/2hJBvAl>



SolarCity and Tesla: All In

There’s nothing shrinking about SolarCity’s gamble on its future in the solar arena, as it completes a drama-laden merger with Tesla, the company owned by entrepreneur Elon Musk. From the looks of SolarCity’s website, the *mental* merge with Tesla is already a done deal.

There’s nothing coincidental about this match. The two companies will offer a full-circle approach to solar.



SolarCity has built a vast infrastructure for mainstreaming the concept of solar leasing. But as outright purchase of solar panels has become more affordable, and net metering has come under siege by utilities, the company’s growth has slowed. The Tesla merger, however, could solve these

challenges with three new additions to the SolarCity portfolio:

- **Building-integrated solar shingles.** Musk seems convinced he can make this type of product a success where other brands have failed. His product is innovative. Roofs look “normal” from below, but act as solar cells from above—resolving consumer expectations about what a roof “should” look like.
- **Residential storage battery.** Tesla’s *Powerwall 2*, a 14-kW residential lithium-ion battery, is said to be launch-ready, offering viable off-grid storage for homeowners.
- **Electric vehicles.** Tesla Motors vehicles, charged with solar power, will also recharge the *Powerwall 2* when not in use. The new *Model S* is shown.

www.solarcity.com



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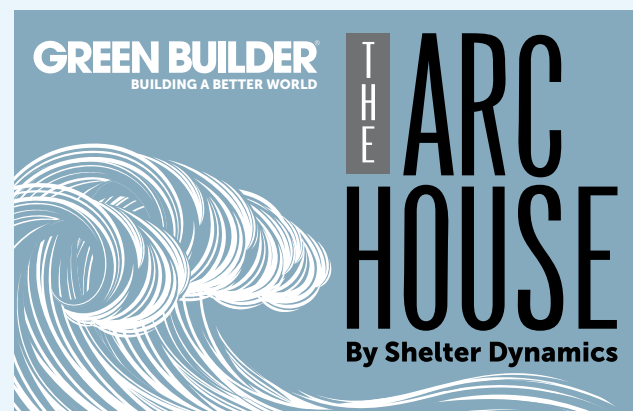
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State of this array. Combine a PV array with a storage battery, inverters and energy management, and you have a home that's built for power.

CREDIT: SHELTER DYNAMICS/ALIGA 3D



Part 4 of The Arc House Focus Series BY JULIET GRABLE

The Arc House demonstrates ways to integrate renewable energy with connected technology.

SMART HOME TECHNOLOGY and solar technology provide complementary benefits: reduced energy use, improved efficiency, and greater comfort and control by homeowners. The Arc House demonstrates how these technologies can fully integrate to create an intelligent, efficient home—one that automatically adjusts to optimize energy use and comfort, and provides feedback to occupants that encourages them to change their behavior.

These technologies are trending toward wider adoption. Here's a look at the home's thermostat, solar array and energy management systems.

OPTIMIZED HVAC

Smart thermostats have been around for several years, but 2015 saw a surge in interest in the technology. And according to a report published by IoT Analytics in March 2016, the global market for smart thermostats will grow by 35 percent annually over the next six years.

Many of the more-popular smart thermostats include intuitive controls and a user-friendly interface. The *Sensi* (<http://bit.ly/2h0KaWu>) Wi-Fi programmable thermostat from Emerson (www.emersonclimate.com) offers the flexibility of programming a different heating or cooling schedule for every day of the week, as well as the ability to easily turn the thermostat setting up or down from a smartphone.

The free mobile app also allows the user to control a thermostat from anywhere, and to control more than one thermostat in more than one location.

Contractors also like the *Sensi* thermostat, as it is compatible with most HVAC systems and can be installed before the Wi-Fi connection is available. The thermostat does not require a common wire (c-wire) for most electric and gas units.

SOLAR PLUS STORAGE

The Arc House's renewable energy concept system includes a solar PV array from JinkoSolar (<http://jinkosolar.com>), a high-voltage



Ready to go. The *Sensi* Wi-Fi programmable thermostat is compatible with nearly all HVAC systems and can be installed in advance, before the Wi-Fi connection is set up.

storage battery, and inverters and energy management from SMA America (www.sma-america.com). The 2.6-kW solar PV array powers The Arc House and charges the storage battery during the day; at night, the home draws on stored energy from the battery. The system can operate on or off grid.

A residential solar system that includes battery storage demonstrates the next development in residential renewable energy. Such systems enable greater control over how and when energy is produced and consumed. Current grid-tied systems must rely on the electricity grid when solar energy cannot be immediately produced and don't offer much in the way of added value.

DIRECTING SOLAR ENERGY

Energy management is key to maximizing "self-consumption"—using as much of the energy generated by a solar array in the home



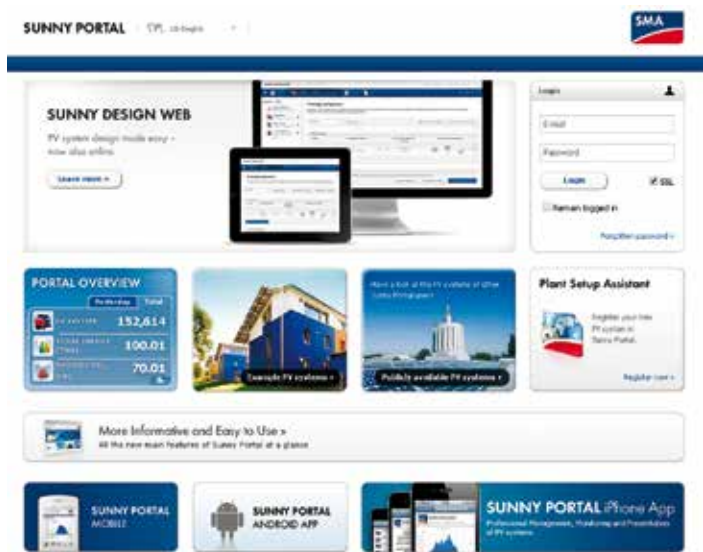
CREDIT: SHELTER DYNAMICS/ALGN 3D

All-weather radial. The Arc House's automatic load control keeps power flowing at an optimal rate no matter what it's like outside.

as possible. In The Arc House, the technology from SMA America ensures that the energy generated from the PV array is used in the most efficient way. The system can “decide” whether to send excess solar-generated energy to the electricity grid or to the battery, based on energy production and use predictions. These, in turn, are based on weather forecasts and past usage data. The system can also work with connected appliances, timing their use and ensuring that they draw on solar power, not the electricity grid, during times of high demand.

Automatic load control ensures the most efficient use of solar power and optimizes energy use so that the home doesn't draw from the grid when rates are high. This eases the burden on the grid and reduces demand charges in regions where utilities employ a tiered structure.

The SMA Smart Home allows occupants to better manage their energy. Through the Sunny Portal app, residents can access detailed information about their home's energy use, the energy generated from the solar array and battery storage levels. The technology also provides recommended actions, so occupants can make deliberate decisions that optimize energy use. **GB**



CREDIT: SMA AMERICA

Power play. Elements of the SMA Smart Home include an app that provides information about energy used, energy generated and remaining battery power.

A Cutting-Edge Renewable Energy System

THE ARC HOUSE'S renewable energy system demonstrates the next step in residential renewable energy: combining an efficient solar PV array with the ability to store solar energy generated during the day, and to manage that energy to benefit the home's occupants and the electricity grid.



- **2.6-kW solar PV array.** The *Eagle Black* modules from JinkoSolar are among the most efficient on the market.
- **Optimizers.** SMA's module-level power electronics ensure that modules affected by shading still perform optimally. With module-integrated and retrofit options, this solution allows for a unique selective deployment strategy that cuts cost and speeds installation.
- **Sunny Boy Storage battery inverter.** Ideally suited for integration with leading high-voltage battery manufacturers, this inverter combines the flexibility of the AC coupling with the advantages of high-voltage technology, enabling a significant reduction in system and installation costs.
- **Sunny Boy PV inverter.** Unique to SMA, the *Sunny Boy US* series of inverters come with secure power supply as a standard feature, offering 2,000 watts of opportunity power when the grid goes down.
- **High-voltage battery.** This component allows energy generated by the solar PV array to be stored for use after the sun goes down. The *Sunny Boy Storage* inverter is compatible with several leading high-voltage battery manufacturers.



Smart + Solar Features

- Solar PV and integrated battery storage system
- Smart thermostat and responsive HVAC
- Energy management system
- Interactive lighting
- Smartphone-enabled security
- Weather integration

A Proving Ground for New Ideas

Emerson's new innovation center takes a collaborative approach to product development.

BY JULIET GRABLE

EMERSON'S COMMERCIAL & RESIDENTIAL BUSINESS PLATFORM focuses on home comfort and food safety. Building pros are likely familiar with many of its popular brands, including *InSinkErator* and *ClosetMaid*, as well as leading-edge products like the *Sensi* Wi-Fi programmable thermostat. But the progressive company (www.emersonclimate.com) is focused on much more than churning out great products.

The Dayton, Ohio-based Helix Innovation Center (<http://bit.ly/1Yulfc1>), which officially opened in April 2016, exemplifies Emerson's commitment to collaborative innovation. Located on the University of Dayton campus, the 40,000-square-foot center consists of six modules that simulate real-world conditions. These include a fully functioning and furnished “connected” home, supermarket, commercial kitchen, light commercial facility, industrial refrigeration system and a data center.

With its open plan and three learning laboratories, the facility is much more than a product testing center. It is designed to foster a collaborative approach—a place where researchers, academics, industry pros and others can develop heating, cooling and refrigeration solutions for a variety of building types.

Each module includes multiple refrigeration and/or HVAC systems. Condensing units within environmental chambers enable ambient temperature control over a wide range of conditions. For the house module, outside temperatures can range from -20 degrees F to 120 degrees F, and relative humidity of 20 percent to 90 percent. Researchers can simulate conditions from “Minnesota to Arizona” within days, allowing them to fast-track tests that would take months in the field.

The house module also includes radiant panels inside, which can be used to simulate passive solar heating.



CREDIT: EMERSON

Big vision. A LEED-certified facility, the Helix Innovation Center will host researchers from all over the world as they collaborate on HVAC solutions.

The focus of the two-story, 2,000-square-foot house module will evolve over time. It is equipped with reconfigurable walls on both floors and separate metering, so researchers can precisely track energy use. Emerson's researchers are currently looking at indoor air quality and air conditioning efficiency, and are exploring home comfort from all angles.

Emerson's Commercial & Residential business platform is focused on developing technologies and services that improve human comfort, support efficient buildings and municipal infrastructure, safeguard food, protect the environment and enable sustainable food waste disposal.



CREDIT: EMERSON

Collaborative approach. Researching home comfort includes holding “ideation sessions” with diverse groups of people, including those from professions outside the HVAC industry and people with disabilities.

Made for the Shade

These guidelines can help designers choose patterned panels that let in just the right amounts of sunlight and fresh air.

BY JULIET GRABLE

PATTERNED ARCHITECTURAL PANELS can be used for shading, privacy screening, railings or building façade treatments. Westminster, Colo.-based Parasoleil (www.parsoleil.com) offers 36 standard patterns, and the company's designers can create custom panels. But some patterns may be more suitable than others, depending on the design objectives. For example, a pattern that creates an effective privacy screen may not be the best choice when the primary objective is shading.

To deliver the best product for each situation, Parasoleil has studied how the human brain perceives patterns, along with how different patterns interact with light and air. Here are some considerations for selecting a patterned panel for shading:

Openness. This characteristic refers to the percentage of the panel that has been removed. In general, a pattern with an openness between 15 percent and 25 percent allows air to circulate. It also provides sufficient shade control for areas that receive direct sunlight.

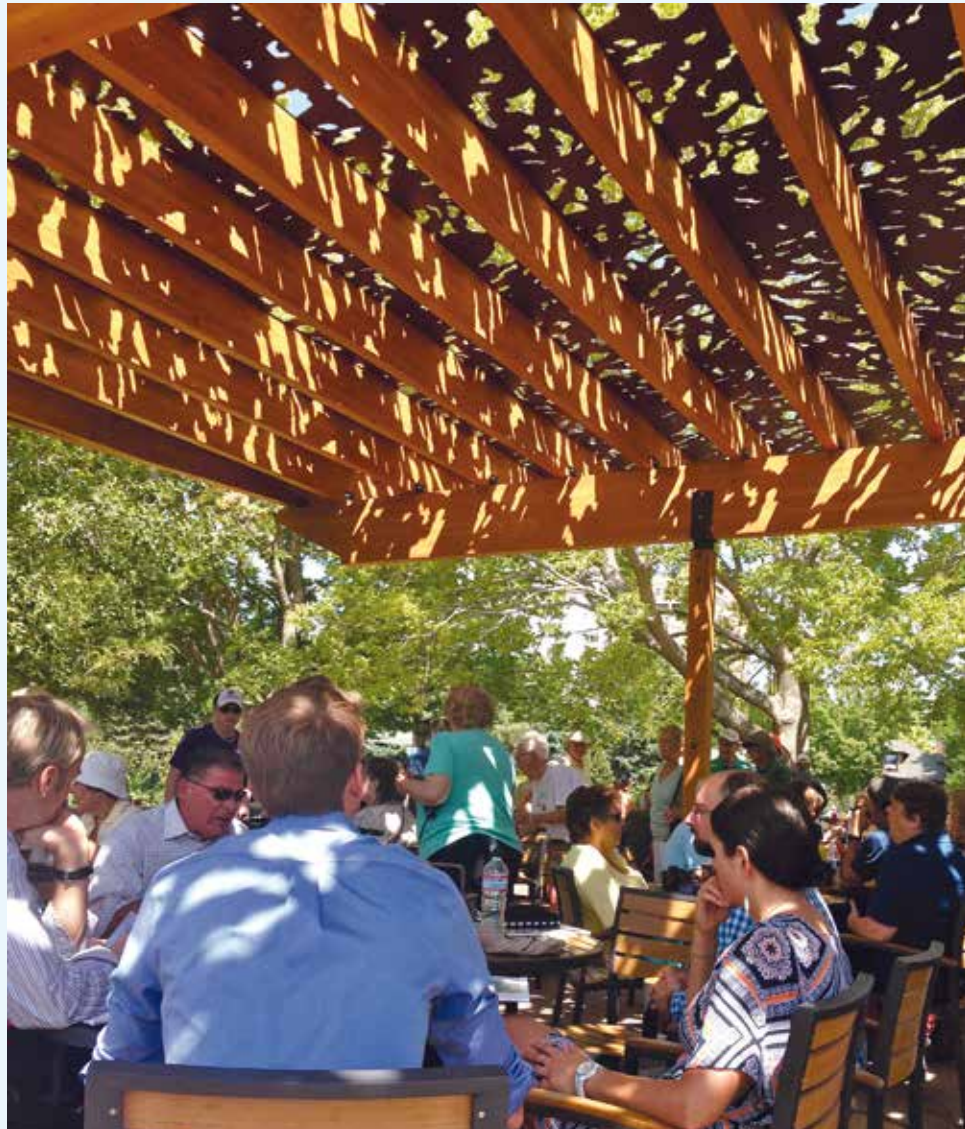
Airflow. When it comes to the comfort of exterior spaces, fresh air circulation is just as important as shade. A more-open pattern better facilitates air movement and heat transfer. A general rule for ensuring comfort of outdoor spaces is to increase the openness by 3 percent for every 10 degrees above 85 degrees F.

Distance. As the distance from the overhead structure to the objects being shaded below increases, sunlight tends to "wrap" around the edges of a patterned panel, shrinking the shaded square footage below it. To compensate for this spillover (and subsequent solar gain), panels installed over 11 feet above ground require a pattern that is 5 percent to 10 percent tighter.

Structure. This is the type of pattern that affects the distribution of light and airflow provided by the panel. A modular pattern consists of repetitive, self-contained units and creates a more uniform distribution of light and airflow. A continuous pattern is less predictable and random, and it doesn't appear to have a discrete beginning or end. This irregularity may cause some areas to be

more shaded while leaving others more exposed.

Material. In general, aluminum or copper are the best choices for patterned panels used for exterior shade. Steel rusts, especially in damp climates, and water passing through the panel can potentially stain objects below. Rusting around the fasteners can compromise the integrity of the connection and potentially create an unsafe condition.

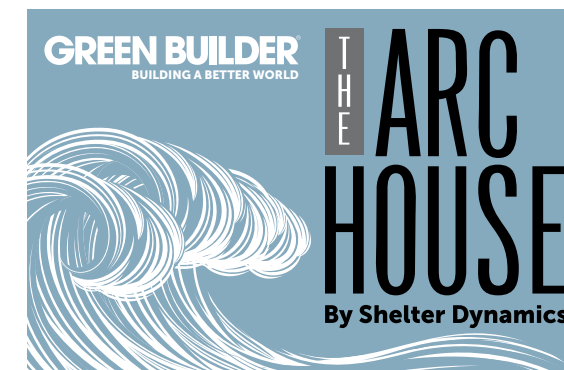


Shading, naturally. Patterned architectural panels from Parasoleil installed at the Denver Botanical Garden provide effective shading. They also create interesting shadows that change with the sun's path.

CREDIT: PARASOLEIL

The Arc House

SMART + SOLAR



Green Builder Media has a decade-long history of identifying and investigating the most topical, cutting-edge issues of our time.

Lately, we've been focusing on the evolution of the smart home, which converges smart home and solar technologies to provide homeowners with the ultimate control over their energy future.

To bring this concept to life, Green Builder Media has partnered with specialty modular builder Shelter Dynamics to showcase their prototype of next-generation living, The Arc House, a hand-crafted tiny home that is simultaneously net zero, resilient, intelligent, and sustainably designed. The Arc House offers ideas for independent, self-sufficient, and sustainable living.

To learn more about The Arc House, visit www.greenbuildermedia.com/vision-house-arc-house or contact Cati O'Keefe at cati.okeefe@greenbuildermedia.com

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Sunny Forecast

There's a new vision for the solar suburbs of the future.

BY MARC GUNTHER

Note: This article originally appeared in *Yale Environment 360*. (<http://bit.ly/1V6f3Sz>) However, certain elements have been updated.

MAGINE A TRULY GREEN SUBURB, one in which energy-efficient homes are powered by rooftop solar panels, and electric cars glide quietly down the streets. Businesses, energy experts and scholars say low-carbon suburban living is not only possible, but on its way—though not in the short run. Some glimpses of the future: In Palm Springs, California, rooftop solar panels are standard in a new community of 42 energy-efficient homes built by Far West Industries of Santa Ana. The homes sold quickly, at prices ranging from \$600,000 to \$700,000. Scott Lissoy, president of Far West, says: “If we’re building in the Coachella Valley, which is one of the hottest areas in California, we’re building with solar panels. It’s the right thing to do.”

VAST POTENTIAL

In Colorado, residents of Adams, Boulder and Denver counties are taking advantage of a group buying program called Solar Benefits Colorado, which offers discounts on solar panels from a company called Sunrun and on an electric car, the *Leaf*, from a local Nissan dealer. It’s one of a series of group procurement projects organized by Vote Solar, an advocacy group.

In Vermont, the local utility Green Mountain Power wants to sell its customers less electricity. Instead, it is selling them energy-saving heat pumps, weatherization, batteries and solar panels that give them more control over their energy consumption. “Really, what we’re in the business of doing is trying to accelerate a consumer revolution that’s already happening, to transform the energy space,” says Mary Powell, the utility’s CEO.

These examples point to the potential of what some are calling “solar suburbs.” The concept is a sweeping one—solar panels cover roofs, electric vehicles sit in garages, energy-efficient homes are outfitted with batteries to store electricity, and a smart two-way electricity system enables people to drive to work and discharge power from their electric cars at times of peak energy demand. Australia’s government has embraced this idea for a new military housing development being built near Darwin, where each home will come equipped with a 4.5-kW rooftop solar system, charging points for electric cars, and smartphone apps enabling owners to



Bright side. Solar power is now a standard feature offered by six of the nation’s largest homebuilders, according to provider SunPower Corp.

track their energy use and carbon saved.

This vision bears little resemblance to the suburbs of today—with their big, inefficient homes, two or three gasoline-powered cars in the driveway, shopping malls and vast parking lots. But advocates say that if all goes well, advances in technology, combined with smart policy, could lower the costs of solar power, electric cars and batteries, and drive a clean energy revolution in the suburbs.

Analysts at the Rocky Mountain Institute, led by Amory Lovins, also see an energy revolution coming. “The technical solutions are there,” says Titiaan Palazzi, a mechanical engineer at the institute who formerly worked for smart thermostat company Nest. “You could eventually get to suburbs or communities that are net-zero energy.”

Meantime, an academic study of the city and suburbs of Auckland, New Zealand, found that detached suburban homes can generate



Burb poster child. Darwin, Australia’s Breezes Muirhead development, with rooftop solar, an electric car charging station and smart electrical system in every home is a model for builders of “solar suburbs.”

more than enough electricity than they need and send the surplus to the city in the batteries of electric cars driven by commuters. Hugh Byrd, a professor at the University of Lincoln in the United Kingdom, who led the research, says another study found similar results for San Francisco. But, he added, realizing the clean-energy potential of suburbs will require, among other things, cheaper batteries with greater range to increase the market penetration of electric cars.

And there’s the rub. For America’s sprawling suburbs to become environmentally friendly—let alone generators of excess energy—distributed solar power, electric cars and battery storage will all have to become mainstream. That will probably happen, but not in the near future.

BEYOND THE NICHE

Across the U.S., distributed solar power—that is, photovoltaic panels installed on homes and businesses—is enjoying explosive growth, expanding by more than 50 percent annually for a decade, according to market researcher Clean Edge. SolarCity, the leading home solar company, says it aims to serve 1 million residential by 2018, and it’s got plenty of competition.

But distributed solar remains a niche business in every state except Hawaii, where 13 percent of residential electricity customers have installed solar. (California’s next, with 3 percent.) Nationally, about 734,000 homes—less than 1 in 100—have on-site solar, according to GTM Research’s *U.S. Solar Market Insight* report. And a 2015 survey of U.S. homeowners by Clean Edge and SolarCity found that just 6 percent said they plan to install home solar in the next year, fewer than those preparing to buy LED bulbs, smart thermostats and efficient water heaters.

(Some other countries, it must be said, are making far more progress. Germany, whose population of 80 million is one-quarter that of the U.S., has 1.5 million photovoltaic systems installed, twice as many as the U.S. Germany now generates nearly 7 percent of its electricity from solar power. In Australia, one in five homes now have photovoltaic panels.)

Another key element of the solar suburb ecosystem—electric cars—has proven to be a hard sell. Back in 2011, President Obama called for 1 million electric plug-in cars (as opposed to hybrids like the Toyota *Prius*) to be on America’s roads by 2015. But by 2015, we were not close: Cumulative sales (were) less than 375,000, reports the Electric Drive Transportation Association.



Powering up. Tesla’s Powerwall battery is one of several battery systems that are raising the solar bar.

As for batteries to store electricity at home, they are new and unproven. In 2015, Tesla set off a spirited debate among industry analysts with the announcement of its sleek *Powerwall* battery. Some said it won't store enough electricity to run power-hungry appliances like air conditioners or clothes dryers, and at an installed price of \$7,000, makes little financial sense for most people. Others said that in states with high electricity costs, batteries will enable solar owners to store power for the evening hours in a cost-effective way. Panasonic and Samsung are also developing batteries for the home storage, so Tesla's Elon Musk isn't alone in thinking there's a business there.

A NECESSARY GAMBLE

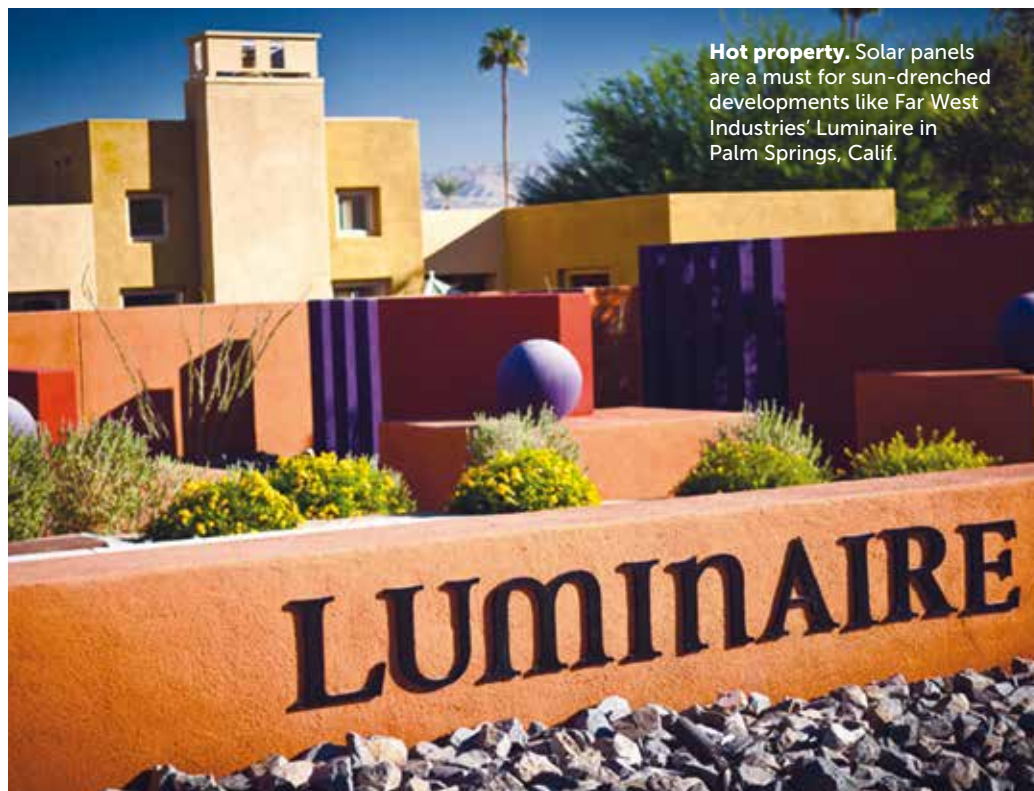
One reason why it's hard to forecast the future of solar, electric cars and batteries in the U.S. is that all are subsidized, and therefore policy dependent—and not just at the federal level. Today, electric car buyers can take advantage of a \$7,500 federal income tax credit, but the credit will expire once certain sales thresholds are reached. So electric cars could jump in price just as they become popular.

The economics of solar depend in part on federal investment tax credits of up to 30 percent for homeowners or for companies that install solar panels and lease them to homeowners—the most common home-solar arrangement today. But those credits are scheduled to fall to 10 percent in 2017 or disappear altogether. GTM Research expects a deep dip in solar installations in 2017 if the tax credits disappear.

State regulation is key, too. In Florida—the Sunshine State—there is essentially no solar power industry, because local utilities retain a monopoly on supplying electricity to homeowners. Some states have capped the amount of residential solar eligible for net metering, which allows homeowners to sell their excess electricity back into the grid and thus reduce their costs.

"There is a lot of uncertainty right now with regard to the policies that have supported solar in the past," says Laura Wisland, a senior energy analyst with the Union of Concerned Scientists.

Despite the unknowns and unknowables, a growing number of investors and a few utility executives have come to believe that the electricity sector is undergoing dramatic change. "That the world's energy system has begun a dramatic transformation to a cleaner, more local future is no longer a controversial statement," says Michael Liebreich of Bloomberg New Energy Finance. Deutsche Bank published an exhaustive 185-page analysis of the global solar market that concluded: "We believe the solar industry is going through fundamental change, and the opportunity is bigger than it



CREDIT: FAR WEST INDUSTRIES

has ever been before."

Not surprisingly, economics are the big driver. Solar panel costs have fallen sharply, and the so-called "soft costs" of solar that include marketing, installation and permitting are declining as well, albeit more slowly. Instead of buying panels, most homeowners now lease them from solar providers like SolarCity, Sunrun and Sungevity or utilities, including Green Mountain Power and NRG Energy. "Leasing has been the game changer," says Clint Wilder, a senior editor at Clean Edge, whose survey found that 82 percent of homeowners say "saving money" is the number one reason they buy clean energy products and services.

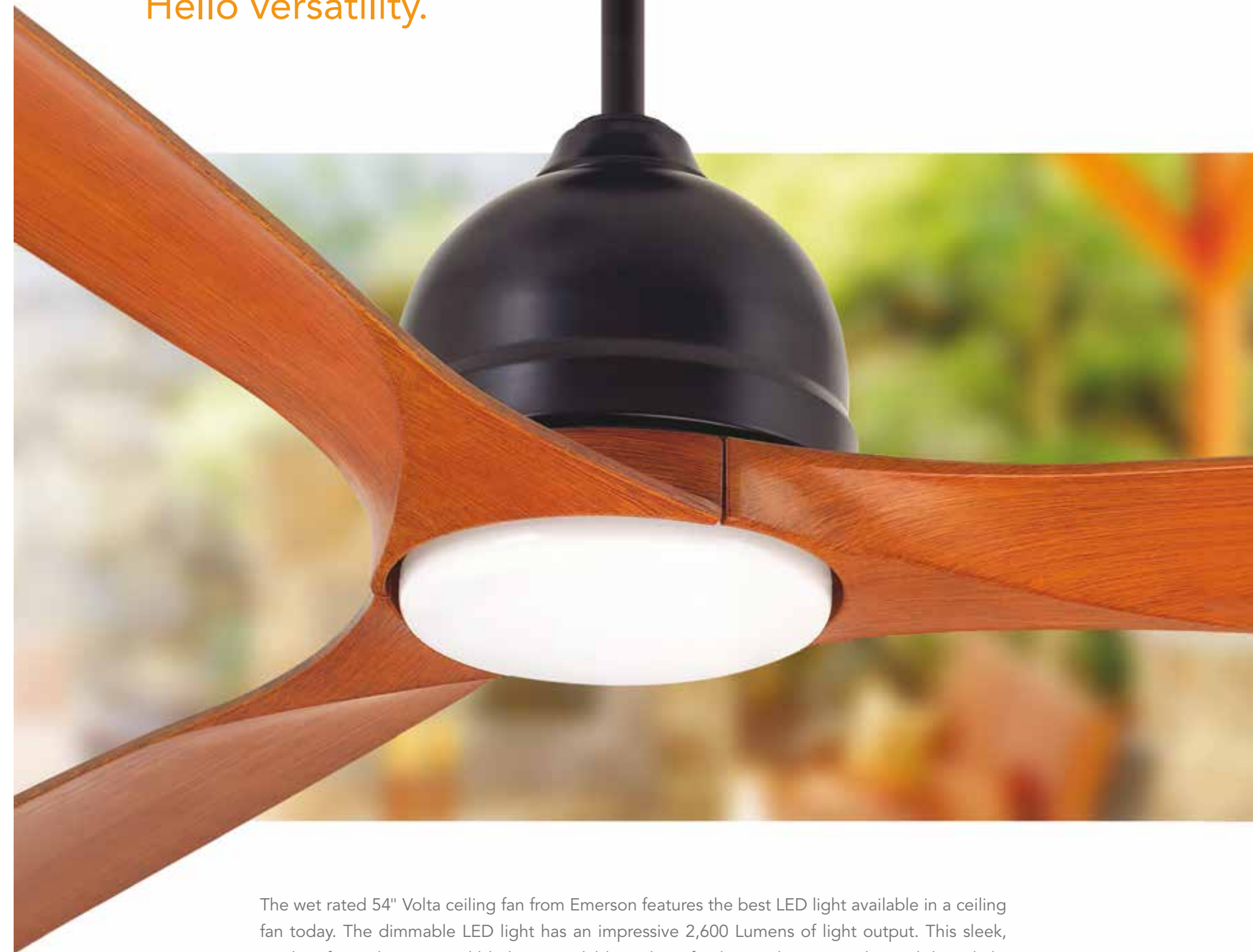
One company—CPS Energy, a municipally owned utility in San Antonio—has even offered to pay select customers who agree to let a solar development firm install panels on their roof.

Homebuilders, too, are slowly embracing solar. Six of the 10 largest homebuilders make solar standard in some developments, according to solar provider SunPower. Lashing panels on a roof when a house is built saves money over installing them later, and the costs of solar can be rolled into a home mortgage.

Cisco DeVries, the chief executive of Renew Financial, a California firm that finances solar and energy-efficiency projects, says the transition to an energy mix that is "decentralized, much cleaner and much more efficient" will come much faster than most people expect. Before the invention of smartphones, he notes, nearly every home in the U.S. had a landline; now fewer than 60 percent do. "The pace of change for distributed energy will start to look a lot like the *iPhone* revolution pretty quickly," DeVries says. **GB**

Marc Gunther is editor at large of *Guardian Sustainable Business U.S.* (<http://bit.ly/2fO3WR0>)

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Featured in the 2016 Arc House for Next-Generation Sustainable Living

EMERSON. CONSIDER IT SOLVED.™

Net-Zero Trifecta: Solar, Heat Pumps and Smart Controls

Getting to net zero is within easy reach with new technologies. The only real hurdles are politics and ignorance.

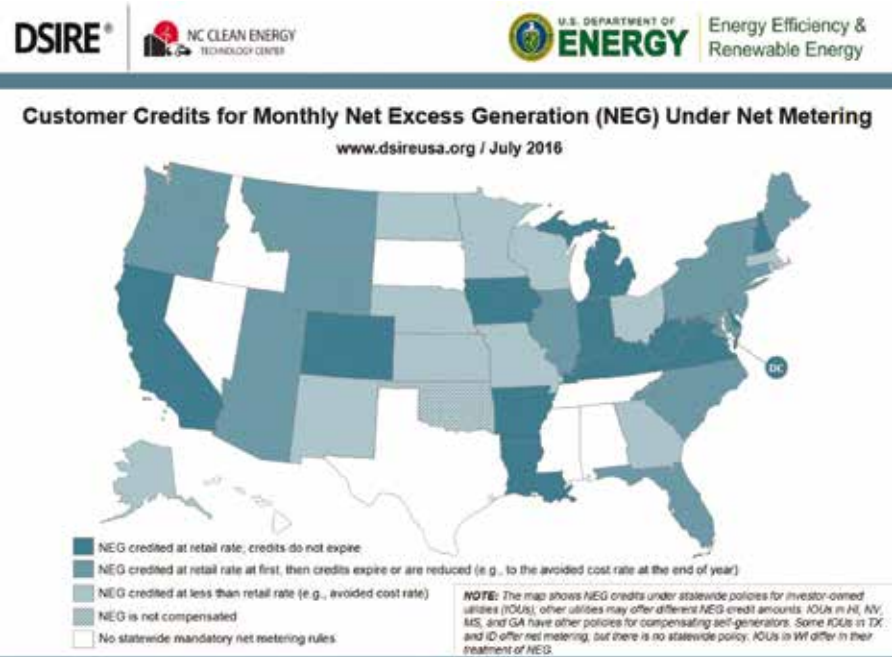
BY MATT POWER

A FEW MONTHS AGO, I SPOKE TO BUILDER Gene Myers of Thrive Home Builders (www.thrivehomebuilders.com) in Denver about whether mini-split heat pumps could be powered by solar PV panels, essentially converting electricity into affordable, clean heating and cooling for homes. “We’re doing that on all of our new homes,” Myers told me. “We have been for a couple years now.” That took me by surprise. At the time, I hadn’t looked closely at how such a marriage of technologies would work. Since then, I’ve been putting the pieces together, planning a system for my own building with a solar array and mini splits, all managed through a smartphone app. What I’ve learned is that the path to net zero with solar heating/cooling is possible, but the devil really is in the details. Some of the devils, however, are elected officials.

INDIRECT, NOT DIRECT POWER

It’s important to understand that solar PV panels do not *directly* power mini splits—at least, not yet. Even the best new DC-to-AC inverters, made by companies such as SMA (www.sma-america.com), can’t overcome the inconsistency of how weather patterns affect PV power generation. According to Zach Nugent of ReVision Energy (www.revisionenergy.com) in Portland, Maine, weather and seasonal issues (along with the Earth’s rotation) mean that power output from PV is not consistent enough to take over the high demand of a mini-split system’s outdoor condensing unit. This limitation applies even to a super-efficient model with a seasonal energy efficiency ratio (SEER) of

15 or more and an energy efficiency ratio (EER) of 12.5 or more, with variable output. For example, the outdoor component of my multi-zone (three mini split) Mitsubishi system draws about 3,800 watts at peak demand. My 6-kW solar array will sometimes deliver that wattage and more—but not consistently. This need for a buffering technology narrows the options for residential solar, and also explains why so many companies are getting into the energy storage arena. PV’s path to heating and cooling—the biggest energy users in the home—is limited to two indirect routes: net metering or batteries.



Mixed blessings. Darker areas show where net metering allows owners to trade energy credits at retail value.

COST OF HEATING COMPARISON

Heat pumps are less than half the cost to operate vs. the equivalent oil or propane system on a per BTU basis. This chart gives you a quick breakdown of relative costs.

Fuel Source	Cost per Unit	Cost per Million BTUs	Cost to Heat Typical Home
Electric Baseboard	\$0.14 / kWh	\$44	\$4,489
Propane	\$2.73 / gallon	\$40	\$3,873
Heating Oil	\$2.70 / gallon	\$25	\$2,421
Heat Pump	\$0.14 / kWh	\$18	\$1,706
Heat Pump with Solar	\$0.09 / kWh	\$11	\$1,023

Based on fuel data and pricing from Maine Energy Office. Assumes typical oil boiler operating at 65 percent efficiency, propane at 85 percent efficiency, resistive electric at 95 percent efficiency and heat pump at 250 percent efficiency (COP of 2.5). Solar PV kilowatt-hour cost of 8.5 cents per kilowatt-hour based on typical pricing economics of 4-kW+ system.

NET METERING: UNDER SIEGE

Grid-tied solar that feeds back into existing infrastructure is by far the least costly (and historically, fastest) path to mass market adoption of solar. It’s the simplest way to get to net zero using mini splits. While the homeowner isn’t technically feeding power directly to the HVAC system, the home is producing as much power as the units consume. Result equals net zero. With net metering, power from the PV panels is fed back into the local grid, and typically the owner gets a credit. As the map shows, about one-third of states currently trade these credits at full retail value. Another third offer less than retail value, and the remainder offer little or no incentive for solar. So, where you live has a big impact on how fast your system pays for itself in energy savings, and how soon in the discussion you want to start looking at batteries. Another major impact on net metering is the disposition of local politicians. Are they beholden to coal, oil or other fossil fuel interests? This is all too common. In other words, despite best efforts to get off fossil fuels, you remain at the mercy of fossilized thinking.

Political resistance to solar comes not only from fossil fuel industries, but also from utilities. They assert that non-solar customers end up paying for the grid infrastructure and PV owners don’t.

A perfect example is playing out here in Maine. Our governor, Paul LePage, a notorious foot-in-mouth bully who has been described by the *Washington Post* as “completely unhinged,” has joined the politically charged anti-solar movement launched by public utilities in several states. LePage has already vetoed one solar incentive bill, and is pushing for a rollback of net metering incentives. And he’s just one example. It’s a national confrontation between old and new technologies, with politicians acting as willing pawns. Without getting too far into the weeds, political resistance to solar comes not only from fossil fuel industries, but also from utilities. They assert that non-solar customers end up paying for the grid infrastructure and PV owners don’t. That’s true at face value. But as solar advocates point out, infusing localized power into the grid has huge benefits for customers and utilities. It not only improves performance in high-demand periods, but can forestall construction of new plants. The pros of net metering are well documented at Media Matters for America (<http://mm4a.org/2gDnDM3>), if you want to read up on the topic. Let’s assume the worst: that metering gets taken off the table by political wrangling. Residential solar owners looking to power mini splits will be put in a frustrating situation. They’ll be producing plenty of power on their rooftops, with no way to transfer it to their equipment. **BATTERIES: (ALMOST) READY FOR PRIME TIME** The solution, of course is batteries. The storage industry is finally catching up to the fast-growing solar PV universe. But this is a bleeding-edge industry. Any system you adopt will involve a substantial leap of faith. For example, you may have heard of Tesla’s *Powerwall 2* (www.tesla.com/powerwall) home battery systems. These self-contained, water-cooled units have a power output of about 5 kW continuous, 7 kW peak and at press time, the product had not yet begun to ship to the U.S. In fact, *Powerwall 2* is so new that agreement

on its performance is hard to find. But if it works as suggested and lives up to its 10-year-warranty, this really is a game changer in terms of home storage batteries.

One *Powerwall 2*, operating as specified, could run a heat pump system such as mine for a few hours. Another company, Adara (see details on page 32) has a battery system that is comparable with the *Powerwall 2*, and ready for installation now. For the sake of analysis, however, let's stick with the Tesla product in a hypothetical application. If you consider that one *Powerwall 2* yields 14 kilowatt-hours of energy storage, and the average American household uses about 30 kilowatt-hours per day, you would probably need two of these stackable units to give you a little wiggle room.

On a sunny day, the Powerwall's 14 kWh system is recharging even as you run the splits, and might suffice to get you through the night. But a couple of cloudy days could leave the batteries empty. The second battery buys you some time. At a cost of about \$5,500 (U.S.) per *Powerwall 2*, plus \$5000 or so for installation, that's about a \$15,000 investment on top of solar and mechanicals. Can this extra cost be rationalized?

Maybe. The answer depends on some highly complex variables that again have no definitive answers. Will the batteries last without significant degrading of power output? And can they be rebuilt affordably at the end of that time period?

Recently, Tesla dealers have been offering the batteries as part of a complete solar charging package. They can pitch the system to homeowners as a way to save a couple thousand dollars a year on utility bills, shortening payback to just a few years.

The only real "payback" is coming from the solar panels, of course. The batteries merely enable the solar in situations where net metering

has gone away. Batteries depreciate in value. Solar actually becomes more valuable once the initial cost is paid off.

HEDGING SOLAR BETS

After researching all the solar options, I arrived at what I would call a "calculated risk with a safety net scenario." Because Maine will offer net metering for at least the near future, installing PV without a backup battery system makes the most economic sense. I'm still an early adopter. With electricity only 11 cents a kilowatt, and natural gas dirt cheap, I have plenty of economic disincentives suggesting I should stay the course, heat with gas and assume the world won't change. I'll only be saving about 2 cents a kilowatt (see chart) over current power prices.

But assuming that the status quo will remain stable in the face of today's global disruptions involving fracking, infrastructure, fossil fuels and politics seems like wishful thinking, verging on ignorance.

As the henchmen of the old fossil fuel economy continue to try shoving the solar genie back into the bottle, I'll take what I consider the lowest-risk approach. I'll convert to solar, and set aside an account to purchase my home battery storage at the last possible moment, if solar incentives fall victim to political sleight of hand.

For those who don't have the resources or the space to take this approach, there are other ways to get off the fossil fuel bandwagon. For example, SolarCity's (www.solarcity.com) solar leasing packages allow owners to get into solar at very low initial cost, and essentially lock in electrical rates for 20 years. Getting to net zero has never been more affordable over the long run, nor more important to the future of our planetary ecosystem. **GB**

Save more. Worry less.

Smart Controls for Splits



ONE THING I REALLY DISLIKE ABOUT my older Rinnai natural gas heaters is lack of remote controls. When traveling or away, I have no way to check, reset or monitor conditions in my building. So it's essential that mini splits offer flexible controls.

For my mini splits, I'll have control from anywhere via a new app from Mitsubishi Electric (www.mitsubishicomfort.com) called Kumo Cloud (www.mitsubishicomfort.com/kumocloud). Wi-Fi-enabled apps like these are becoming much more common, although in my view the dongles you need to attach to the units are still overpriced. The Wi-Fi adapter that attaches to each of my Mitsubishi M-series mini splits retails for about \$200. That's \$600 with three units.

The advantage is that I can now control the three splits as three separate zones using my smartphone and the free *Kumo* app. The app is available for iOS, Android or Fire OS-enabled devices, and the devices are controlled via your home wireless network with a web-based browser. The only drawback is that if your Wi-Fi router goes down while you're away, you have no way to reset it remotely, and you'll lose connection to your system.

One feature I'd like to see added to the app is the ability to have an alert sent to the user when temperatures in any mini split reach a certain minimum, or when connection with the units is lost or resumed (such as during a power outage). This could be useful for vacation travel to avoid frozen pipes and other problems.



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Life Lines

A longer-lived solar storage battery starts with starts with proper charging and maintenance.

BY MATT POWER

AT THE RESILIENT LIVING CAMPUS in Pine River, Minn., technicians have developed a system that optimizes lead-acid batteries used for solar energy storage.

“We’re interested in both home storage and RV systems,” notes Dan Pavék, the young technician studying battery dynamics at Hunt Utilities Group’s research center (www.hugllc.com). He’s inside the “ManiShop,” a passive solar warehouse-sized building with a living roof and more other green features than can be easily listed here. “A large RV has about six big batteries in it,” Pavék continues, “and we’re hearing from owners that they typically get only three years of solar storage before they have to replace them. We want to try to double that.”

Pavék knows this isn’t the end game for cleaning up the footprint of battery storage, but he sees it as an important upgrade that will bridge the gap to other, cleaner forms of batteries now in development—such as algae or silicon-based technology.

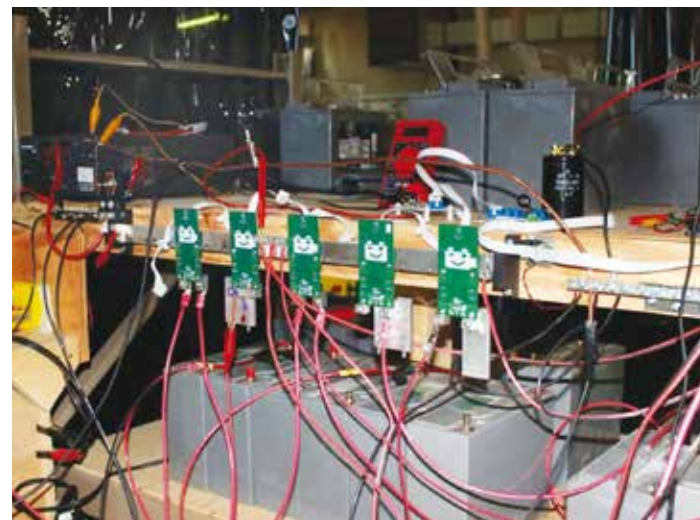
The group’s approach to lead-acid batteries is sophisticated. It’s easiest to pull a little of Resilient Living’s online explanation (<http://bit.ly/2gNowzR>). Among the challenges HUG is trying to address in its solar-heated ManiShop research building:

- Batteries in series or in parallel must be well balanced, or they destroy one another. If one battery begins to fail, it is stressed the most, accelerating the failure process. This can result in a catastrophic failure, and possibly fire or property damage.

- Under current practices, batteries cannot be swapped out individually—the whole bank must be replaced. This generally is a large expense to the owner of the system.

- Batteries in a series are only as good as the weakest battery installed. For example, if you add a new 100 percent capacity to a bank with other batteries that can only put out 80 percent capacity, the new battery will end up chronically undercharged, shortening its life. Also, the older cells become the new weak cells and deteriorate quickly.

- Lead-acid cells require careful charging and maintenance to maximize their life cycle. Most systems require a technician to manually analyze, monitor and perform this maintenance, which carries a significant labor expense.



CREDIT: GREEN BUILDER MEDIA

Wiring matters. At the Hunt Utilities Group Resilient Living Campus, batteries are arranged in various configurations and tested for output, recharge and long-term performance. The goal is to “socialize” lead-acid batteries to optimize longevity.

- All types of batteries have their own maintenance requirements and charging parameters. Technicians and engineers have to be specially trained for each type of battery that they are required to maintain.

TRADITIONAL BATTERY BUS WIRING

Traditional battery bus systems require heavy conductors and connectors capable of handling the maximum current of the batteries. Typical applications today employ batteries that are wired in series, or some combination of series/parallel.

As is often the case in homebuilding, sometimes the most significant advance in efficiency is the one right under our noses. Too often, for example, builders focus on higher level engineering details such as R-value and glazings before addressing big design impacts, like siting and building orientation. In the case of batteries, this research seeks to demonstrate how less-efficient wiring methods and lack of individual monitoring of batteries can lead to early failure. The end result of this research is the *Battery Socializer* networking system.

Unlike traditional battery banks in use today that are only as good as the weakest battery, the *Battery Socializer* employs microprocessor control of each battery along with a voltage abstraction system to monitor, optimally maintain and protect each battery in the bank individually. The result is extended battery life, the ability to replace only defective batteries, add capacity as needed, and the ability to mix batteries of different types and conditions. **GB**

To learn more about HUG’s research, visit www.hugllc.com.

For more about resilient housing and homes that are “ready for anything,” visit the Resilient Times website (<http://resilienttimes.com/>).

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No Surprises in 2018 IECC Online Voting Results

Less than one of every eight proposals saw change in outcome from October's public comment hearing.

BY MIKE COLLIGNON

RIGHT ON SCHEDULE, the preliminary results from the 2018 IECC online vote were released by the International Code Council (ICC) on Tuesday, Dec. 6. The verdicts largely mirrored the results of the public comment hearing in late October. Of the 85 proposals considered, only 12 percent of the code change proposals had their outcome changed by the online vote.

The residential energy code's most contested proposals did not see a reversal of fortune. What does that mean for the homebuilding industry?

- **Mechanical equipment tradeoff:** Like the three previous iterations of the code, builders will not be allowed to trade off envelope insulation when using more-efficient equipment. (Author's note: Both sides would be wise to put pressure on DoE to update the NAECA requirements on equipment. Otherwise, we'll be witnessing round five of this debate in the spring 2019.)

- **ERI path:** This section underwent major changes, but the online vote merely affirmed actions taken at the public comment hearings. First, the ERI levels are going up slightly (see Table). Next, the use of on-site power generation determines the prescriptive envelope backstop. If renewables are used, the 2015 IECC prescriptive requirements must be met. If renewables are not used, then the existing 2009 IECC requirements remain the backstop.

- **RESNET 301** (with a twist): RESNET/ICC/ANSI 301 will now be the only ERI methodology allowed in the ERI path. However, if the project has to adhere to the IRC, then the ventilation rates from the 2018 IRC (which mirror ASHRAE 62.2-2010) are to be used. Currently, RESNET 301 references the ASHRAE 62.2-2013 rates, although it has been stated the standard could change to be congruent with the IECC.

Here's a look at a few of the code change proposals that saw their fate changed by the online vote:

- Appendix RA, **Recommended Procedure for Worst-Case Testing of Atmospheric Venting Systems Under R402.4 or R405 Conditions** was ultimately removed from the code, after initially being retained.

- The addition of **a definition for grid-interactive electric storage**

Table R406.4 (N1106.4) Maximum Energy Rating Index	
Climate Zone	Energy Rating Index
1	57
2	57
3	57
4	62
5	61
6	61
7	58
8	58

systems was accepted at the public comment hearing after the proponent made a committee-recommended correction to an accompanying table. But that decision was overturned by the online vote.

- An **exception to allow individual wall-framing cavities** for transfer air between two spaces on the same level, in compliance with the IMC, was at first added. But online voters disagreed with those at the hearing and kept the exception out of the code.

- **RESNET/ICC/ANSI 380**, a standard for testing airtightness, was prevented from entering the code by the online voting community.

Business as usual. Most of the items discussed as possible changes in our November issue came to fruition.

This differed from the opinions of the public comment hearing participants.

- **Cross-laminated timber** was denied entry into the mass wall definition.

- A **cavity-only wall insulation option** was added to the prescriptive table R402.1.2 for climate zones 6-8. While it passed the public comment hearings, it did not pass the online vote.

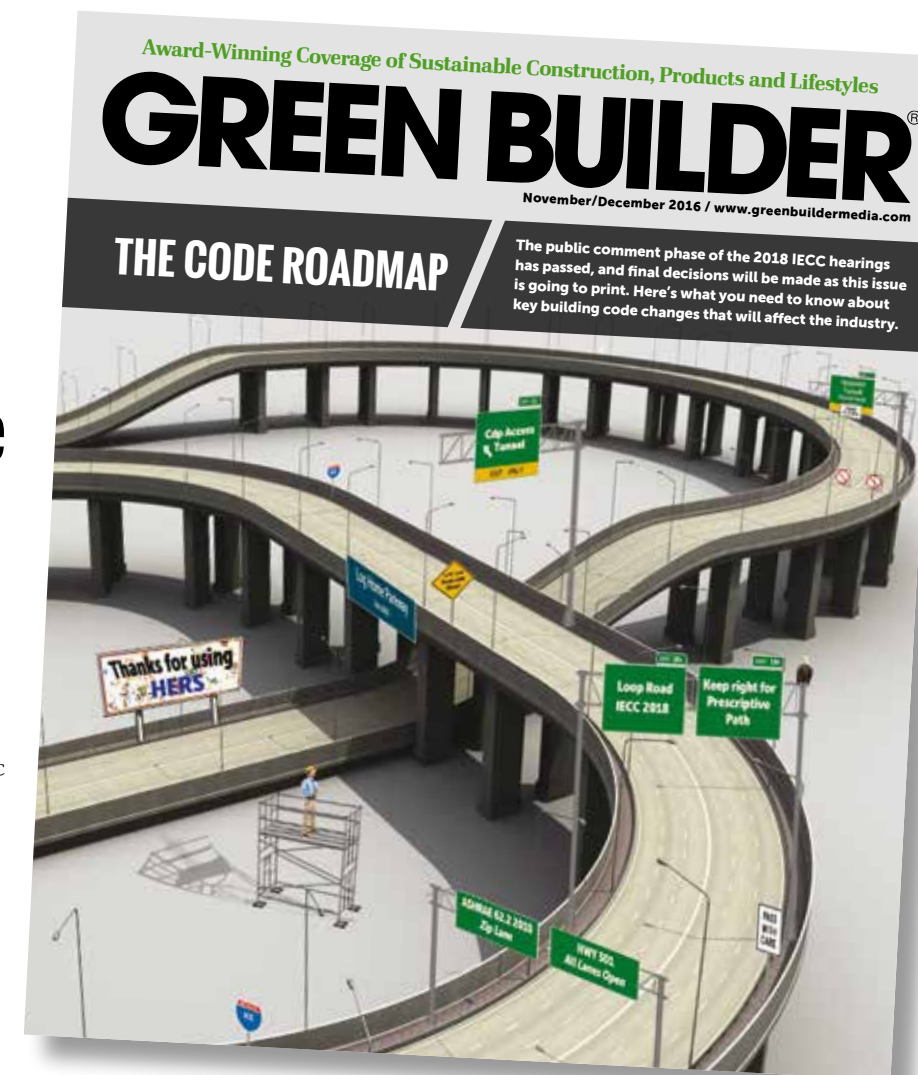
- An attempt was made to **add climate zone 0 to Table R402.1.2 and Table R406.4** to be consistent with ASHRAE Standard 169-2013, Climatic Data for Building Design Standards, but online voters rejected it.

- A proposal to **improve U-factors for fenestration in climate zones 3-8**, which was supported by the energy efficiency community and the WDMA, was approved at the hearings but disapproved by online voters.

One proposal in the commercial energy code caught our eye: CE175-16, which called for **showerhead flow rates not to exceed 2.0 gpm at 80 psi**. This proposal had two parts: one for commercial and one for residential. The commercial code proposal passed, while the residential proposal did not. However, this entire proposal has a sense of uncertainty hanging over it. According to the ICC:

"This code change proposal addresses the scope and application of the International Energy Code and the International Plumbing Code. The action taken at the Committee Action Hearing on this proposal coupled with the final action taken at the 2016 Public Comment Hearings and OGCV will be limited to an advisory recommendation to the ICC Board of Directors who will determine the final disposition on this proposed change in accordance with Section 1.3 of CP 28, which stipulates that the ICC Board of Directors determines the scope of the I-Codes."

The topic of water efficiency is a political football of sorts. It seems to be tossed around from the IPC to the IgCC to the IECC. Amazingly, this vital topic has never really found a home within the I-Codes.



It is our hope that the ICC Board will honor the action of its members by allowing the public comment hearing *and* online voting results to stand. It is certainly clear to those paying attention that more needs to be done to conserve and protect one of our planet's most essential resources. **GB**

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

COURTESY OF The Green Builder® Coalition

The Green Builder® Coalition is a not-for-profit association dedicated to amplifying the voice of green builders and professionals, driving advocacy and education for more sustainable homebuilding practices.

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Saving Water

Tips, Technology and Common Sense Solutions for a Thirsty World

Tracking Every Drop

Utilities and municipalities are harnessing smart technology to meet their water conservation goals.

BY JULIET GRABLE

A PILOT PROGRAM LAUNCHED in Long Beach, Calif., has proven smart meters are an effective tool for catching leaks—and for catching customers who are violating mandatory conservation restrictions.

Although the program involved 200 customers—only a tiny fraction of the city’s service area—it demonstrated that smart water meters are a critical part of advanced metering infrastructure (AMI), which allows two-way communication between a utility and its customers. Just as smart energy meters provide detailed feedback on a customer’s energy use, smart water meters provide detailed information on the volume and timing of water use.

Building professionals should have a basic understanding of the technology so they can field questions from their clients and encourage them to enroll in voluntary programs.

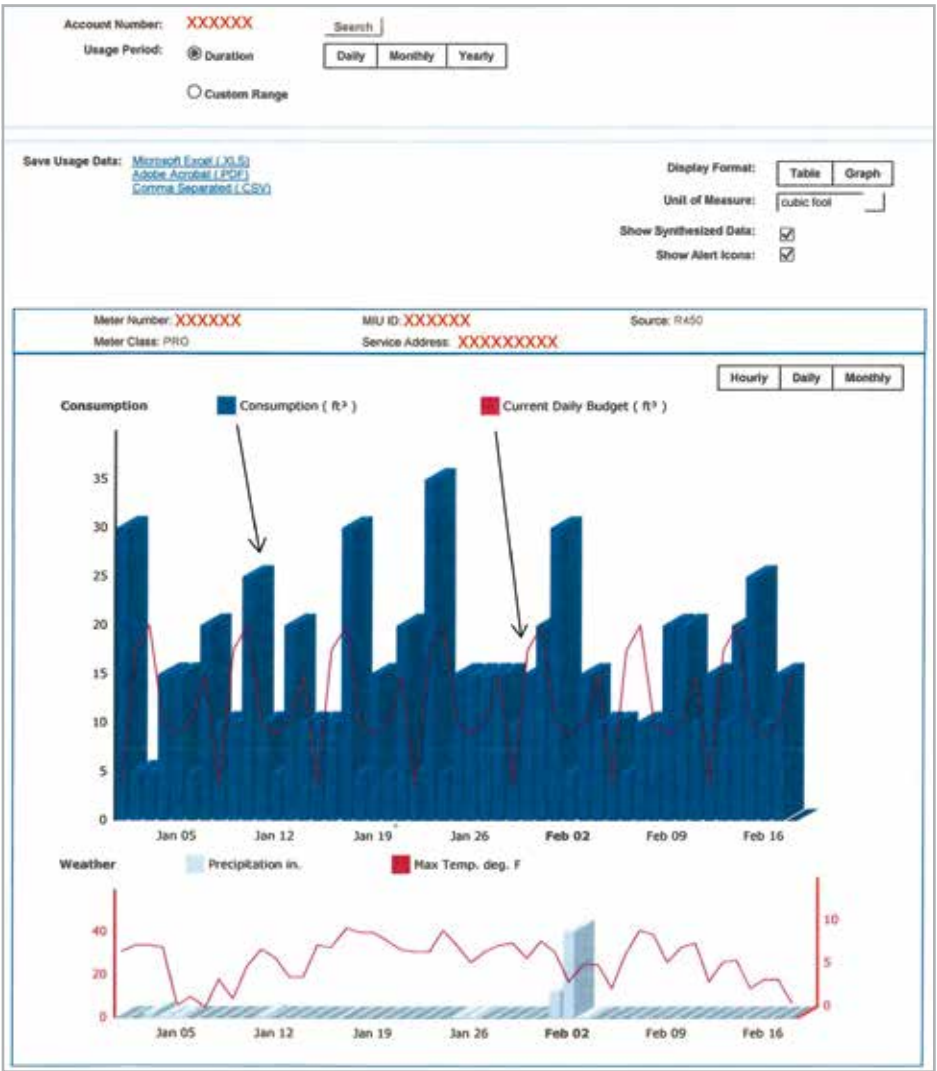
As has been shown with energy use feedback, a customer who receives feedback on water use is more likely to change behavior to reduce that use.

Customers can also know instantly whether certain conservation measures, such as a low-flow toilet or a smart sprinkler, are having an effect. Smart meters benefit the customer and the utility by helping detect leaks. If a customer’s usage never falls to zero within a 24-hour period, that can indicate a problem.

“The meters also save money, because they save someone from having to physically read the meter,” says Dean Wang, conservation specialist for the Long Beach Water Department.

Transparent Technologies’ (www.transparenttech.com) Innov8 (<http://bit.ly/2g3NknH>) digital registers selected for the Long Beach pilot work with existing meters. Because they operate on batteries and communicate wirelessly via the Verizon cellular data network,

the units did not require new network infrastructure or electrical hook-ups. The company supplied a web-based analytics service, so the utilities and customers could track use. The meters sent data on flow rate and volume every five minutes, which was translated into easy-to-read line graphs.



Options. Neptune Technology’s IQ water usage tool is one of two systems the city of Dubuque, Iowa, has used to help customers track water usage.



Water watchdog. Because smart water meters track water flows and volumes so closely, they enable utilities to catch a customer who is watering on the wrong day or during the wrong time of day.

But just as some areas receive spotty cell phone coverage, the meters don’t work as well in some parts of the city. This problem will need to be addressed if Long Beach considers full deployment. For now, some of the meters have been collected and are being re-deployed.

“It’s a good idea from a functionality standpoint,” says Wang. “The question is always the cost.”

THE HUMAN ELEMENT

Many other cities have implemented smart water meter pilots, especially in California, where utilities are mandated to reduce their customers’ water use by 20 percent by 2020. A few cities have gone even further. Dubuque, Iowa, replaced all of its meters with ones from Neptune Technology Group (www.neptunetg.com) as part of the city’s comprehensive Smarter Sustainable Dubuque initiative. These include an “unmeasured flow reducer,” which can track very low flows (less than a quarter gallon per minute) and detect leaks that might otherwise go unnoticed. A radio frequency meter interface unit collects and transmits data to the collection center.

When the meters were replaced, Dubuque launched a Smarter Water pilot program using a portal developed by IBM (www.ibm.com). The 300 residential customers who participated in the pilot could access detailed data on their water use, which included comparisons to similar households. Over 12 months, usage was reduced by 6.6 percent.

“Participants could compare themselves to other households ‘like them,’” says Cori Burbach, sustainable community coordinator for the City of Dubuque. “This competition component, and the robust community engagement program that went along with the dashboard, accounted for much of the program’s success.” The combination of high-tech and “high-touch” engagement included in-person, neighborhood events and a help desk staff person.

The IBM portal provided fine-grained data, but it was expensive. More recently, Dubuque began offering a service called DBQ IQ to all of its customers. Developed by Neptune, this portal provides water usage and weather data. But unlike the IBM portal, it compares usage to past activity and does not provide comparisons to similar households.

So far, only about 5 percent of Dubuque’s 24,000 customers have signed up for the new portal, and most customers are interested mainly in the leak detection program. The city offers incentives, including bill adjustment if a customer finds and fixes a leak, and a leak-fixing grant that covers up to 50 percent of the cost of any repair under \$100.

Accounts are flagged if usage spikes to 10 times more than a customer’s previous 30-day average, says Rose Hoerner, Dubuque’s utility billing supervisor. “This system gives this information two to three weeks earlier than the previous one, and is very important, especially during the winter months, for catching frozen or broken pipes quickly and preventing property damage.”

HARNESSING BIG DATA

In 2009, San Francisco-based WaterSmart Software (www.watersmart.com) developed a platform which facilitates communication between utilities and their customers. The software uses data analytics, drawing from census, climate and property data to generate comparisons between similar users. Highly visual and easy-to-understand reports track usage and offer customized tips for saving water. It also sends leak alerts.

The City of Cotati, Calif. and the East Bay Municipal Utility District (EBMUD) were among the first entities to test-drive the software. Cotati officials estimate the platform has helped reduce water usage by about 5 percent. Today, many cities around the country are using the software, which does not require smart water meters to function.



Full package. WaterSmart Software’s platform uses easy-to-understand reports to track usage, sends leak alerts and offers customized tips for saving water.

Wang says he is not sure when Long Beach will upgrade its water meters. But in the meantime, the city has partnered with WaterSmart to offer the platform to 36,000 residential customers.

As part of the service, the city is providing quarterly water usage reports that highlight rebate programs and include customized water-saving tips. The reports, which Wang calls “polished, with great visuals,” also compare a customer’s water use with that of similar households.

“Behavioral research suggests that if people like you are doing something, you are more likely to do it yourself,” says Wang.

More recently, WaterSmart released a new, more-affordable version of its software, *WaterSmart Essential* (www.watersmart.com/essential), which is aimed at smaller water suppliers. **GB**

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 PAGE 41

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FROM THE TAILGATE

New Offerings for the Sustainable Minded

By Ron Jones

Don't Be Afraid of the Dark

SOME YEARS AGO, a good friend of mine went to the trouble and expense of finding an out-of-print copy of collected works by the great American poet Wendell Berry. He then made it into a gift to me.

My friend made special note of one precious jewel hidden in this deep treasure chest of verse—a very short piece titled, *To Know the Dark*. It reads:

*To go in the dark with a light is to know the light.
To know the dark, go dark. Go without sight,
And find that the dark, too, blooms and sings,
And is traveled by dark feet and dark wings.*

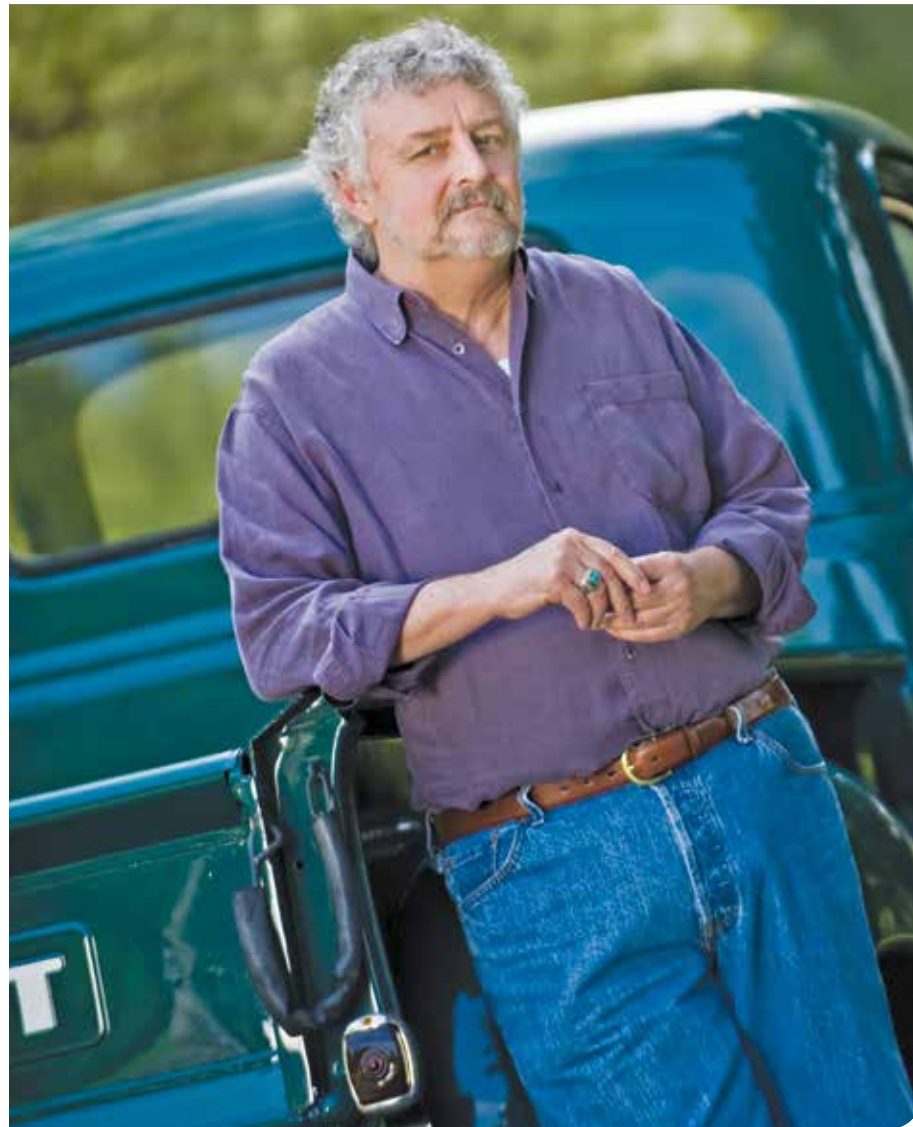
Our most ancient ancestors must have known the dark very well. But once they learned to protect their backsides in the relative safety of a cave, with a campfire strategically placed and diligently maintained at the entrance, the relationship of our species with the dark has been in relentless evolution.

Every advancement in technology has undeniably provided us with benefits in the form of convenience, efficiency and accessibility. But, equally undeniably, there is another side to the coin of progress. In this case, it is the erosion of our self-reliance and our ability to fend for ourselves. It's one thing if a light bulb burns out—we simply replace it because a new one is usually available, and the act is not beyond our common capabilities. But if the power goes *down*, that's quite a different situation. Suddenly, the complexity of the problem has multiplied exponentially.

Our editorial calendar promotes an examination of where we're headed: "The solar transition is well under way, but the next phase has just begun, as the Internet of Things integrates with on-site and micro-grid energy production in new, exciting ways." We are understandably intrigued and excited by the prospect of generating our own power, and with the rapid proliferation of "intelligent living solutions" that promise to make our lives better.

But with each of these new opportunities comes the proportionate responsibilities of understanding not only what they do for us, but *how* they do it. What is our usual response when the Internet connection goes down? Makes one stop and think, doesn't it?

And so perhaps it should be with a healthy blend of caution and fascination that we embrace the newest advancement in technology



and *smart living*, as well as the one after that, because with each step along the way we give up a bit of control, another piece of our natural ability to respond.

There is something quite reassuring about an all-night supply of firewood. Something deep in the back of our collective memories tells us that this is a good thing, that we have power over at least one basic source of comfort and safety. But we should take care to not lose our ability to know the dark, and to travel there without trepidation. **GB**



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