INNOVATION
Three innovators answer the call for sustainable building materials with game-changing bio-based products.

GLOBAL
Italy’s Stefano Boeri plans to transform one of the world’s most polluted cities, Shijiazhuang, China, into an oasis of habitable forest.

LOCAL
Crossing Water brings clean water to Flint, Michigan, by employing a model that addresses needs beyond access to clean water.

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What gets specified at the beginning of the job affects everyone who has a hand in it — from the designer to the architect to the contractor and the installer. You can’t always control what kind of chemicals and problems have previously been swept under the rug. But no matter what substrate challenge you may encounter, the industry-changing innovation of Tandus Centiva’s ethos® Modular with Omnicote Technology™ has you covered.
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✓ Enhance Human Health and Wellbeing
✓ Build A Green Economy
✓ Enhance Community & Social Equity
✓ Reverse Climate Change
✓ Restore & Protect Water
✓ Promote Sustainable Materials
✓ Protect our Ecosystems
✓ Enhance Building Performance
✓ Support New Technology
✓ Ensure Resiliency
✓ Believe Homes should be Green
✓ Other: “Connect with Others Who Greenbuild”

#IGreenbuild
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Recycled Earth
School teacher Jennifer Runde’s 4th- and 5th-grade classes completed a fantastic art collage with recycled National Geographic magazines in celebration of Earth Day. Courtesy Jennifer Runde

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LETTER FROM OUR LEADERS
Dave St. Peter
President and CEO of the Minnesota Twins
While the world watched, *One World Trade Center* grew in both height and symbolism, its 1,776-foot crystalline form bringing unmatched views back to Lower Manhattan. A redundant structural steel frame, the result of creative collaboration between Skidmore, Owings & Merrill and WSP Cantor Seinuk, ensures that its safety is as substantial as its stature. Read more about it in *Metals in Construction* online.
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Sustainability doesn’t always come to mind when you think of professional baseball. But with bright lights, open skies, and thousands of fans filling the seats at any given game, the Minnesota Twins recognize the role energy and water efficiency, reduced waste, and sustainability education play in creating the best possible experience for our fans, players, and community.

Professional sports franchises have the ability to create local change that can set an example and have a truly global impact when it comes to sustainability initiatives. We don’t take this responsibility lightly.

When Target Field opened in 2010, the facility was quickly dubbed “the Greenest Ballpark in America." Target Field earned Leadership in Energy and Environmental Design (LEED) Silver thanks to many sustainability features integrated into the design and construction of our facility.

Never resting on our laurels, the Twins organization then pursued LEED for Existing Buildings to ensure our operations and maintenance practices remained cutting edge and continued to improve. And just a few weeks ago, we were honored when Target Field became the first professional sports venue in the world to earn three different LEED certifications, most recently achieving LEED Gold through the new Arc performance platform, an innovative tool that helps buildings, communities, and cities—including large-scale venues like ballparks—track performance on an ongoing basis.

The Minnesota Twins organization believes our future success—both on and off the field—is built on a business model that embraces operational excellence, efficiency, environmental stewardship, and social responsibility. LEED has helped us work toward this mission.

We honor the power of sport by leading through example, and we will continue to use our sport to inspire, build the best fan experience while causing no unnecessary harm, and work with our fans, community, suppliers, partners, and employees to have a positive influence in the world.

Win Twins!

LEED ON
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MAINTAIN YOUR LEED PROFESSIONAL CREDENTIAL WITH USGBC+ BY READING THIS ISSUE AND COMPLETING THE CORRESPONDING QUIZ AT PLUS.USGBC.ORG

LEED GREEN ASSOCIATES MUST EARN 15 CONTINUING EDUCATION HOURS WITHIN TWO YEARS OF EARNING THEIR CREDENTIAL.

LEED APs MUST EARN 30 CONTINUING EDUCATION HOURS WITHIN TWO YEARS OF EARNING THEIR CREDENTIAL.
USGBC’s Green Home Guide website offers homeowners sound advice for better living.

BY ALEXANDRA PECCI

After installing high-efficiency appliances and lighting during renovations of her Eichler home, Elizabeth Milne, a lawyer from Palo Alto, California, was shocked to see her electricity bill actually go up. The culprit? A newly installed instant hot water heater on the sink that immediately provided boiling water—but that also relied on an always-running heating coil that kept the water at a high temperature 24 hours a day.

“I just unplugged it and my utility bill went down,” she says.

Like many, Milne is on a journey to green her home. In addition to installing better appliances, she also repainted the walls with low-VOC paint and replaced the kitchen backsplash with tiles made from recycled glass. But she wants to do more—on a reasonable budget—and has questions about things like graywater reuse, the most environmentally friendly furniture, the life cycle of different products, and the overall impact that different “green” decisions make compared with others.

“Everyone talks about green, but it’s not entirely clear what that means,” she says. “Does that just mean it’s less wasteful and more efficient than before?”

Making It Easy

To help consumers find answers to questions like these, pursue do-it-yourself changes to their homes, and find professionals who can help them along the way, there’s the U.S. Green Building Council’s (USGBC’s) website greenhomeguide.com, which relaunched in 2016 with a renewed focus on the benefits of LEED (Leadership in Energy and Environmental Design) for a residential audience.
The website allows homeowners, apartment dwellers, and other consumers to find in-depth articles and tips for tackling questions and projects like the ones Milne has encountered and many more. There’s also a comprehensive directory of more than 17,500 green home professionals divided by specialty into 23 categories like architecture, landscaping, cleaning, pest control, and interior design, to help consumers find assistance and expertise.

Articles on the website are highly detailed, wide-ranging, and practical, tapping into real-life concerns of everyday homeowners and renters who want to make healthy and sustainable living decisions, and often providing actions that individuals and families can take on their own. For Milne’s graywater questions, for instance, there’s the article, “Easy as 1, 2, 3: How to Recycle Gray Water,” which features three simple ways to reuse gray water for three different budgets. There’s even a discussion about Milne’s hot water conundrum in the site’s “Ask A Pro” section, which goes over the pros and cons of an on-demand hot water recirculating pump versus an under-sink tankless water heater.

In remodeling her home, Milne enlisted the help of Lucile Glessner, LEED AP, Allied ASID, principal and owner of Saratoga, California–based Lucile Glessner Design.

Glessner says Green Home Guide, with its continuously updated content and information about the newest trends and building materials, is not only helpful for DIY-ers, but can also be a useful way for professionals to educate clients who might not know much about green building, aside from basics like solar panels. Glessner says she’s found that sometimes providing too much information about sustainability right up front—especially if cost concerns come into play—can scare people off. That’s where Green Home Guide can help. The articles not only tackle “how-to’s,” but also the associated costs with different projects and options.

“If you’re trying to sell the green building in the beginning without the economic perspective it’s difficult and it can create some barriers instead,” she says. “I can just send them to the site and they can read something if they’re interested. And they can make that decision on their own.”
What Consumers Care About

Parsing the Green Home Guide website analytics reveals which topics are most important to the roughly 830,000 people who use the site each year. For instance, the top keyword searches driving users to the site were “laminate flooring,” “formaldehyde,” “solar panels,” “VOC,” “asbestos,” “recirculating hot water,” “carpet,” “popcorn ceiling,” “paint,” and “floor toxins.”

William G. Dohe, AIA, LEED AP, principal of R+D Architecture in Easton, Pennsylvania, is one of the many professionals listed in Green Home Guide’s directory. He echoes that healthy, green flooring is often a concern for his clients, who are worried about things like using renewable materials and the potential for off-gassing. For instance, he says clients ask about bamboo all the time, since it’s touted as a sustainable option.

“We end up having that discussion that, yes it’s a rapidly renewing material on the one hand, but on the other hand it’s made halfway around the world,” he says. “That opens the door to a larger discussion about what makes a material green, particularly for you in this particular location.”

Discussions and articles about flooring are abundant on the site, including ones that get into the nitty-gritty details about whether bamboo really is the best green option. Indeed, some of 2016’s most popular articles are ones about flooring and floor covering, including ones that offer in-depth information about when it’s safe to be in a home after polyurethane varnish has been applied to wood floors, the best and safest green carpet options, the healthiest and safest wood floors and finishes, and the use of formaldehyde in engineered wood and laminate flooring.

Another big concern for consumers? Cost. “If you tell me the green light fixture is $5,000 and the other one is $500, I’m probably going to go with the other one,” Milne says.

Green building and design professionals say educating consumers can sometimes show them that the green option is actually less expensive, comparable in cost, or will pay itself back within a few years. So it’s no wonder that many popular articles relate to cost, such as how to save money on utility bills, using houseplants to improve air quality, and DIY solutions for testing the health of homes.
Small and Big Steps
Some of the most-read articles offer suggestions to help consumers make small changes to improve the health and environmental friendliness of their homes. Two of the most popular in 2016 were “9 Ways to Make Your Home More Energy Efficient” and “Three Ways to Make Your Roof More Energy Efficient,” for example. There are even articles like “How to Go Green As a Renter.” But the site also provides a gateway for homeowners who want to take on more ambitious projects, like building a LEED-certified home.

Doug Storey, managing partner of Two Storey Building in Bolton, Massachusetts, is another one of the professionals in the directory. He says his firm built one of the first LEED-certified homes in Massachusetts, but works with clients with a range of sustainability goals.

“There's a group of people that are very conscious of green building and the big picture idea,” he says. He notes one client he’ll be working with this summer is doing a deep energy retrofit on their home and replacing all the siding, insulation, roofing, and windows. Others on a budget, though, want their homes to be comfortable and energy efficient.

“For every person it's a little bit unique what the most important issues are in their home,” he says. Green Home Guide aims to help people figure out what those issues are and how to best handle them.

Glessner also thinks the website makes such issues manageable and realistic.

“That's why I like this site,” she says. “I think it's well done and I'm going to be using it with my clients.”

By the Numbers:
greenhomeguide.com

Who’s reading GreenHomeGuide.com? Take a look at a few site analytics:

- The site has about 830,000 annual users
- Users engage in about 930,000 sessions and roughly 1.145 million page views each year
- 85.5% of traffic comes to the site through organic search
- The top 5 user locations are United States (84.19%), Canada (5.55%), United Kingdom (2.77%), Australia (1.38%), and India (1.09%)

Top 5 articles of 2016
GreenHomeGuide.com’s articles on health, energy efficiency, and DIY topics are what drive consumers to the site.

1. How to Handle a Popcorn Ceiling That May Contain Asbestos
2. Can I Safely Seal and Waterproof My Butcher Block Countertops?
3. 9 Ways to Make Your Home More Energy Efficient
4. Three Ways to Make Your Roof More Energy Efficient
5. What Tests Can I Do Myself to Check How Healthy My Home Is?
Motor City is poised to become the epicenter of urban agriculture.

By Kiley Jacques

It’s no secret Detroit has suffered. The postindustrial city’s economic and demographic downturn has left it in a compromised state for decades. But in a two-square-block area of its North End, change is afoot.

In 2011, the Michigan Urban Farming Initiative (MUFI), an all-volunteer nonprofit organization, purchased a defunct apartment complex at auction. And ever since, MUFI president and co-founder, Tyson Gersh, has been building something altogether new—the nation’s first urban “agrihood.”

There are about 200 agrihood models currently operating in rural and suburban areas around the country, but this is the first infill-style model. “To take it a degree further,” says Gersh, “we wanted to make it a sustainable urban agrihood, to tie into some certifying designations, and to give companies an opportunity to participate.”

The mission is multifold: to use urban agriculture as a platform to promote education, sustainability, and community; uplift and empower urban residents; address Detroit’s social issues; and potentially serve as a model for the redevelopment of other urban communities.

To that end, MUFI is developing a three-acre agriculture campus on which there are multiple projects underway. Ultimately, the campus will comprise an urban farm, fruit orchard, community garden, children’s sensory garden, rainwater harvesting cistern, and a shipping container house—combined they demonstrate an “adaptive reuse of the built environment” Gersh explains: “We are repurposing the existing land and the infrastructure in a way that is serving a different need than its original intent but is still functional . . . [and] in a way that will serve a blue or green goal.”

Each project has been taken under the wing of a corporation for sponsorship and implementation.
For example, General Motors is behind 40-foot two-bedroom shipping container house (p23)—the inside of which was roughed in by volunteer employees at GM’s Detroit-Hamtramck plant. In fact, the company has provided hundreds of employee volunteers to work on various projects at the farm. Currently, it is transforming its offices at several campus locations and has recently announced a program for nonprofit organizations to obtain free office furniture and equipment. MUFI is a benefactor. “This donation will save us thousands in office equipment purchases we’d otherwise have to endure,” says Gersh.

Of the existing buildings on the property, Gersh says it has been challenging to figure out ways to use them productively. “The default is to demolish them, which tends to be expensive and, at the end of the day, just neutralizes the problem without adding direct value. We are trying to repurpose that existing infrastructure.”

Hence the transformation of a long-vacant three-story building into a Community Resource Center (CRC)—MUFI’s most recent undertaking. With support from the Michigan Economic Development Corporation (MEDC), principal sponsor and USGBC Platinum-level member BASF Chemical Company, BorgWarner, USGBC Gold-level member General Motors, USGBC Silver-level member Herman Miller, and Green Standards, among others, the new 3,200 sq-ft center will be a space for educational programs, events and meetings, and MUFI’s operational headquarters. It will also house two commercial kitchens to service a new café and to enable future production of revenue-generating product lines made from farm ingredients.

The café will be located inside a 1,700 sq-ft greenhouse located on vacant land next to the CRC. It will follow an adjusted buyers’ club model, the idea being to make it accessible for the neighborhood while generating revenue for MUFI. Gersh describes it as self-subsidizing and says it’s an example of “infrastructure that has relevance to both our existing neighborhood and those who want to explore it.”

In essence, the former food desert is growing into a food hub.

**BASF**

How did BASF come to the table? Business strategy and sustainability manager Doug Brown explains how he and his colleague, Brooke Gast, wanted to do something...
The produce from the farm goes to individual households using a pay-what-you-can model, as well as local markets, restaurants, and food pantries such as churches and shelters. Photo: Michelle and Chris Gerard

beyond building exhibit booths at conferences—so-called “one-and-done engagements.” So Gast did some homework. And the pair put roots down in Detroit, where it became evident that Gersh’s project was where they wanted to concentrate their efforts.

Brown is excited to rehabilitate the onsite “shells.” “Tyson is part owner of the land, and he is on board with us leveraging our best and brightest technologies,” he says. For the CRC, core materials supplied by BASF include advanced insulation; liquid-applied weather air barriers; drywall with Micronol, a small bead that absorbs and releases heat based on temperature settings; no-VOC paints with antimicrobials; solar glass films; and Green Sense concrete pervious pavement, among others. “Everything we put in there will have some sort of demonstrable sustainability contribution,” says Brown.

Leadership in Energy and Environmental Design (LEED) Platinum is the goal. The plan is to make this “the most sustainable campus/neighborhood that has ever been seen—a model of sustainable urban infrastructure.”

Like Gersh, Brown values alliance. “We can’t do it alone,” he says. “This is a great way for us to engage other partners, other material suppliers, and really test the boundaries of true collaboration.” He wonders if corporations large and small can come together in a space like MUFi’s agrihood. “It’s an exciting business model; we can do it on a small scale with a big impact. Ideally, we do this and some great partnerships are formed and we repeat it. The potential is immense.”

With its mission to “push sustainability forward faster,” Sustainable Brands—a global community of business and brand strategy, marketing, innovation, and sustainability professionals—got on board, too.

Jonathan Reese, director of business development, says the company is committed to building a legacy and that MUFi’s agrihood is an exceptionally inspiring endeavor, given its transformative effect on the community. “This project brings a lot of the community out,” he says. “People attach to growing plants and they attach to food. It’s a great equalizer—everybody needs to eat and everybody likes good food.”

Reese notes the importance of the agrihood’s location. He is aware of the growth happening in Detroit, and he has witnessed the sentiment shared among people involved in building the city back up: “Their pride is palpable. That has been very inspirational to me.”
He has also been impressed by the project's novelty in terms of Sustainable Brands' own scope. “We are in uncharted waters,” he says of their decision to back MUFI's work. “We wanted to find a project that would get people involved, do good, and spread virally.” They also sought something scalable.

Reese sees his company’s role, in part, as covering and conveying the process as MUFI grows to include the CRC. Sustainable Brands’ B2B news media platform will run an ongoing series of stories about the project and the companies supporting it. “We want to look under the hood to see the mechanics of the project and how all of these companies have come together,” he says. The hope is to reach as broad an audience as possible. As Reese points out: The greater the number of people who see it succeed, the greater the number of people empowered to try it.

What of MUFI’s impact to date? A recent survey examined the number of people who have purchased property in the area because of the agrihood. Residents were asked if they would be in the North End if not for the farm. Those who answered no were then asked how much they spent on the purchase of their homes and how much on home investments. The total figure is well over 3 million dollars. “This neighborhood would not see that degree of investment otherwise,” notes Gersh.

One man's rallying call has become a shared source of pride—a “real-life legacy,” Gersh is quick to credit those who have come to his table. “What we are doing is pretty unusual,” he acknowledges. “I think the companies should be applauded for stepping in and taking the risk to support something innovative. Much in the way Detroit was built to support the corporate sector, we are now at this interesting intersection of [what] a postindustrial urban environment is going to look like . . . we are right at the edge of that. And having these companies back our cause and help us push forward is really cool.”

Above: The gardens serve as a resource for the public to plant their own plants, grow their own food, and learn the skills from knowledgeable individuals at MUFI. Photo: Michelle and Chris Gerard

Right, top: MUFI will deconstruct this defunct building down to its foundation, installing a rubber (or possibly another nonpermeable material) membrane over it, thereby effectively converting the basement into a retention pond. Photo: Ara Howrani

Right, bottom: This shipping container, which offers 320 sq-ft of living space, two bedrooms, a kitchen, and a bathroom, will house an intern (“student caretaker”) who will live in the home year-round while managing the farm and conducting agricultural research.
Adaptive Reuse

The foundation of a defunct building has been repurposed for use as a rainwater harvesting cistern. Waterproofed, filled with water basin matrixes, capped with a permeable membrane, and tied into an automated irrigation system with built-in moisture detection technology, it irrigates automatically, thereby mitigating stormwater runoff on the municipal end, reducing MUFI’s reliance on the grid, and optimizing irrigation practices.

A shipping container home is MUFI’s answer to the need for demographic-appropriate housing. The majority of the existing housing stock consists of massive 100-year-old homes that have been divided into rental units that are extremely expensive to heat. The call for smaller, more cost-efficient housing has been made. Heeding that call, the shipping container home serves as a scalable model. It was built atop an existing foundation by laying canal tubes inside the footprint of the crawl space and sitting the home on top of those—floating it in the center, like an island, and then connecting it to the existing foundation. It’s a way to circumvent the reels of red tape associated with removing existing foundations and utility lines, and using existing infrastructure to serve a purpose.
Responding to the risks posed by climate change is no longer reserved for socially responsible companies. There is now a clear priority for all businesses that want a prosperous future.

**BY CALVIN HENNICK**

A car in the 1970s traveled, on average, fewer than 15 miles on a gallon of gasoline. Today, that number is pushing 35. Around a decade ago, solar power was still largely seen as a niche energy source, reserved for organizations that were either exceptionally enthusiastic about sustainability or the recipients of large subsidies. Today, utilities are leading investment in solar with a doubling of U.S. large-scale solar projects to about nine gigawatts in 2016, while suburbanites are topping their roofs with solar panels, slashing their energy bills and even sometimes selling some back to the grid.

What changed? The marketplace.

Over time, gasoline became more expensive, and the cost of solar panels came down quite a bit. In fact, photovoltaic prices have fallen 26.5 percent for every doubling of cumulative installed capacity, according to the 2017 Sustainable Energy in America Factbook from Bloomberg New Energy Finance and the Business Council for Sustainable Energy. Also according to the report, the U.S. has added 76 gigawatts of renewable energy generating capacity in the past five years, improved energy productivity by 10 percent, and improved fuel economy by 12 percent. Over the same period, average retail electricity prices have fallen by 4 percent, and total gas production has jumped 12 percent. Also, renewable energy sources, together with natural gas, now meet half of U.S. power demand, up from 38 percent in 2011.

But the shifts toward more efficient cars and renewable energy didn’t happen on their own. While consumers have certainly become more concerned about gas mileage since the days when gasoline cost under a dollar per gallon, much of the increase in fuel efficiency was driven by federal standards. And while the cost of manufacturing and installing solar panels has dropped dramatically, the solar power industry has relied on subsidies for most of its existence to make it competitive with energy from fossil fuels.
A solar panel is produced at SolarWorld, America’s largest manufacturer of solar panels.
Fuel efficiency and solar power both illustrate how green technologies can win out over less sustainable practices. Many of today’s vehicles are safer, offer more features, and run cleaner on less fuel. Many observers project that solar energy will be the dominant global power source in the coming decades.

But often, as these two instances show, green technologies need a little push before they’re ready to compete on equal footing with the status quo.

“You need a combination of policy and business action,” says Sue Reid, vice president of climate and energy programs at Ceres, a nonprofit organization that advocates for sustainability leadership.

Ceres was founded after the Exxon Valdez oil spill in 1989, with the idea of bringing environmentalists and capitalists together to help create a sustainable business model that would be good for both the environment and for large-scale business. During its nearly three decades of existence, Ceres has attempted to influence public policy around sustainability while working hand in hand with the business community to encourage sustainable practices. But at a time when aggressive federal action on key issues like climate change appears to be unlikely, Reid says, the role of businesses and investors in advancing the green economy is even more heightened.

Sue Reid, vice president of climate and energy programs at Ceres.

“Businesses, even in this rather bleak landscape in terms of making progress at the federal level, are continuing to step up and say, ‘This is important,’” Reid says.

Reid highlights policies including climate and energy targets, cap-and-trade, or carbon taxes, as the next frontier of public policy. Each of these policies is attracting businesses but not yet achieving uniform private sector support, explains Reid. Until stakeholders work out their long-term interests in line with investors’ views, it will be difficult to push for these next generation policies.

Ceres works to help businesses see where sustainable practices can be a financial boon to them and also uses the clout of investors to help promote sustainability. The organization represents large investors—including some of the biggest public pension funds in North America—that combine to manage $14.5 trillion in assets. Whereas company executives face the pressures of quarterly earnings reports, long-term investors view their finances over decades, Reid explains. If climate change threatens water supplies for the companies in which investors have a stake, for example, then that can negatively affect portfolios decades down the road, long after today’s executives have retired.

“It’s the foundational principle that environmental and business interests shouldn’t be at odds,” Reid says. “Especially when you embrace a longer-term time horizon, business values go hand in hand with sustainability.”

Since Ceres was founded, a number of other organizations—including the U.S. Green Building Council (USGBC)—have been formed at the nexus of business and environmental concerns. Ceres is a member of the We Mean Business coalition, which includes organizations like BSR (which develops sustainable business strategies through consulting, research, and cross-sector collaboration) and the B Team (a nonprofit formed by global business leaders to spark “a better way of doing business” that promotes the well-being of the planet) among others.

In recent years, due in no small part to the work by Ceres and others, it has become de rigueur for corporations to describe their efforts to mitigate climate change in their corporate sustainability reports. But whether it is in the awareness gained from these practices, or the tangible effects of the warming climate, corporate attention to the business risks of climate change is palpable. And this attention is leading to a new level of business action.
Take the Low Carbon USA coalition. A project of Ceres and the World Wildlife Fund, the call for low carbon policy has attracted upwards of 1,000 businesses and organizations, including USGBC. Signatories include not only the climate progressive types, but notables such as DuPont, Monsanto, and power giant NRG Energy. The statement pledges commitment to addressing climate change and asks elected officials to support low carbon policies, including implementing the Paris Agreement, a good example of what Reid means by businesses embracing sustainability as a core business value.

For more evidence, consider the influence of global institutional investors, such as the U.S.’s CalPERS $275 billion pension fund, that prefer investing in green building projects. Indeed, more than 250 members of GRESB, the Amsterdam-based group that assesses the sustainability of real estate private equity funds and real estate investment trusts (REITs) worldwide, use the organization’s data in their investment management and engagement process to optimize the risk/return profile of their investments. Investor focus creates real results, with mega-real estate players such as TIAA-CREF, Tishman Speyer, and Hines actively working to calculate carbon footprints and improve their GRESB scores.

In late 2015, Microsoft co-founder and billionaire philanthropist Bill Gates announced the Breakthrough Energy Coalition, a global group of investors committed to developing new clean energy technologies. The group includes such business luminaries as Amazon founder Jeff Bezos, Virgin founder Richard Branson, Hewlett Packard Enterprise chief executive Meg Whitman, and Facebook founder Mark Zuckerberg.

This group is serious about investing in the clean energy future. This past December, the coalition announced the Breakthrough Energy Ventures fund, a pool of more than $1 billion to support companies and technologies that have the potential to reduce greenhouse gas emissions. In particular, the fund will target the electricity, transportation, agriculture, manufacturing, and architecture industries. Hallmarks of the fund, according to the coalition, will include patience, judgment by scientific milestones, flexible investment capabilities, and a significant global network.

“Our goal is to build companies that will help deliver the next generation of reliable, affordable, and emissions-free energy to the world,” Gates said in a statement when the fund was announced.

“When it comes to energy, people say you cannot make money, meet demand, and also benefit the environment,” Jack Ma, executive chairman of Alibaba Group and a board member of the coalition, said at the time. “But we can, and we will!”

Investment, business, and policy—all three are needed to reach the greenhouse gas emissions targets necessary for the aspirational 1.5 degree warming limit set forth in the Paris Agreement.●
MORE THAN WATER
As national media attention on the Flint water crisis wanes, an organization called Crossing Water continues to bring services to residents, employing a model that addresses needs beyond access to clean water.

When Flint, Michigan, resident Vanessa Terrell first learned that even boiling her water wouldn’t make it safe to drink, she told her granddaughter that they were “back to pioneer days.”

Terrell doesn’t own a car and relies on her bicycle to get around Flint, making it nearly impossible for her to transport large quantities of water from pickup locations back to her home. Her granddaughter, when she was only eight years old, lugged cases of bottled water home with her on the school bus, bringing two cases on days when she could find a friend to help her carry them. Terrell called the Michigan 2-1-1 help line to get water delivered to her house, but she says that she’s received inconsistent service. She was taken off the delivery list several times, she says, because she wasn’t at home to receive the water. Although Terrell lives on her Social Security income, she also does volunteer work, both at a local church and at the Catholic school that her granddaughter attends.

“Just because I wasn’t home doesn’t mean I’m not still in need,” Terrell says.

While learning that the city’s drinking water contained unsafe levels of lead was a shock, Terrell says, it’s only one of the stressors of living in Flint, where two in five residents live in poverty and 35 percent of adults read at a first-grade level. “Any situation—education, medical, roads, transportation, groceries, housing—you name it, it’s broken,” Terrell says. “It needs help.”

The reason Terrell sends her granddaughter to Catholic school, despite her limited means, is because of what she calls the “deplorable” state of local schools. At the charter school that her granddaughter previously attended, Terrell says, there were 52 students in her second-grade classroom. Terrell’s granddaughter has been diagnosed with attention-deficit/hyperactivity disorder (ADHD), which Terrell suspects may be a result of exposure to lead in the water, although she can’t say for sure. Her granddaughter’s blood tests came back negative for lead, and Terrell can’t afford a hair test that would show whether the girl was exposed to the poisonous heavy metal in the past.

This was Terrell’s situation—scared of the water in her pipes, unable to bring clean water home or get it delivered without difficulty, and worried about much more than just what was coming out of her faucet—when a woman knocked on her door last year with an unexpected delivery of bottled water. The woman was a volunteer from an organization called Crossing Water.

“I just liked the feel,” Terrell says of the visit. “I liked what I felt in my soul. I said, ‘How do I get involved with your group?’”
Previous spread: Flint resident Vanessa Terrell receives safe drinking water and filters for her faucets from Crossing Water. Right: Michael Hood started Crossing Water in 2015 in an effort to educate Flint residents on the dangers of the municipal water system as well as to help get clean, safe water to people in need.
Not long afterward, Crossing Water visited her house again, this time with several more cases of water and a filter for her faucet. Terrell knew that her neighbor was in need and asked that the group bring some water to her, as well. There was only enough for Terrell, and so Terrell split the delivery with her neighbor. Then, on a Saturday when the group was meeting in Flint, Terrell pedaled her bike across town “like a bat out of hell” to be among the volunteers.

“Crossing Water, they don’t just talk to people about the water. They’re trying to help on any level you need help on,” Terrell says. For example, the group rebuilt a porch for one of her elderly neighbors. “It’s not just about the water. That’s why I wanted to be part of this organization.”

Rewind to late 2015, when the city was mired in the very depths of the water crisis. Michael Hood followed the news from his home in Ann Arbor, 55 miles to the south.

**Flint Water Crisis TIMELINE**

**APRIL 16, 2013** – Flint’s state-appointed emergency manager signs a contract to purchase water from the Karegnondi Water Authority (KWA), moving away from the Detroit Water and Sewerage Department, which had previously provided water to Flint.

**APRIL 17, 2013** – The Detroit Water and Sewerage Department sends Flint a letter terminating their service in 12 months, meaning the city must find an alternative water source while construction of the Karegnondi pipeline is completed.

**APRIL 25, 2014** – The city begins using the Flint River as its water source. The city does not treat the corrosive water to prevent lead from leaching into pipes, and residents soon begin complaining about water color and mysterious rashes.
Hood—a wilderness guide, former EMT, and a nontraditional student who’d recently earned a bachelor’s degree in social work from Eastern Michigan University while in his mid-50s—vetted news articles and posted them on his Facebook page, trying to compile the best available information. One day, a friend commented on one of his posts, telling him, “Thank you for all you do for the people of Flint.” The friend meant the comment sincerely, but to Hood, it felt like a gut punch. “I wasn’t doing anything,” Hood says. “I was just posting on Facebook. Any moron can do that. So that partially inspired me, or pushed me, into going to Flint. I said, ‘I don’t need to sit here. I can go in and see what’s going on there.’” Within a week and a half of that visit, Hood started what would become Crossing Water, running the organization out of a church basement in Flint. Hood was horrified by what he saw as the state’s lack of meaningful action, especially around communication, and one of Crossing Water’s first efforts was a public

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Far left: The organization operates out of a church basement in Flint. Left: Laurie Carpenter (shown standing) is the director of training at Crossing Water.

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AUGUST 15, 2014 — The city issues the first of two temporary boil orders for water due to bacterial contamination.

OCTOBER 1, 2014 — General Motors announces that it will no longer use Flint water in manufacturing after workers notice rust spots on newly machined parts.

JANUARY 2, 2015 — The city warns residents that total trihalomethanes (TTHMs), a disinfectant byproduct that can cause health problems with long-term exposure, exceed federal limits.

JANUARY 9, 2015 — The University of Michigan Flint tests its water and finds elevated lead levels at two drinking fountains.
awareness campaign. The group, partnering with a Lansing ad agency and owners of advertising space, put up 22 billboards all over Flint letting people know—in multiple languages—that boiling the water wouldn’t reduce its lead content. (Boil orders were issued in 2014 due to bacterial contamination, sowing confusion in many residents who believed that boiling water would also keep them safe from the lead that had leached into their water.) Crossing Water also printed up 15,000 postcards and distributed them to low-income households, and aired public service announcements on radio and television, aiming to educate residents about the lead contamination and point them toward available resources.

“We didn’t put our names on any of this stuff, because that really wasn’t what it was about,” Hood says. “But consequently, everyone thought the state was putting out all this stuff, because there was nothing else out there. They look like state public service announcements. We’ve done this now three times, and the last ones, we put our names on it, so people know they’re from us.”

It doesn’t take much prodding to get Hood to talk about his feelings on the state response to the water crisis, which he usually punctuates with a four-letter word or two. He gives the city government some leeway, saying that Flint doesn’t have the capacity to handle a crisis this large. “But the state government sure does, and we saw them sitting on their hands,” Hood says.

In addition to the public information campaign, Crossing Water organized volunteers to go door to door in Flint, distributing water, installing filters, and finding...
out what else people needed. While the city and state were also distributing water, many residents viewed—and continue to view—government officials with deep mistrust, a wariness that’s understandable when one considers how the water crisis began and how long it took officials to acknowledge that there was a problem. There were even rumors that city police were using water deliveries to serve arrest warrants, although the police department denied that this occurred.

Hood runs an annual free Thanksgiving dinner in Lansing, and he recruited some volunteers he manages for that program to help out in Flint. Additionally, the state chapter of the National Association of Social Workers gave Hood access to an email list of 6,000 of its members. After Hood emailed the group, around 350 social workers agreed to volunteer with Crossing Water.

Neither Hood nor anybody else draws any salary from Crossing Water. The organization has raised between $20,000 and $30,000, mostly in small donations, Hood says, but much of the group’s funding has come straight out of Hood’s own bank account. He’s burned through his entire life savings and retirement fund to keep Crossing Water going, and he also estimates that he’s given up more than $100,000 in lost income. He didn’t work for pay all last year or this year, and he’s put his business—Vertical Ventures, a rock climbing and wilderness guide program—on hold while he attends to Crossing Water.

Hood’s life partner Laurie Carpenter serves as director of training for Crossing Water, in addition to working fulltime, and the couple lives off of her income while Hood puts in 12-hour days for no pay in Flint.

MARCH 26, 2015 – An EPA official questions whether an outbreak in Legionnaires’ disease in Genesee County is due to the switch to Flint River water.

JUNE 24, 2015 – An EPA official says that the lack of corrosion control for Flint water constitutes a major public health concern.

JULY 1, 2015 – Gov. Snyder reports that the state DEQ says there is no widespread lead problem, while the state Health and Human Services department says that elevated levels of lead in blood tests are due to seasonal trends.

SEPTEMBER 2, 2015 – A researcher from Virginia Tech says that the corrosiveness of Flint water is causing lead to leach into residents’ drinking water. The state DEQ disputes the findings.
Above: In September of 2014, a study revealed unhealthy levels of lead in Flint’s children’s blood tests.

Right: Crossing Water also distributes portable showers to the residents of Flint.

“We’ve put everything we’ve got into this thing,” Hood says. “It’s a big investment, and a big sacrifice, but the people of Flint are sacrificing a lot more than that.”

Perhaps because of Hood’s own background in social work (he was set to begin a master’s program in the field in the fall of 2016 but deferred until this year), and because of the heavy presence of social workers among the group’s volunteers, Crossing Water has taken a holistic approach to its work. Instead of simply bringing people water and installing filters, volunteers have tried to meet whatever needs they can for the residents they serve. Sometimes that has meant rebuilding a porch. Other times, it’s meant delivering diapers, wet wipes, toothpaste, and dental floss. The group has also brought residents bread, and rice, and bus passes, and soap, and children’s books, and clothing, and hand sanitizer, among other items.

Nonprofit groups are sometimes criticized when they try to tackle problems outside of the scope of their original mission, and Hood admits that Crossing Water has become “the king of mission creep.”

“People say to us, ‘Well, you don’t sound like you’re very efficient,’” Hood says. “And we say, ‘We’re damn well not very efficient, but we’re damn well effective.

**Flint Water Crisis TIMELINE** (continued)

- **SEPTEMBER 24, 2015** – A study by a researcher from Hurley Medical Center shows high levels of lead in Flint children’s blood tests.
- **SEPTEMBER 25, 2015** – The city says it is in full compliance with federal water laws, but warns residents to only use cold water for cooking, drinking, and making baby formula.
- **OCTOBER 1, 2015** – The state DHHS confirms the results of the Hurley study, the city urges residents not to drink the water, and the county declares a public health emergency.
- **OCTOBER 16, 2015** – Flint reconnects to Detroit’s water system.
Beyond Flint

In a June 2016 report titled “What’s in Your Water? Flint and Beyond,” the Natural Resources Defense Council (NRDC) calls lead contamination of water a “national problem.” According to the organization, which helped win passage of the Clean Water Act in the 1970s, federal data reveals a widespread health crisis that could potentially affect millions of Americans.

In 2015, according to the report, more than 18 million people were served by water systems that violated the Lead and Copper Rule, a 1991 EPA regulation limiting the concentration of lead and copper allowable in public drinking water. Many of these violations were due to failures to properly test water for contamination or to report contamination to state officials or the public. But water systems serving 3.9 million people showed lead levels exceeding 15 parts per billion in at least 10 percent of tested homes, the federal “action level” at which systems are required to take further steps to optimize corrosion control, educate the public, and replace portions of lead service lines.

According to the report, Flint is not even included in the EPA’s database of violators, which the NRDC attributes to chronic underreporting problems. The NRDC says that this suggests a “much bigger lead problem” than what is revealed by official data.

Lead exposure, the organization notes, can cause irreversible damage to the brains and nervous systems of babies and young children—decreasing children’s cognitive capacity, causing behavior problems, and limiting the ability to concentrate.

The NRDC recommends significant investments in national water infrastructure, including the replacement of more than 6 million lead service lines, the replacement of decaying or outdated parts in distribution systems, and improvements to drinking water treatment plants. The group also recommends that the Lead and Copper Rule be amended to require the full replacement of all lead service lines, to require more robust monitoring, and to require clear, ongoing, timely, and culturally appropriate public education and notification of lead problems.
SEPTEMBER 11, 2016 – The EPA says that Flint residents will likely need to use filtered or bottled water through the end of the year.

DECEMBER 20, 2016 – The state attorney general brings felony charges against two former Flint emergency managers, bringing the total number of people charged in connection to the water crisis to 13.

JANUARY 24, 2017 – State officials announce that lead levels in Flint water no longer exceed federal limits in 90 percent of samples, but residents are told to continue to use filters during the replacement of pipes, which is expected to take years.

MARCH 28, 2017 – A federal judge approves an $87 million settlement in which the state will pay to identify and replace at least 18,000 unsafe water lines by 2020.
anybody have a stove that they don’t need? There’s many a time that he has schlepped a refrigerator or a stove from Ann Arbor up to Flint, or clothing for a family, or he’ll get their plumbing fixed, or find a medical resource they need.

“The people going into these houses are really trained in crisis intervention,” Ziefert adds. “The water is the precipitating event, but all of the other stresses on families are compounding what’s going on with the water. It’s not just water that they need. They need reassurance. They need access to resources. They need somebody to tell them that they’re going to be okay.”

Wachendorfer says that, in addition to its operating model, one thing that sets Crossing Water apart is the mere fact that it’s still there. “While there are still certainly some folks that have stuck through this [crisis] all the way through, they’re few,” Wachendorfer says. “When the cameras and the spotlights were on, and it was all over the national news, everybody was showing up. Then, that started to die off, and over the last year, that has evaporated almost completely. But Crossing Water is still there. For a group of folks that primarily came from outside the city, that is unique. That is what stands out to me.”

Hood attributes much of Crossing Water’s success to the debriefing sessions that the group holds after each day of canvassing. The group feeds its volunteers a home-cooked meal, and then people sit and discuss the day’s events while they eat.

“It has become a really, really critical part of the success of why we keep our social workers,” Hood says. “One of the things that social workers go through is burnout. Social workers see lots of trauma, lots of really bad trauma, and they experience what’s called secondary trauma. Our model helps alleviate some of that trauma by allowing them to sit down to a hot meal amongst their comrades and their colleagues and share their stories, oftentimes in tears. They can share these stories with people that understand and care.”

In Flint, Vanessa Terrell continues making deliveries with Crossing Water. “I like to roll up my sleeves and help my neighbors,” she says. “I understand their fears, because I’m living the same nightmare. I do get despondent, because the struggle is hard. When I go door to door and see other people’s situations, I realize I do have it better than some. It just gives me that little kick I need to get going.”

Gretchen Thomas, a disabled Flint resident and recipient of Crossing Water’s services, calls the group “awesome.”

“I told the ladies from Crossing Water, without people helping us like you, I don’t know what I’d do,” Thomas says. “It’s great what they do. They’re taking time out of their lives to aid us, and it means a lot. They really have a heart.”

Now that the quality of Flint’s water has improved, one of Crossing Water’s next challenges is to convince residents that it’s safe to move from bottled water to filtered water. Although the state will maintain pickup points for free bottled water through at least September of 2017, no one expects the practice to continue forever, and many Flint residents can’t afford to purchase bottled water on their own. “We go through two cases every other day,” Terrell says. “That’s a lot if you’re paying for it out of your pocket.”

Terrell tries to spread the message that filtered water is safe, but she confesses that she can’t bring herself to drink it—or to give it to her granddaughter. “I try to tell people to at least try to cook with the filtered water,” she says. “But that’s asking a lot. It’s not paranoia. We were told there was nothing wrong with the water. I have little to no trust in the government when it comes to this situation.”

One thing in which Terrell is confident: Even as the water situation improves, Crossing Water will remain in Flint, helping residents and tackling the city’s other problems.

“The people that are actually here know that there were more problems before the water,” Terrell says. “The water just added to the problems that we already had. Crossing Water will actually say out loud that there are more problems in Flint than just the water. You can’t take care of one without taking care of the other.”

“Crossing Water will actually say out loud that there are more problems in Flint than just the water. You can’t take care of one without taking care of the other.” –Vanessa Terrell
From Polluted Metropolis to Forest City

Italy’s Stefano Boeri plans to transform one of the world’s most polluted cities, Shijiazhuang, China, into an oasis of habitable forest.

WRITTEN BY LORNE BELL
In 1972, the streets of Milan, Italy, were a hotbed of politics and protests, and 16-year-old Stefano Boeri was at the center of the action. But as Boeri marched for economic justice, an eccentric street artist named Friedensreich Hundertwasser was preaching a different ideal, one that would inspire the future architect’s vision of sustainable design.

“I remember him holding up a small oak tree in one hand, and he was talking about the trees being considered as houses for tenants,” says Boeri, now 60. “I wasn’t especially interested in ecology, but Hundertwasser was one of the first to observe the relationship between humans and trees from a different perspective, and that was very, very influential.”

Hundertwasser eventually helped design one of Vienna’s most popular tourist attractions, the Hundertwasserhaus, a mixed-use complex with 250 trees and bushes growing inside residences and across the building’s facade.

Boeri went on to study architecture in Milan and earned his PhD from the Istituto Universitario di Architettura in Venice. Today, his Milan-based company, Stefano Boeri Architetti, is one of Italy’s most renowned sustainable design firms. It’s also a pioneer in “Vertical Forests”—buildings that feature hundreds of trees that sprout from balconies, creating an ecosystem of flora and fauna that stretch across the structures’ exteriors. The architect’s leaf-covered creations can be seen in cities across the world, from Switzerland to the Netherlands to China.

Boeri’s flagship Vertical Forest is a $60 million, geothermally heated, Leadership in Energy and Environmental Design (LEED) Gold building in Milan completed in 2014. The solar-paneled residential towers—27 and 19 stories tall—feature 900 trees, each 10 to 30 feet in height. On flat land, that’s equivalent to nearly five acres, or 215,000 square feet of forest. Along with 20,000 shrubs and flowering plants, the greenery creates what Boeri and his team call a microclimate, producing humidity, filtering dust and pollution particulates, absorbing carbon dioxide, and producing oxygen.

In summer months, the Vertical Forest can reduce the building’s surface temperature by 54 degrees Fahrenheit, cooling the inside by as much as 5.4 degrees. And rainwater that would otherwise flow unused to the sewers is recaptured by the building’s vegetation and an advanced irrigation system.

Individually, Boeri’s Vertical Forests make measurable impacts on energy use and the buildings’ immediate surrounds. The Milan towers remove 11 tons of carbon dioxide from the air each year, according to Boeri’s firm. But the designer’s next project will do much more than build a Vertical Forest on a city block. It will transform Shijiazhuang, China, one of the most polluted urban centers in the world, into a “Forest City.”

“Lung Busting” Pollution

On December 19, 2016, a thick, noxious smog hung over Shijiazhuang, China, shutting down schools and businesses for the city’s 10.7 million residents. The South China Morning Post described the air as “lung busting.” Even inside their homes, citizens could not escape the choking smog from burning coal and car emissions. And it was not an unusual day in Hebei province.

The World Health Organization ranks Shijiazhuang’s air quality 14th among the world’s most polluted cities. On that chilly winter afternoon, the level of PM2.5 and PM10, two of the most toxic airborne particulates for human health, were reportedly more than 1,000 micrograms per cubic meter. The WHO recommends exposure be kept under 25 and 50 micrograms, respectively.

Which is why Stefano Boeri’s plan for Shijiazhuang seems both brilliant and, well, crazy. The Italian architect plans to turn a 556-acre section of the metropolis into a “Forest City,” with dozens of Vertical Forests stretching across five multi-use districts. The idea is to create a borough-sized air purification system for 100,000 city residents. Based on the data from Boeri’s one-off Vertical Forests in Milan and elsewhere, the Forest City could have a massive impact, removing tons of carbon dioxide from Shijiazhuang’s air and reducing the levels of toxic particulates to safe, habitable levels.

“Every year in China, 14 million people abandon the countryside for the city,” says Boeri, “and Shijiazhuang is the result. It’s one of many megalopolises where public policies are creating a nightmare in terms of environmental impact and quality of life, and [the
Chinese government is] now seriously considering the consequences of their planning.”

Boeri’s team is currently exploring locations but has not announced a construction date or budget for the project, branded ForestCityShijiazhuang. He says it will likely strive for LEED certification.

The development will be built on just under one square mile of Shijiazhuang and focus on vertical density. Shijiazhuang proper spans 825 square miles and is the largest city in northern China’s Hebei province—almost three times the size of New York City. That urban sprawl has multiplied the impact of development and pollution across the landscape.

The master plan calls for five petal-shaped districts, each housing 20,000 residents in mid- and high-rise buildings. The petals surround a central park with a hospital, school, and cultural activities, but each multi-use district will provide nearly every amenity to residents: commercial, retail, public spaces, and gardens. The result is a reduction in both urban sprawl and the pollution that comes from transportation.

The centerpieces in Boeri’s master plan, though—and what distinguishes it from other multi-use urban developments—are the Vertical Forests themselves. Based on each Vertical Forest’s green cover and the design’s scale, the project could create millions of square feet of forest, all within one square mile of city space. Boeri’s hope is to use ForestCityShijiazhuang as a prototype and replicate the design in polluted cities around the world.

Previous spread: Bosco Verticale (Vertical Forest) is a pair of residential towers in the Porta Nuova district of Milan, Italy. Stefano Boeri’s design approach is a combination of research and architectural practice. He is a founder of Multiplicity, an agency for territorial investigation researching for the clues and traces produced by new social behaviors.

This page: A greywater filtration system (used with water that has gone down the sink or shower) ensures the trees are adequately watered.
The Forest City in Shijiazhuang will be a new city for 100 thousand inhabitants. A city of a new generation, capable of becoming a model of sustainable growth in a large country seeing, each year, 14 million farmers migrating to the cities.
Growing an Ecosystem

Planning a Forest City’s greenery is not a task for the average weekend gardener, so Boeri tapped Studio Laura Gatti, an award-winning landscape consulting firm in Milan, to develop ForestCityShijiazhuang’s horticultural strategy. Gatti and her colleagues worked with Boeri on several Vertical Forests—including the designer’s first in Milan—and they’re now studying the best approach to realizing a living, breathing Forest City in Shijiazhuang.

“These are more than residential buildings,” says Gatti, an agronomist who also teaches at the University of Milan. “They’re an intervention of trees—a way to regenerate the whole environment.”

That regeneration begins with an exploration of the region’s climate, soil ecology, and native tree species. From there, Gatti and her team will reach out to local nurseries to see what trees are available, selecting each to fit the buildings’ design, balcony dimensions and weight limits, outside environment, and the trees and vegetation that will surround them. Only “safe trees”—those free of defects and impervious to strong winds—will make the final cut. And because each tree is planted in multi-membrane, concrete containers, trees with aggressive root systems are also out.

Once the trees are chosen, Gatti will work with nurseries throughout the growing process. And from day one, the team must coordinate and communicate its choices with the project’s architects, engineers, construction crew, gardeners, and maintenance personnel.

After the Vertical Forests are completed, maintaining the trees requires a highly sophisticated irrigation system. Israel-based Netafim, which pioneered high-efficiency drip irrigation technology on Israel’s desert farms, designed the Milan Vertical Forest system. The company’s technology uses a combination of collected rainwater, graywater from residents’ apartments, and underground water sources to drip irrigate the building’s thousands of trees and plants. Each planting container absorbs approximately 0.4 kg of CO2 a year.
has a chip, sending soil moisture information to central computers that command the pumps.

Trimming the trees also requires trained professionals—horticulturists who are unafraid of heights. To clip the outer reaches of the Milan Vertical Forest’s nearly 1,000 trees, a crew of three rappels down the building’s sides, snipping and shaping the trees to maintain adequate light and shade for residents.

Gatti’s horticultural process is exhaustive, and it takes time to create and monitor a working ecosystem in an ever-changing climate. She and her team entered the Milan project in 2008 and planted the building’s vegetation in 2012.

While ForestCityShijiazhuang’s scale will be a challenge—and its impact will be just part of a holistic solution to pollution in cities around the world—Gatti is optimistic that Vertical Forests and Forest Cities can lead to more significant change in how humans view the natural environment. Since opening the Milan Vertical Forest, she says, residents report improved well-being from seeing flowering trees and plants—and the birds, bees, and butterflies they bring—just outside their windows and balconies.

“Vertical Forests are places where people can recognize our relationship with nature,” says Gatti, “not just green design. They can be a [sign] that things can be different. That cities can be different.”

Boeri agrees. And while his Vertical Forests and vision for ForestCityShijiazhuang might seem as eccentric as his street artist muse, the architect aims to do more than turn heads with his designs.

“Art is best when it opens new perspectives,” he says. “When it anticipates new environments and ways of thinking that are not yet real.”

Visit plus.usgbc.org to see a video of tree trimmers at work in Milan, Italy.
BIOLOGICAL REVOLUTION
During a Greenbuild 2016 session titled “Positive Disruptors,” imaginations were set alight by a discussion of green building “super materials.” By adapting biological processes, three of today’s leading innovators have collectively managed to harness fungi and employ rhizomes to make healthy and renewable products for a resilient built environment.

Eben Bayer, co-founder and CEO of New York–based Ecovative, explains how his discovery of mycelium’s strength and fire resistance led to the engineering of MycoBoard™, a wood alternative surpassing conventional substrates, and MycoFoam™, a fungi-based material used in protective packaging. Bayer’s technology uses substrate from wood chips and plant stalks, moistened with water and inoculated with mycelial cells (the vegetative part of fungi). Those cells grow through and around the substrate, all the while deriving nutrition from it. In time, the mycelia form a complex molecular network, which acts as a glue, essentially holding everything together.

The choice of substrate, the strain of mycelium, and the growing method determine the product’s properties, which may be cushioning and absorbing, leatherlike, or rigid. Ecovative’s lower-density products, which behave much like styrofoam, have achieved a third party–verified Class A fire rating.

The first application of MycoFoam™—molded packaging—offered an alternative to plastics. Today, it is mass produced and sold directly to end users such as Dell, as well as via the Ecovative website, for use as a structural core in everything from furniture to doors to acoustical panels. Available, too, is a range of finished products for office interiors, such as decorative acoustical tiles, which can be customized for mounting to walls and ceilings.

Operations have expanded to include a second factory, where they are scaling up production of three-by-six-ft and four-by-eight-ft sheets of MycoBoard™. “In the past, we only made our products available in the molded shape form,” notes Bayer. “So, I am really excited to see what architects and building designers [do with] the material, now that it is commercially available.”

Another Ecovative innovation, the Grow It Yourself (GIY) kit, is Bayer’s answer to the many requests from people for products he couldn’t provide. “We created the GIY kits so artists and designers and even students could get raw material from us—dehydrated substrate [that acts] like a sea monkey. They add water and can make anything.” Lighting designer Danielle Trofe has devised a lampshade from the material; her aptly named MushLume installation features in the eco-minded 1-Hotel Brooklyn Bridge. Ecovative is set to partner with her to offer a version of her lampshade as one of their GIY kits.
All Ecovative products are made from locally sourced raw materials, have low embodied energy, and are beneficial to human health in that they contain no Living Building Challenge red-listed chemicals, emit no VOCs, have a high R-value, and are Cradle to Cradle Gold certified. “I think it is extremely responsive to Leadership in Energy and Environmental Design [LEED] and WELL Building Standard [WELL] criteria,” says Bayer, noting that acoustical tiles can improve any building’s sustainability profile. Their products are also responsive to climate change by mitigating CO2 during production.

In terms of future innovations, Bayer anticipates more applications in the durable goods arena—furniture and home/office interiors. Of bio-based products in general, he says: “I see them playing a bigger and bigger role in green building . . . I see biomaterials starting to change how we build.” He points to BioMASON, a company in North Carolina using bacteria to bind sand together to make everything from countertops to bricks. “[Those bricks offer] a beautiful biological solution to another greenhouse gas producer—[concrete]. We are going to need many more innovations like that to start to really influence building over the next 10 to 20 years. I think we are on the cusp of a biological revolution in building.”

What will it take to get there? Time.

Scaling up the manufacturing process took Bayer seven years; there was also the time it took to test and validate his materials, and then gain a market presence. “All of that is the harder thing to achieve in some cases than getting the technology right,” he says. “New technologies take a while to catch up to the incumbents, and if you are on the cutting edge of building, sometimes you aren’t on the edge of being safe and healthy in terms of, say, energy performance.”

Other constraints include building codes, which can hamper more “futuristic concepts.” Bayer gives the example of a building “grown” from thin-wooded pine shelves and mycelia. “The entire building cavity was filled with our living substrate—like a massive GIY kit.” The substrate grows into the pine and into the insulation and glues the whole building together, like spray foam. Once the pine completely dries out, a super-strong, lightweight, insulated, fire-resistant, VOC-free structure remains. “It’s really cool but not totally predictable because we don’t have total control over biology yet. And it doesn’t meet code for that sort of construction methodology.” Bayer feels some allowances should be made for experimental building that brings biology into the fold—to create actual living buildings.
San Francisco–based Biome is another frontrunner in the biomaterials sphere. Their high-tech green wall system monitors and improves indoor air quality using microbiomes that exist on plant roots and ingest air-polluting toxins.

Named Taiga T35 (T35), their system is an “immersive piece of landscaping technology,” comprising 35 plants and five air purification chambers. It integrates hardware, software, and biology, so there is an array of materials including metals, plastics, coatings, and biologics that all require careful sourcing. “We are not just using off-the-shelf components,” says founder Collin Cavote, noting that their products are toxin free. “The materiality is super important to what we are doing.”

Using NASA-vetted technology, all Biome products are optimized to remediate air pollution. Sand pulls air molecules from the room, into the system, and through the root mass of (typically tropical) plants to facilitate and enhance bioremediation of things like formaldehyde and benzene—typical indoor air contaminants. “We rely on those plants to foster the right microorganisms,” explains Cavote, adding that a plant grown in their system is nearly 200 times more effective at purifying air than plants grown in soil; the activated carbon soilless medium in which they are grown acts like an absorbent agent—much like a Brita filter—and the root system’s microbes digest the pollution. “It becomes a cyclical process, whereby the activated carbon gets renewed and the plants get nutrition.”

The impetus for his invention? Cavote explains how, in 2006, he went off-grid for a year. “I was really living in nature,” he recalls. “When I came back to city life and school, I realized how drab the built environment is—a sterile concrete jungle—I really felt that shock.” Air pollution, in general, troubled him. “It’s one of the biggest global health concerns,” he says. “Climate change is an air-quality issue.”

Simultaneously, he was studying the ways in which plants clean air. Research at the time proved that it is the roots, not the leaves, that perform that function. His work included an examination of the largest green wall in North America and its cleaning rates. “I decided I wanted to productize it to make the technology of a $200,000 green wall that requires $20,000 per month of maintenance to be accessible to a family with a new child or a hotel,” explains Cavote. And Biome was born.
Top: T35 automatically cares for 35 plants within its five air purification chambers. Bottom: Research to understand how humans can generate clean air in space led to an amazing discovery: micro-biomes that exist on plant roots that eat air pollution.
To become a products company, Cavote worked with designers and engineers and brought it to market about a year ago. Given the fast pace of urban living, Cavote felt it vital to develop an “automated nature product”—one that would require little maintenance—for it to be viable. “We are basically trying to create a tool for the design community to specify nature.”

The Biome green wall is in high demand in Northern California’s Bay Area, particularly in the tech sector, which is invested in making healthy work environments. Cavote cites an Environmental Health Perspectives study that demonstrates indoor air quality is directly related to productivity, crisis response, and information usage. He sees his product as a tool that can be used to reach productivity goals. Currently, he is working with a few banks on their customer-facing side as well as in their internal workings to provide employees healthier workspaces. The next move is into the residential sector. Connor Developers is on board to start using them in some of its high-rise condominiums nationally.

Cavote sees his green wall at work “anywhere nature is desirable.” The possibilities seem endless. “We are increasingly excited about schools and hospitals—places where children and the elderly and sick are really in need of the benefits nature can provide,” he says, adding that studies show healing is speeded by access to nature. “We want to be able to provide the research to make our customers confident that this is an effective choice.”

As a declared certified product, Taiga 35 targets LEED and WELL transparency and biophilia criteria. The suite of sensors that measure real-time CO2, light, temperature, and humidity make it an active tracking mechanism for WELL.

“We are increasingly looking at how to help clients achieve that certification,” notes Cavote. Rather than being viewed strictly as an accessory to be added toward the end of a project, they are getting involved during the earlier stages, thereby providing more opportunities to meet building certification requirements.

Like Bayer, Cavote feels bright about the future of bio-based building materials. “I think this is a new age. . . we are transitioning from less bad to actually healthy with materials that will make people live longer, not just as long as they should have lived in the first place.”

On yet another front, EcoSynthetix’s spectrum of products have replaced petroleum-based SB latex with a bio-based material in paper coating applications. Their patented EcoSphere biolatex® binders are used on a commercial scale around the globe. “Our system has very good form fit, and we are able to displace up to 25 percent of the petrochemicals with our biopolymer,” says Doug Ireland, director of building products.

Fifteen years after their initial product entered the marketplace, the idea came about that they could tailor their biopolymer for different applications. Enter: DuraBind, a glue/binding agent used in building materials like insulation, composites from natural fibers like hemp and jute, and wood composites including particle board, medium-density fiber (MDF) board, and oriented stand board (OSB). According to Ireland, engineered biopolymers enable manufacturers of such products to decrease the amount of highly regulated chemicals, such as formaldehyde, in their formulation.

He describes the process by which DuraBind is made as one that applies technology to “nature’s biopolymer” from feedstocks such as corn, tapioca, and potato to engineer—via a reactive extrusion process—a new biopolymer. “We use what nature gives us and then take away some of the negative characteristics of natural biopolymers, such as season-to-season variation, to make a very consistent product.”

Other benefits of EcoSynthetix’s biopolymer products include improved building safety, and reduction in the complexity of processes associated with working with highly regulated chemicals. Their carbon footprint, too, is minimal compared to those of competitors. Conventional binders like the urea-formaldehyde (UF) resin binder have a carbon footprint of 2.86 CO2e, and N-DMBI, which is a synthetic binder system, measures about 4.0. DuraBind measures 1.03.

“From a sustainability standpoint, we are replacing petrochemical components,” says Ireland, adding that particle board is, on average, 90 percent either FSC-certified or recycled wood and 10 percent petrochemicals. “What we bring is a product that is 98 percent sustainable wood and 1.5 percent petroleum based. There’s a significant improvement in terms of the sustainability of the board.”
DuraBind is designed to comply with the LEED credit for composite wood materials. In terms of WELL, Ireland says: “It’s a little early for us to know exactly how we fit there, but it is a natural product so there are no VOCs and no off-gassing, which makes it healthier for building occupants.” Given DuraBind takes the place of formaldehyde-based technology, the air quality in buildings and homes is immediately improved.

Much of Ireland’s time is devoted to explaining to potential clients the benefits of DuraBind. Facing a conventional industry accustomed to formaldehyde-based products and systems is a challenge. “You have to be very prudent and conservative in your program,” he says. “You have to ensure that the quality and performance is going to meet or exceed expectations over the long term.”

To make bio-based products attractive to more conventionally inclined customers, they position their product as having three pillars of strength: profit, performance, and sustainability. For clients to change their buying habits, the economics must be viable, the performance level must meet or exceed standards that the previous system/incumbent chemistry had delivered, and the green attributes must be marketable. “If you can deliver the first two, and convince them of the marketability of sustainability, then you are providing a means by which they can earn a competitive edge,” explains Ireland. “We are trying to take down hurdles to make it easier for companies to make the transition.”

Currently, Ecosynthetix supplies many of the top 15 composite panel companies in Europe, North America, and Asia. Ireland sees future possibilities: “I think there are more applications we could look at, like plywood and veneering. The constraint isn’t the technology; it’s a matter of transforming industries.”

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**BioMASON** uses proprietary technology to grow Biocement™ from microorganisms. The technique forms biologically controlled structural cement, eliminating the need for the fuel-fired curing/hardening process. The product can be incorporated into existing facilities or manufactured on site. Benefits include energy cost savings, reduction in carbon emissions, and alignment with green building credits.

**Blue Planet** makes carbon-sequestering concrete. Their patented technology uses waste CO2 as a raw material to produce carbon-negative building materials. The Blue Planet mineralization process by which concrete is formed is based on the naturally occurring process that turns the Earth’s lithosphere—containing approximately 70,000,000 billion tons of CO2—into carbonate rocks. Green attributes include reduced greenhouse gas emissions, low embodied energy, high solar reflectance, energy cost savings, and alignment with green building credits.

**PILI Biotech** biofabricates colored dyes—a clean alternative to pigments containing heavy metals. This young startup uses microorganisms to replace nonrenewable, toxic petrochemical- and nonscalable vegetal-based dyes for use in paints and textiles. This “living palette” has the potential to become a global supplier of renewably sourced dyes.

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Super Materials to Watch For

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In Step with Sustainability
Saint Anthony Village is winning accolades for moving toward becoming a green city.

By Mary Grauerholz

For a town of fewer than 10,000 residents, Saint Anthony Village in Minnesota is more than ahead of the environmental curve; you could say the city is designing the road. In 2016, Saint Anthony—the first town in Minnesota to incorporate the reuse of water—received the state’s Sustainable City Award. Several years before that, the village became a GreenStep City in a voluntary program run by the Minnesota Pollution Control Agency that helps the state’s cities achieve their sustainability and quality-of-life goals.

Joining GreenStep fit like a glove with Saint Anthony’s environmental vision for its 2018 Comprehensive Plan, which has been in the works for years. But the town didn’t stop there. Stakeholders, including residents and city officials, added an extra “chapter,” or section, to the plan to drill even deeper into a more environmentally minded community. The other chapters cover land use, housing, transportation infrastructure, and environmental and water resource goals—this new chapter focused on community sustainability specifically.

“We want to make sure sustainability is woven through all the chapters of the comprehensive plan,” says Mark Casey, city manager of Saint Anthony. For instance, Casey says, “We try to be a walkable community. How does that look? GreenStep would say, we’re going to put a sidewalk in this neighborhood to encourage walking.” That made GreenStep perfect for implementation.

But what about sustaining the work with policy and a vision toward the future? To fill in that missing piece, Saint Anthony again broke new ground, becoming the first—and so far the only—Minnesota town to use the U.S. Green Building Council’s (USGBC) ADVANCE campaign to map out an augmented framework. As Casey says, “Where the Minnesota GreenStep program focuses more on the implementation of 29 best practice strategies, USGBC’s support helped us set performance goals more holistically. Our goal was to have sustainability in our comp plan. We used ADVANCE as the vehicle to develop that plan.”
In a marathon strategic planning process last year, a motley group of 30 people that included Casey, city planner Breanne Rothstein, and consultant Brian Ross—and led by Stephanie Leonard, project manager for community with USGBC Minnesota—hammered out a way to weave sustainability through its 2018 comprehensive plan.

Leonard is a USGBC staff member working to further the organization’s mission and work in local communities. As part of her role, she works with community- and faith-based partners through the ADVANCE campaign to engage new, underserved, underrepresented audiences, and also oversees volunteers in Minnesota, Nebraska, and North Dakota. As Leonard says, “You can’t do ADVANCE without a solid group of volunteers.”

The volunteers in the Saint Anthony project included students at the University of Minnesota Institute on the Environment, who helped formulate the original plan before the gathering; city and parks employees from St. Paul and other towns who served as industry experts; and Citizens for Sustainability, a group of committed residents.

“Saint Anthony had been working for a long time on sustainability,” Leonard says. “It’s always been part of their mission. But they hadn’t really put a framework around it. They hadn’t created a holistic plan.” Leonard’s job was to “make sure people were ready to jump in.”

“At that time, we had done ADVANCE with school districts,” Leonard says. “This was the first time we moved on to a city in Minnesota.”

In the June 2016 workshop, the 30 participants started the review of imperative issues facing the village: Location, Transportation, Sustainable Sites, Energy and Atmosphere, and Water. “The workshop helped create a common language around sustainability and set wheels in motion for achieving higher impact,” she adds.

Leadership in Energy and Environmental Design (LEED) credits supported agenda and discussion topics, Leonard says, specifically elements of LEED for Operations and Maintenance (O+M) and LEED for Neighborhood Development (ND). For instance, on the topic of Energy and Atmosphere, the team discussed setting reduction targets for public buildings and incentivizing private dwellings.

Ryan Snow, USGBC’s director of global community development, led the evolution of the ADVANCE campaign, which expands access to green buildings and healthy neighborhoods by gathering experts and communities. The potential of ADVANCE, he says, is enormous. “The work with Saint Anthony through the campaign in Minnesota is an awesome example of how we can scale this work and focus beyond single buildings, on the health and vitality of a whole community,” Snow says.

Ross, AICP, a senior program director at the clean-energy nonprofit Great Plains Institute, facilitated the ADVANCE process and watched as industry, community, city officials, and USGBC staff, among others, worked out the foundational document. A nationally certified urban planner and LEED Green Associate, Ross helps manage the GreenStep program.
A Comprehensive Plan, Ross says, is primarily about goal setting; as he describes it, “a touchstone for the future.”

“The City’s planning consultants [WSB & Associates of Minneapolis] did a very good job of gathering stakeholders, getting the full, universal perspective, and giving ownership to the community,” Ross says. “Saint Anthony Village is one of the really early communities in the comprehensive planning process to incorporate sustainability. They’ve also folded in energy and climate goals, something that’s not historically required.”

City manager Casey says Saint Anthony is aiming much further down the road than 2018. The question he and his colleagues face, he says, is how the city should proceed in the next 10 years and beyond through that lens of sustainability, which Casey refers to as “Vision 2040.”

When the Saint Anthony City Council added sustainability in the mission statement in 2012, “It took off,” he says of the movement. Another factor that added energetic enthusiasm, he adds, was introducing the 3 E’s—environment, economy, and equity: “We want to make sure we’ve woven in all three pieces of sustainability.”

Before it officially becomes Saint Anthony’s Comprehensive Plan, the document will undergo review by the Metropolitan Council, the regional seven-county government. Part of that is a required “edge matching” step in which adjoining cities comment on the Plan. Then the Saint Anthony City Council will vote. Ross believes the document, with its ADVANCE underpinning, will sail through, giving the village another feather in the community cap. As he says, “They’re on the forefront of addressing sustainability.”
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What is your greatest fear? That logic may not always prevail. I am a person of reason and facts—and I fear that we are in an era of denial of truth, science, and logic.

Which historical figure do you most identify with? One could hope to be Jefferson, Edison, or Plato, but I more relate to the “humble bureaucrat” who has a garden in China dedicated to him and other civil servants.

Which living person do you most admire? Barack Obama for his values, humility, thoughtfulness, perseverance under fire, and for being a class act.

What is your greatest extravagance? Prime season tickets for Washington Wizards basketball.

What is your favorite journey? A sentimental journey—any return to old haunts, favorite memories, happy moments. I still get a chill going back to campus, flying into Washington, a walk with a special friend. Sorry, I travel too much to have one favorite place.

What do you consider the most overrated virtue? Confidence. It too often verges on arrogance.

Which words or phrases do you most overuse? “Really”—as I express amazement, skepticism, wonderment, or incredulity.

What is your greatest regret? Not doing a better job in communicating the urgency of addressing climate change and telling the powerful story that energy efficiency, renewables, life-cycle costing, and the green economy can lead to economic revival, health, and a bright future—all while addressing climate.

Which talent would you most like to have? A less painful version of Mr. Spock’s mind meld—to more fully have empathy, understanding, and wisdom. Or play the piano.

What do you consider your greatest achievement? Being in the right place, at the right time, and having the good luck to provide the early funding for LEED.

If you were to die and come back as a person or thing, what do you think it would be? An immortal young Robert Redford. Hey, a guy can dream.

If you could choose what to come back as one thing, what would it be? A rich philanthropist, i.e., Gates or Buffett.

What is your most treasured possession? My memories. Sorry, not big on “things.”

What do you regard as the lowest depth of misery? Having a child be unable to achieve his or her full potential.

What is your favorite occupation? Doin’ it. Consulting on a variety of green strategies. But I’ve always wanted to be a philanthropist.

What is your most marked characteristic? Cheerful, positive spirit.


What is it that you most dislike? Hearing a child cry, followed closely by anyone in pain. Or hearing a developer defend “least first cost.” Now, that’s painful.

What is your motto? “If you don’t have a dream, how you gonna have a dream come true.”

What will you have put on your tombstone? If that day must come, “He tried to make the world a better place.”
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