July/August 2014

USGBC+

TRANSFORMING OUR BUILT ENVIRONMENT

GLOBAL
Architects around the world look to the past to introduce bioclimate strategies in designing greener buildings.

ENVIRONMENTAL
Green advocates in California push for increased efficiencies through pioneering laws and regulations.

STRATEGIES
The future of large-scale net-zero building is here and has become a trailblazer for the green building industry.

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USGBC+ GLOBAL, ENVIRONMENTAL, STRATEGIES
July/August 2014

ON THE COVER
Mural on the theme of global warming.

Group project by visual arts students in a design course at Grenfell Campus, Memorial University of Newfoundland, Canada. The mural image is formed from 100 panels each measuring 12" x 12."

Artists: Mark Adams, Jon Baker, Devan Burry, Rachelle House, Gabrielle Hughes, Nick Hynes, Warren Jung, Heidi Lake, Heather McCarthy, Jill Murphy, Bailey Oake, Maria Penney, Amanda Power, Courteney Pritchett, Martine Robicheau, Krystal Stockley, Ellen Vickerson, Sarah Willett.

Courtesy of Instructor Michael Coyne
mcoyne@grenfell.mun.ca • findyourcorner.ca

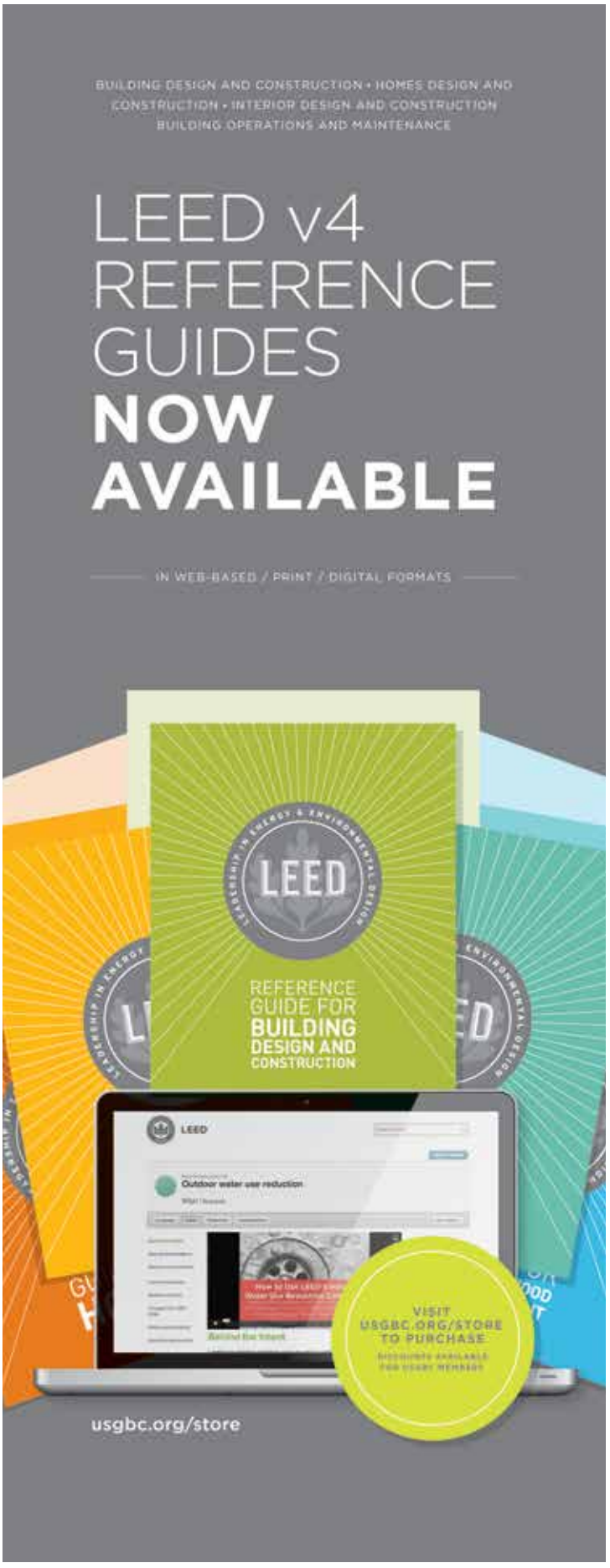
features

Mural on the theme of global warming, 2007; acrylic on foam board; Courtesy Michael Coyne

LEED ON

LEED impact categories

departments



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TRANSFORMING OUR BUILT ENVIRONMENT

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CURRENT LEED STATISTICS

AS OF JULY 8, 2014

Total commercial LEED projects globally ▶ **65,356**

CERTIFIED: **24,133**
REGISTERED: **41,223**
LEED FOR NEIGHBORHOOD DEVELOPMENT: **395**

Gross square footage of LEED projects ▶ **12.0 billion**
Includes LEED-certified, LEED-registered

LEED for Homes Units ▶ **155,837**

CERTIFIED UNITS: **57,792**

LEED ON

"It is our responsibility to take everyone forward."

– Shri Narendra Modi, Prime Minster of India

CONGRATULATIONS, SHRI NARENDRA MODI.

New India Prime Minister Shri Narendra Modi has captured the hearts and minds of Indians, winning on a platform focused on job creation and economic growth.

The U.S. Green Building Council (USGBC), developer of the LEED (Leadership in Energy and Environmental Design) green building program understands that a compelling business case is a critical step toward growth. USGBC is investing extensive time and resources in India. India is already the world's third largest market for LEED outside of the U.S. Together, USGBC and Shri Modi's administration have the power to grow that market even further.

LEED and the green building industry are responsible for tens of thousands of jobs, economic growth, savings and reduced impact on the environment, which means healthier and happier citizens and families.

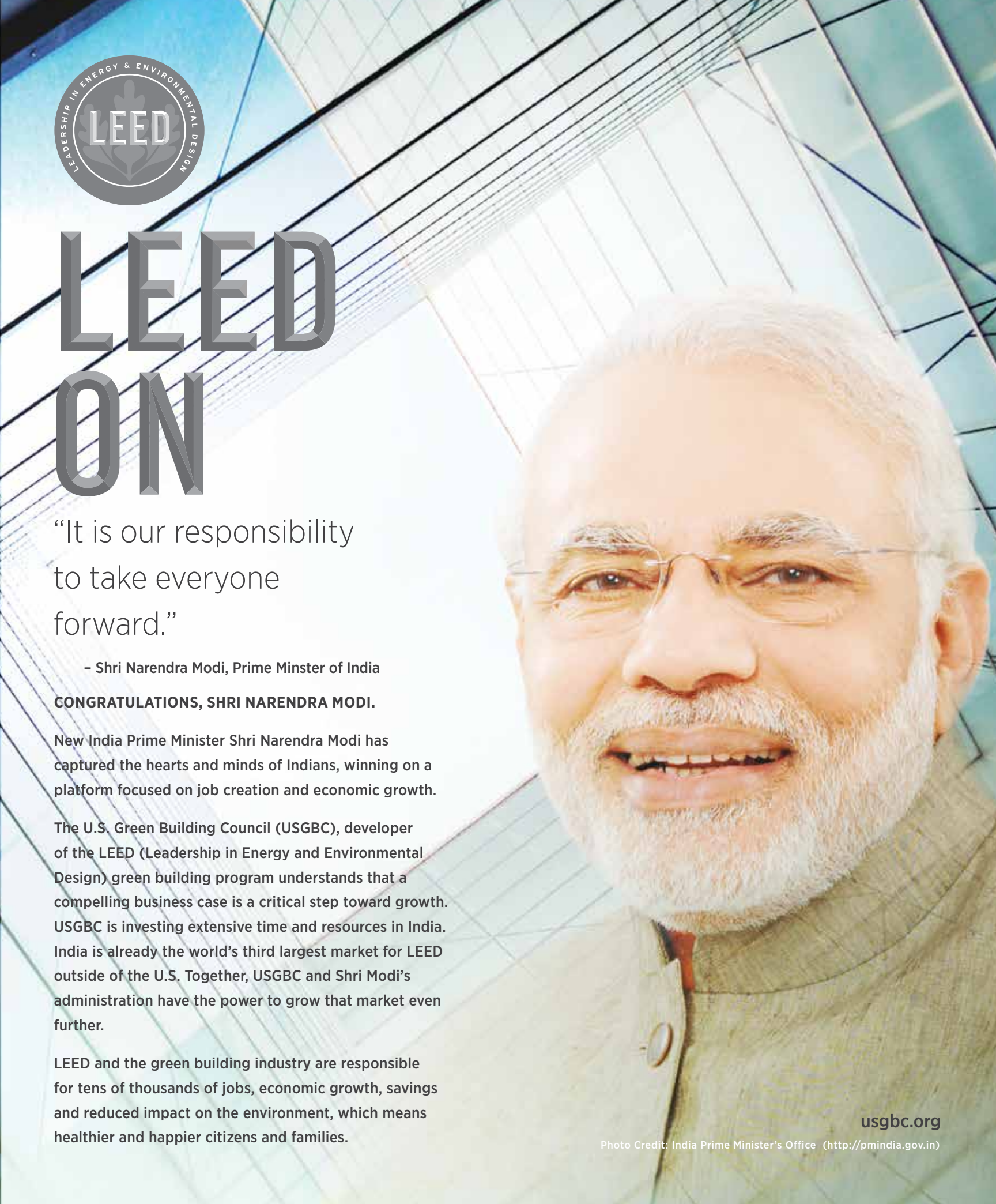

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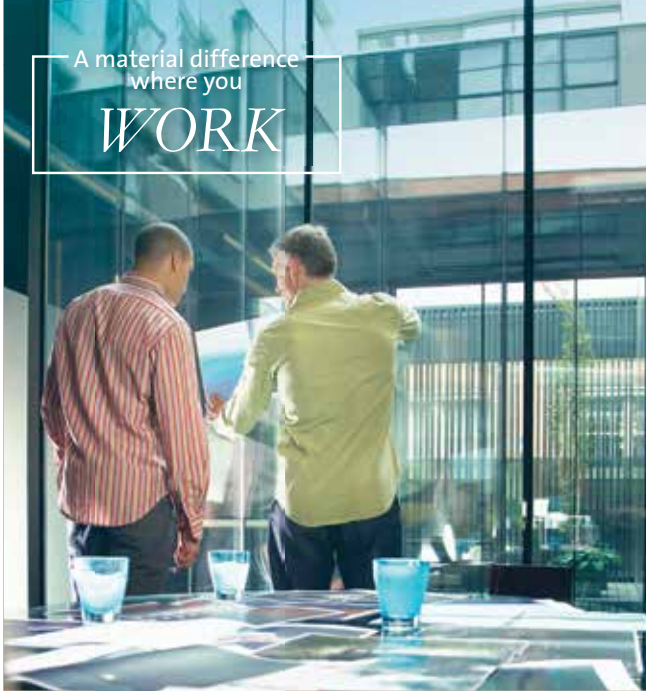
Photo Credit: India Prime Minister's Office (http://pmindia.gov.in)



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Time to **Roll Up** Our Sleeves

Photo: Chip Somodevilla

"The green building community is **catalyzing meaningful change** for our environment and our future, and **your work** is more important than ever."

Gina McCarthy
Administrator
U.S. Environmental Protection Agency

I recently visited Salt Lake City's Public Safety Building, one of the largest net-zero buildings in our nation. That tour reinforced for me that the buildings where we live, work, and play have a profound impact on our health and the environment.

The way we heat, cool, and light our buildings contributes to climate change—and climate change supercharges risks not just to our health, but also to our communities, our economy, and our way of life. President Obama calls it one of the greatest challenges of our time.

That is why earlier this summer, the U.S. Environmental Protection Agency proposed carbon pollution standards for existing power plants, the single largest source of carbon pollution in the United States. The EPA's action is designed to turn climate risk into business opportunity, to spur private sector innovation and investment, and to build a world-leading clean energy economy.

The U.S. Green Building Council and its members have been at the forefront of solutions to combat climate change, reduce energy consumption, and reduce health risks from the built environment. Your work is a great example of the innovation the EPA's proposal aims to encourage.

USGBC knows that a clean environment is a matter of public health and that great design can fight climate change not only by using smart materials and increasing energy efficiency, but also by encouraging physical activity and access to healthy foods. And through programs like the EPA's ENERGY STAR, even existing buildings can significantly cut carbon emissions.

History has shown that we do not have to choose between a healthy economy and a healthy environment. We can—and should—have both. Since 1970, the Clean Air Act has reduced air pollution by 70 percent while the U.S. economy has more than tripled in size.

By prioritizing ideas such as active design, USGBC is promoting buildings that boost vitality, health, and happiness. USGBC members are pushing the design envelope, building gems like the Department of Energy's new Research Support Facility—the world's largest net-zero building.

We cannot solve climate change overnight, but we can take steps toward progress. The green building community is catalyzing meaningful change for our environment and our future, and your work is more important than ever. Let's celebrate our successes, while rolling up our sleeves to tackle the challenges to come. I am eager to see what we can build together.

LEED ON,

Growing Up Net Zero

Hood River Middle School's net-zero music and science building is growing the engineers of the future.

By Rachel Kaufman

If children are the future and conservation starts with them, then it follows that green schools are the future and conservation begins there.

Welcome to Hood River, Oregon, where the Hood River Middle School's new science and music addition, a LEED Platinum building, recently marked another milestone: its third year running as a net-zero building, meaning it produces all the energy it needs on site. The 6,900-square-foot building is a showcase as to what's possible when you think to the future.

Hood River Middle School's main building is 89 years old, and the former music area was a sagging bus barn from the 1940s. When the school board approved $25 million to upgrade school buildings across the district, though, the addition wasn't on anyone's minds.

"We were doing projects at nine different schools and [the board] decided they wanted one project to be LEED-certified," says architect Alec Holser of Opsis Architecture. But a science teacher, Michael Becker, who's been at Hood River MS for 10 years, came to the design charrette—and he brought his students.

"They were the ones who brought up a net-zero energy building," Holser says. "They even helped us identify resources." At the same time, Becker, who was running the school's Food and Conservation Science program—a "green home-ec 2.0," he calls it—was independently raising money for a greenhouse for students to use. That $75,000 got integrated into the new building, which now opens straight from the science lab to the greenhouse to the outdoor gardens.

The new school has an abundance of natural daylighting such as clerestory windows.

The architects and engineers introduced multiple methods to achieve net zero in the building. Shown right is an illustration of some of these sustainable strategies.

Photos: Michael Mathers

The new building is a world apart from the old one—and even from the historic main addition. "Our main building has a giant boiler," Becker says. "On a cold day, you go into the building and it's boiling, and by the afternoon it's freezing, because you can't run the heater all the time or you turn the kids into beef jerky. Kids walk in [to the new building] and recognize with their bodies that it's the right temperature."

That climate control is achieved by radiant heating thanks to a geothermal system that runs horizontally under the school's football field and through a nearby stream, a 35-kw photovoltaic system, and a "solar preheater" that warms fresh air as it enters the building.

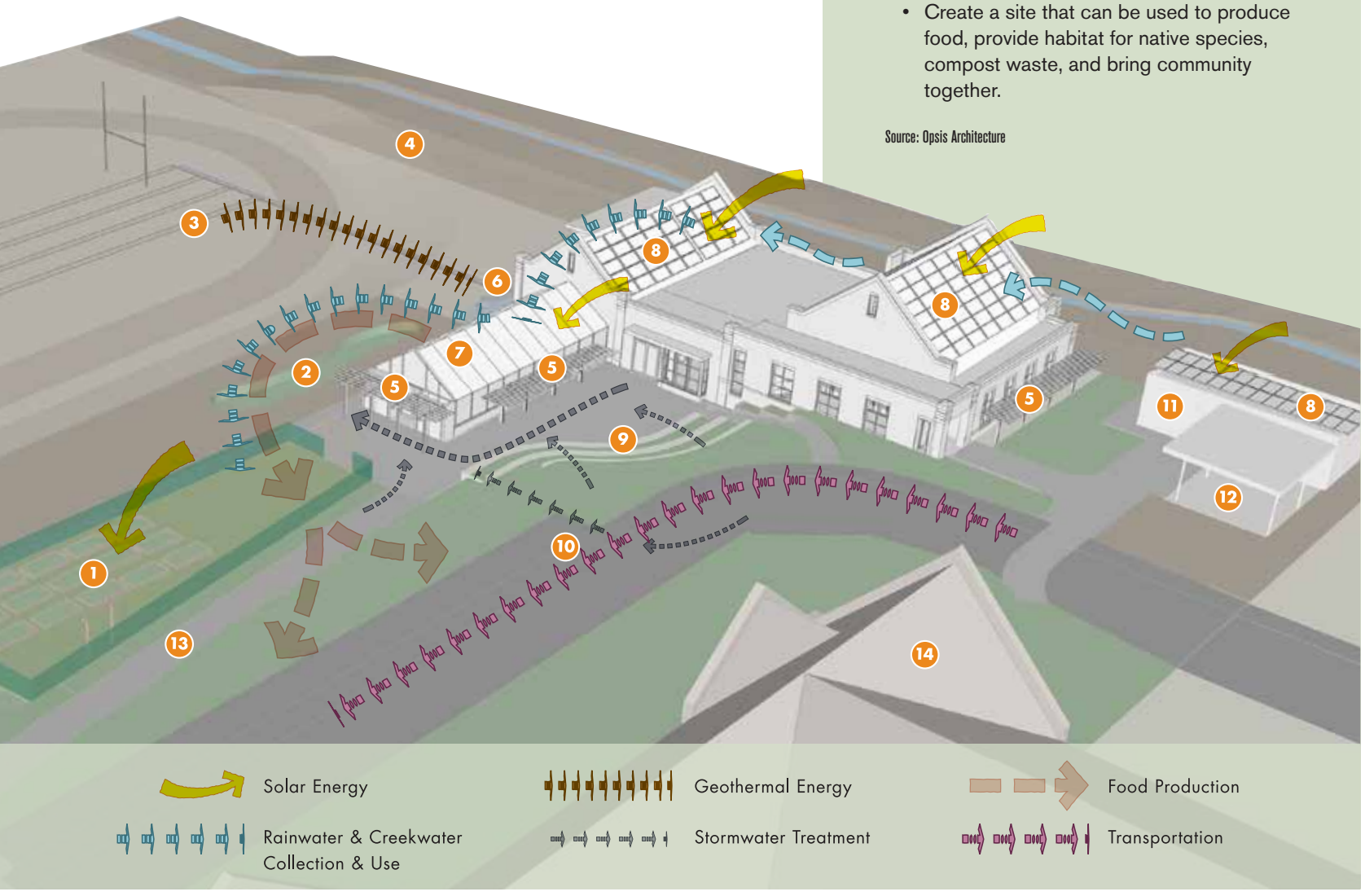
The building also boasts excellent insulation, natural lighting, and a 14,000-gallon tank that collects rainwater to flush toilets and water the gardens. And 90 percent of the bus barn, including old-growth hardwood, was recycled into the new building.

That helped with the new building's aesthetics. The original building is on the National Register of Historic Places. The new doesn't look like a green building. "All the details, the brick walls, the roof shapes, all of these things come from references to the [main] building. People … don't think of it as a green building, which was one of our goals," Holser says. In addition to the LEED certification, the music and science building has been decorated with major awards for its green-ness: an American Institute of Architects Committee on the Environment award and a 2030 Challenge award.

And if that's not enough, the music and science wing is not just a place where students learn, it itself is a teaching tool. "It's not like everything happens down in the basement, and nobody knows what's going on," says Becker. In fact, the mechanical rooms were designed with wide stairs so a class

HOOD RIVER MIDDLE SCHOOL
SCIENCE AND MUSIC BUILDING

1. Garden
2. Bioswale
3. Geo-Exchange System
4. Arboretum
5. Shading Device
6. Water Storage
7. Greenhouse
8. Solar PV Panel
9. Amphitheater
10. Bicycle Path
11. Maintenance / Storage
12. Bicycle Storage
13. Sloped Access Path
14. Historic School



GOAL

Reduce the use of resources and increase environmental awareness through design, construction, and use of the building and grounds.

Methods

- Create a net-zero energy building that uses no more energy than it creates through efficient building systems and responsible use of resources available on the site.
- Create a building that teaches sustainable concepts and systems.
- Reduce impact on the water cycle.
- Reduce use of building material through the use of recycled and reused materials.
- Create an environment that is conducive to health and learning by making good use of daylight, acoustical properties, and natural ventilation.
- Create a site that can be used to produce food, provide habitat for native species, compost waste, and bring community together.

Source: Opsis Architecture

Through the Outdoor Classroom Project, Michael Becker connects students to the environment and community, creating a multidisciplinary, multisensory learning experience.

Photo: ©Adam Smith

of students could all see what was going on; wall cross-sections are visible so students can learn about insulation, and seventh and eighth graders maintain and redesign the systems.

"We worked closely with [Becker] and the students to come up with systems they could actually control and understand," Holser says. "I think there's a lot of buildings that say they do that, but all they do is have a display in the lobby that says 'Here's the amount of energy you're using.' We have one of those, too, for the general public, but the students kind of ignore the display—but they can tell you everything about the building and how it works, and they can go online and show you how much energy it's using."

"We have a lot of college professors come to do tours," Becker says. "They think they're going to do the tour with me, but they get the tour from eighth graders and it blows their mind."

Building a LEED Platinum addition—and then going to net zero—wasn't cheap. "There was a concern about the cost," Holser says. But ultimately the school board saw the value.

"We had the chance to do something unique and different … We are housing a program that has a lot of momentum behind it … And then yeah, we're looking at a 12-year payback on the extra money we spent." With no electric bills for the life of the project, the county should be sitting pretty for the building's probable 100-year lifespan.

Ultimately, though, the building is growing a new generation of conservationists—and not just kids who grow up to shop organic. The curriculum, which integrates conservation and food production into science, is growing budding engineers. "We're working now on developing an environmental engineering certification," Becker says. He adds, "By the time the kids are eighth graders, it's amazing the level of ownership they have. They show up wanting to work on the building—knowing that the first thing I'm going to say is you have to make scale drawings and do your background research—I have a lot of kids show up with that work done over the summer. It's like, 'How do I get to work?'"

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Desert Mindset

The University of Arizona at Tucson campus takes the RainWorks Challenge.

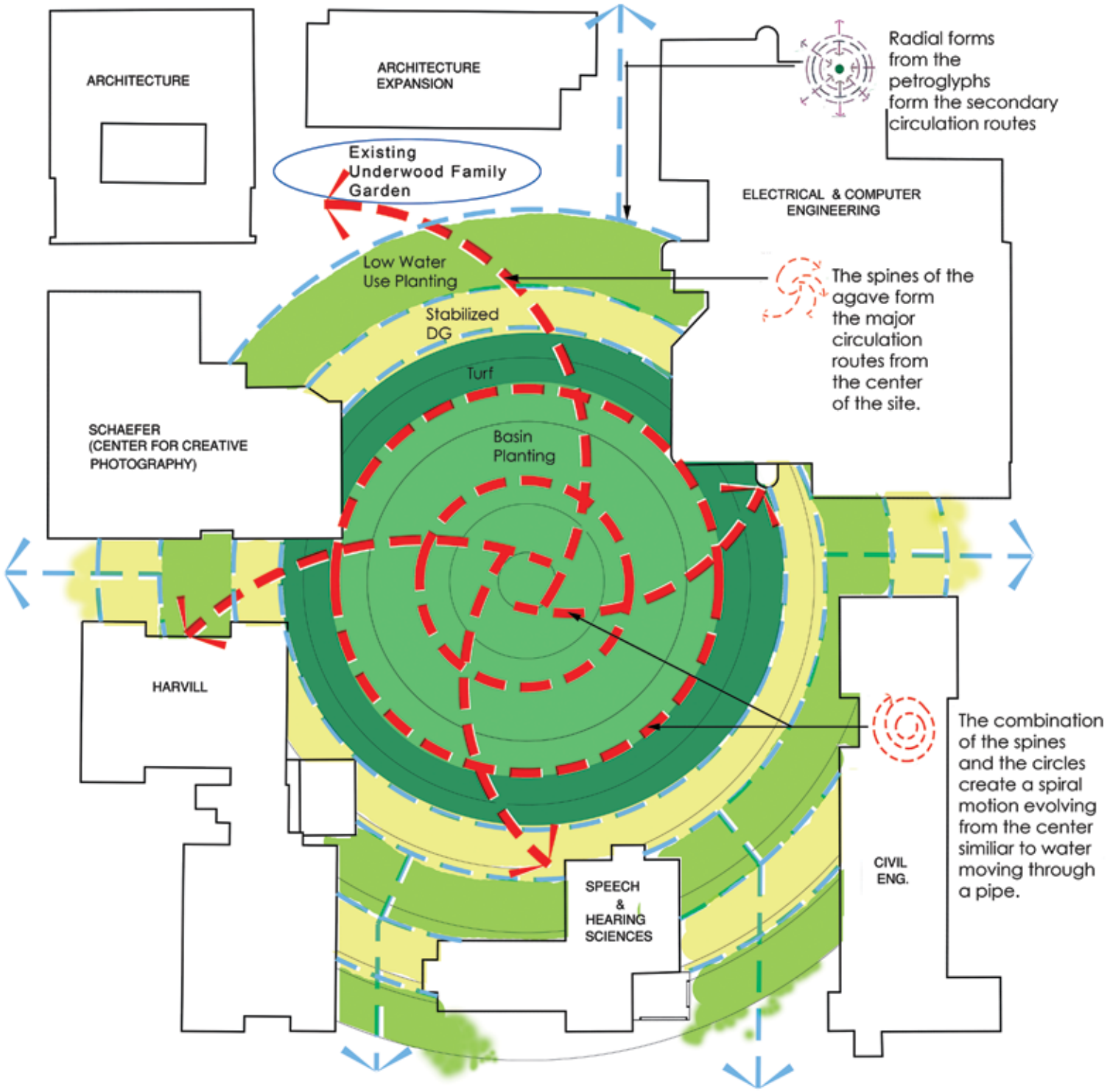
By Jason T. Berner

Tucson receives 12 inches of rain a year, and much of that rainfall evaporates or "evapotranspires" through its plantlife. Future climate change scenarios going out to 2099 expect increased temperatures will likely reduce snowpack, which will impact streams in the spring by reduced surface water runoff entering streams, according to the EPA. And with future amounts of precipitation projected to decrease during the spring, available water resources to meet high summer demands of a growing population will be reduced. Also, with limited existing surface water and future projections of decreased precipitation for Arizona, it makes sense that universities, such as the University of Arizona at Tucson, focus on water conservation efforts using rainwater, gray water, and condensate collection systems.

The university has a recent history of designing and building sustainable landscapes that conserve limited water sources, including the Sonoran Landscape Laboratory, which uses 83 percent less potable water than similar Tucson landscapes. Sonoran Landscape Laboratory landscape architecture professor Ron Stoltz has

Sustainable landscape projects at the university have influenced the city, which now has a municipal rainwater-harvesting ordinance, requiring 50 percent of water used for irrigating landscapes to originate from onsite sources.

Photo: Bill Timmerman. www.billtimmerman.com



provided 3,000 tours annually, teaching community members about capturing rainwater from rooftops, collecting water from air conditioning units, and reusing gray water from drinking fountains for arid landscapes. Tucson and the University of Arizona have a mindset for water conservation and always look for ways to limit the use of turfed landscapes.

In 2012, the EPA announced the first annual Campus RainWorks Challenge, a design competition open to all universities in the United States to submit green infrastructure designs for their campuses. Design teams were composed of students of various academic backgrounds, including engineering, landscape architecture, urban planning, and environmental sciences, mentored by a faculty advisor. The competition was intended to encourage students and faculty to think creatively about how to manage stormwater runoff using green infrastructure, including green roofs, permeable pavement, cisterns, and bioretention practices for their campuses.

Stoltz and students from the master of landscape architecture program, Micaela Machado and Rayka Robrecht, redesigned an existing 70,000-square-foot parking lot (equivalent

Renderings: Micaela Machado

to the size of one-and-a-half football fields) into a community gathering place—which includes underground cisterns that collect condensate water from nearby buildings and retention basins. The green space design will be the second largest on campus. Parking spaces lost will be replaced with parking garages located throughout the campus. The design's intention was to educate the public about the use of rainwater and water conservation—for example, water collected by the cisterns for irrigation would reduce normal annual irrigation needs by 87 percent (610,000 gallons saved).

The students approached the design problem in multiple layers, including engineering, ecological, social, education, and horticulture, creating an integrated design. The design mimics the forms of a storm and an agave plant, highlighting the movement of water. In 2013, the University of Arizona's design was awarded second place for large academic institutions, being the only winning design for an arid landscape. The design also won an Arizona State American Society of Landscape Architects award for integrated water conservation practices. For these types of landscape projects, Stoltz has found it

The University of Arizona has a recent history of designing landscapes that conserve water resources, such as the Sonoran Landscape Laboratory that uses 83 percent less potable water than similar Tucson landscapes.

Photo: Bill Timmerman. www.billtimmerman.com

important to engage campus facilities staff early on in the process. Implementing a sustainable landscape project requires help from staff who are aware of existing sources of water from buildings. Facilities staff found alternative sources of existing water for the design project. And by involving them with water conservation projects, this helps to ensure annual maintenance happens, notes Stolz.

"We often work with a large number of design constraints such as budget, fire lane access, and existing utilities, which makes it difficult to envision anything past what is in front of you. A student competition affords students an opportunity to design without someone saying, 'You can't do that.'" Stolz will continue to use the Campus RainWorks Challenge as a design project for the master of landscape architecture students, making students solve real-world and local water conservation problems. For instance, sustainable landscape projects at the university have influenced the city, which now has a municipal rainwater-harvesting ordinance, requiring 50 percent of water used for irrigating landscapes to originate from onsite sources.

Students participating in this challenge increase the intellectual capital of the green infrastructure inside and outside of academia. The design challenge not only highlights how to conserve water in the arid west, but also shows University of Arizona students and staff how universities throughout the country adapt similar technologies under different climates. For the second annual competition, universities had the option to design master plans or site plans. This year, the EPA plans on funding implementation of selected site plan projects from the competition.

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Healthy Approach

With sustainability and community in mind, Gundersen Health System strives for zero energy this year.

By Karen Aho

When designers talk about healthy buildings, they often focus on interior considerations: air circulation, light, temperature, and maybe energy efficiency as it translates to lower customer costs. Gundersen Health System takes a broader view. The physician-led nonprofit, which includes a leading teaching hospital, trauma center, and dozens of community clinics in Wisconsin, Iowa, and Minnesota, didn't think it was right to go green without considering the more far-reaching effects beyond its buildings' walls.

Whether powering boilers or running chillers, Gundersen wanted to develop efficient operations with the health of everyone in mind, and that meant tapping into alternative energy sources. Ideally, those sources would also create local jobs and improve air quality, even for those living hundreds of miles downwind.

"We really take to heart our organization's mission and purpose, to say that we are about the health and well-being of our patients and communities," says Dr. Jeffrey Thompson, Gundersen's CEO. For Thompson, setting a goal of eliminating his health system's dependence on fossil fuels represents a vital step toward improving public health: The byproducts of fossil fuels are known to cause cancer, liver, and kidney diseases; reproductive and respiratory issues; cardiovascular death; and stroke.

Although no small task for any building, reducing energy use is particularly daunting for a medical facility. Hospitals, which continually heat and chill air, burn an average of 2.5 times more energy than other commercial buildings, according to the U.S. Department of Energy. Medical buildings alone are responsible for 8 percent of this country's greenhouse gas emissions. "That's one of the lessons I've learned: how consumptive we are," says Jeff Rich, executive director of Gundersen's energy-efficiency program, Envision.

Rich headed the Gundersen energy audit in 2008 after energy bills were projected to increase by as much as $500,000 every year. In response, the organization decided to reduce consumption and slashed its energy use by 10 percent within six months and by 25 percent within two years. "One day a few of us got to talking and we asked ourselves, What would it take to get the entire hospital to net zero? Would that even be possible? Or economical?" he says.

At the time, Gundersen Health System used an average of some 250,000 BTUs per square foot a year—a typical output for a hospital. By 2013, just five years later, Gundersen

was averaging 150,000 BTUs per square foot and its new hospital, the LEED-certified Legacy Building began performing this past January at a remarkable 115,000 BTUs per square foot, a level many didn't think possible. "I remember the conversation with the Legacy project manager and design team, and they kept asking whether 115,000 BTUs per square foot was a goal or more of a target," recalls Kari Houser, Gundersen's director of construction and engineering. "But we set the goal and we achieved it."

The health network slashed $2 million from what began as a $5 million annual energy bill and partnered with farms and counties to produce renewable energy projects, create jobs, and lower patient costs. By 2013 Gundersen had reduced its carbon dioxide, sulfur dioxide, and mercury emissions by more than half—even while adding facilities.

"We see reducing emissions as part of our mission: to treat and prevent disease," Rich says. "We've really had to have a consistency of purpose to get here."

Gundersen is hardly alone in its desire to incorporate healthy energy use—across the country, hundreds of hospitals have joined the Healthier Hospitals Initiative. But Gundersen has set a high bar, prompting other healthcare facilities to consider and address the public health implications of its operations. Envision received so many requests for information from health systems around the world that it set up a for-profit consulting service.

Setting new standards for energy efficiency was not easy, however. Gundersen boldly set out to achieve net-zero energy use in Wisconsin, a state where winters are long and coal is cheap, making it tough to justify scrapping the fossil fuel

Renewable Sources

In an effort to break free from fossil fuels, Gundersen Health System has partnered with counties and farms in Wisconsin to create local, renewable energy. Gundersen says it is on track to achieve energy independence this winter. Projects include:

A biomass boiler

The largest energy producer in the Envision portfolio is the La Crosse-based biomass boiler, which burns organic wood materials, such as wood chips and forest residue. The process creates steam for boilers that is in turn used for heat, sanitation, and dehumidifiers. The steam also powers a turbine that generates 2.5 million kWh of electricity a year. The biomass boiler is expected to offset 38 percent of the entire health system's fossil fuel use.

Biogas landfill

The biogas project captures methane gas produced by degrading waste at the La Crosse County Landfill. The gas is piped into the Gundersen Onalaska Campus, where it powers engines used to generate heat and electricity. By producing more energy than the multi-building campus needs, the biogas project has made the healthcare site energy independent.

Geothermal heat pump

The geothermal system is comprised of 156 wells drilled under a parking lot to a depth of 400 feet, where the ground remains a constant 48 degrees. A 300-ton geothermal heat pump circulates water throughout the system, acting as a moderator: In winter, it takes energy (heat) from warmed underground water and transfers it to the building; in summer, it takes energy (heat) from the building and transfers it to the water wells. It is the largest energy-saving component, saving 70 to 80 kBTUs per square foot annually.

"We see reducing emissions as part of our mission: to treat and prevent disease."

– Jeff Rich

for a potentially risky unknown. "We're not rich in ocean currents or geothermal springs; other areas of the country are blessed with better sunlight," says Rich. At times, engineers, already understandably conservative when navigating the highly regulated and complex requirements of hospital design, were skeptical. Some projects fell through due to changes in regulatory incentives or when initial savings projections turned out to be wildly optimistic.

A heavily promoted and highly anticipated brewery biogas project, expected to generate 3 million kWh of electricity a year, ended up with unanticipated impurities in the gas stream and had to be scrapped. "When you're working with a technology that's new to you, you have to prepare for the unknown and the unexpected," says Rich.

"Not everything goes as planned, but some things go better than planned," he adds. By harnessing the biogas from a single landfill project, Gundersen powers its entire Onalaska campus, making it the only energy-independent multi-building healthcare complex in the country. A geothermal heat pump at the Legacy Building is alone expected to save 70 to 80 kBTUs per square foot annually.

Thompson, a pediatric intensivist and neonatologist, hopes that Gundersen's lead will encourage organizations to take more responsibility for the long-range health implications of their energy policies, too often pushed downstream as somebody else's problem. "A lot of things in human health aren't directly measurable," he says. "It's hard to draw a direct line between the coal burned in Ohio and the child affected by the particulates raining down later in Pennsylvania. But we believe it's our responsibility as a healthcare organization to take that issue on and to think as broadly as possible." ●

Left page: (left to right) Jeff Rich, executive director, GL Envision, LLC.; Jeffrey Thompson, MD, CEO, Gundersen Health System; Kari Houser, director of Construction and Project Management, Gundersen Health System; Alan Eber, manager, Gundersen Facilities Operation, Gundersen Health System.

Photos: Gundersen Health System

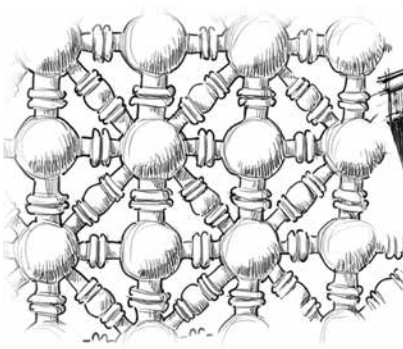
Twin wind turbines
Two twin-turbine wind farms in rural Wisconsin, one built in partnership with an organic farm cooperative, produce about 5 megawatts of electricity apiece, enough to power a combined 2,600 homes. The electricity is sent to the grid and sold to homes and businesses. The project offsets about 13 percent of Gundersen's energy independence goal.

Dairy manure digesters
Scheduled to begin this year, the GL Dairy Biogas Project, a partnership with Dane County and three family farms, will use manure from more than 2,000 cows to generate an expected 16 million kWh annually, enough to offset 14 percent of Gundersen's energy needs. Captured in airtight digester tanks and heated to 100 degrees, the dung decomposes and produces methane, which is trapped and burned in a generator to create electricity.

Solar power
Installed in 2008 on the La Crosse site, solar panels atop an entry ramp power most of the underground garage's lighting, making it the country's first LEED-certified parking garage. Solar hot water heaters installed in 2010 at a La Crosse campus daycare and in 2012 at an Onalaska renal dialysis center meet most of each building's hot water needs.

Bioclimatic DESIGN

Architects around the world look to the past to introduce bioclimate strategies in designing greener buildings.



WRITTEN BY **Alison Gregor**

Some of the best new green buildings are those that challenge our ideas of conventional architecture—but don't challenge the environment. Building designs that embrace and respond to the local environment, called bioclimatic architecture, as opposed to trying to thwart nature with mechanical systems, are seeing a 21st-century revival.

Much of the world's architecture, prior to the 20th century, responded to the regional climate and could be considered bioclimatic. "If you look at older buildings, you see that people were very good at adapting to climate to get the maximum performance, but we kind-of got lazy once air conditioning and electric light came along at the turn of the last century," says Patrick Leonard, the director of Paladino and Company, a green building consultant based in Seattle.

Over the course of centuries, builders around the world had refined different types of bioclimatic architecture, particularly in regions such as North Africa, the Middle East, Southeast Asia, and Europe. For instance, the traditional Spanish hacienda design uses thick, thermally dense walls to retain heat or chill, thereby regulating temperature and creating a stable indoor microclimate, says Sam Kimmins, the principal sustainability advisor for the Forum for the Future, a global sustainable development organization based in London.

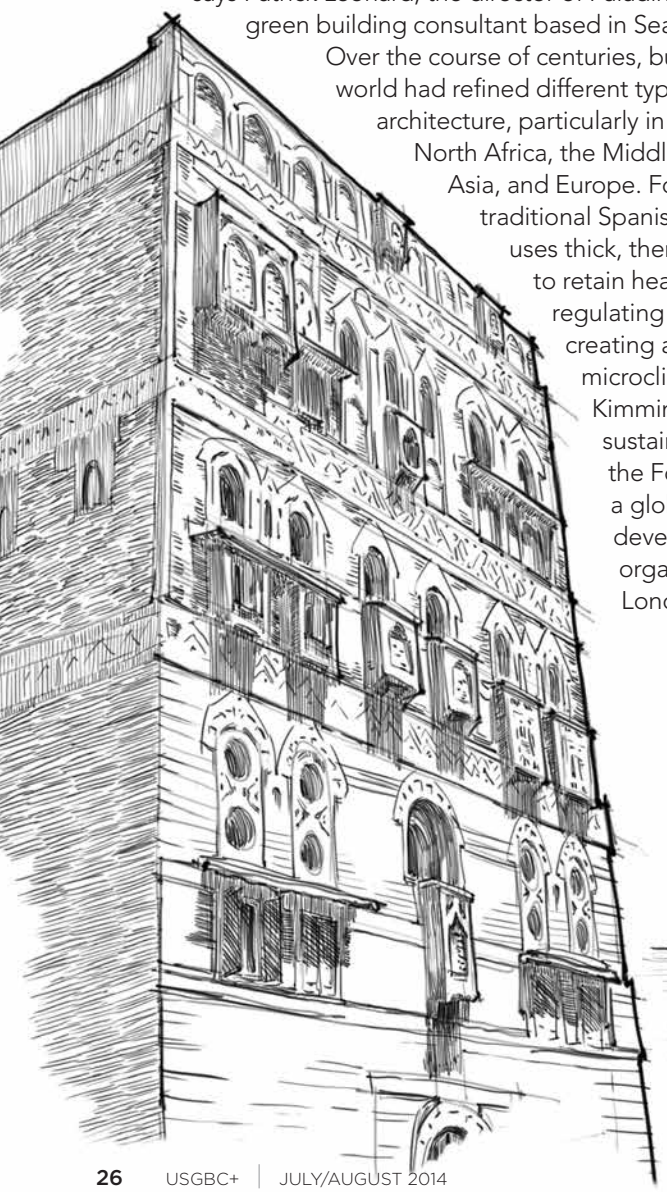
The haciendas have "small windows to reduce solar gain, or overheating, to the south, and larger windows to the north to bring in light," he says. Similar thick-walled structures are found in ancient Greece, Yemen, and other regions.

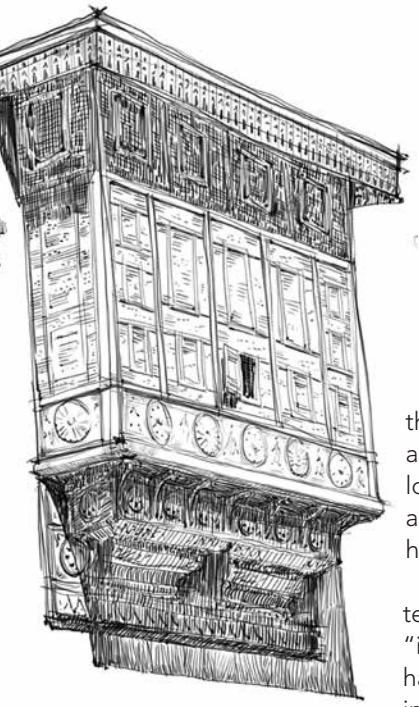
Leonard pointed to the traditional high-peaked, curved roofs in China and Japan, developed to control stormwater and snow, as well as the indigenous architecture of Hyderabad, Pakistan, which has a structure designed to capture winds and channel air flow for natural ventilation.

Sod houses built by Scandinavian and Nordic cultures hundreds of years ago were some of the first bioclimatic structures to integrate vegetation, says Bruce Dvorak, a professor in the Department of Landscape Architecture and Urban Planning at Texas A&M University. "With stone and timber and other supporting materials, the sod formed the bulk of the walls and insulated the house," he says. "Live sod was also placed on the roof. The living sod on the roof shaded the building during the summer and insulated the house during the winter."

By the late 19th century, much of the world's architecture had evolved to use characteristics of the building site and building fabric to create a comfortable internal environment, Kimmins says. Some tactics used were air flow across ponds to create natural cooling; plantings to create shading; a stack structure to bring about natural ventilation; or orienting rooms in different directions and adapting window sizes to regulate temperature.

With the advent of modern technology in the 20th century, contemporary design trends shifted away from being responsive to natural conditions and emphasized instead isolating buildings from nature to try to overcome those conditions. The evolution of technologies to thwart nature wasn't necessarily a bad thing, Leonard says.





"I think it's a great innovation that we don't have to be climate-adaptive, because it opens up a lot more of the world for trade and commerce and just being habitable," he says.

Still, the evolution of new technologies and spread of "international style" architecture have created situations where, for instance, the glass office towers so popular in Western cities are built in desert climates that turn them into greenhouses. In some instances, there are even so-called "green" buildings constructed that have little or no responsiveness to the environment.

One of the latest trends in architecture is to use new technology to enhance, amplify, and measure the performance of traditional bioclimatic techniques.

"I think now we're more focused on resource conservation and using what's locally available, so we've got an opportunity to take the best of both worlds—in other words, how do we apply new technology to help us climate adapt?" Leonard says.

One example is a case of biomimicry in Harare, Zimbabwe, where a mid-rise building without air-conditioning was designed to stay cool with a termite-inspired ventilation system. Scientists digitally scanned termite mounds to map their architecture in three dimensions, and then architects and engineers applied the acquired knowledge about tunnels and air conduits to create a blueprint for self-regulating buildings for humans.

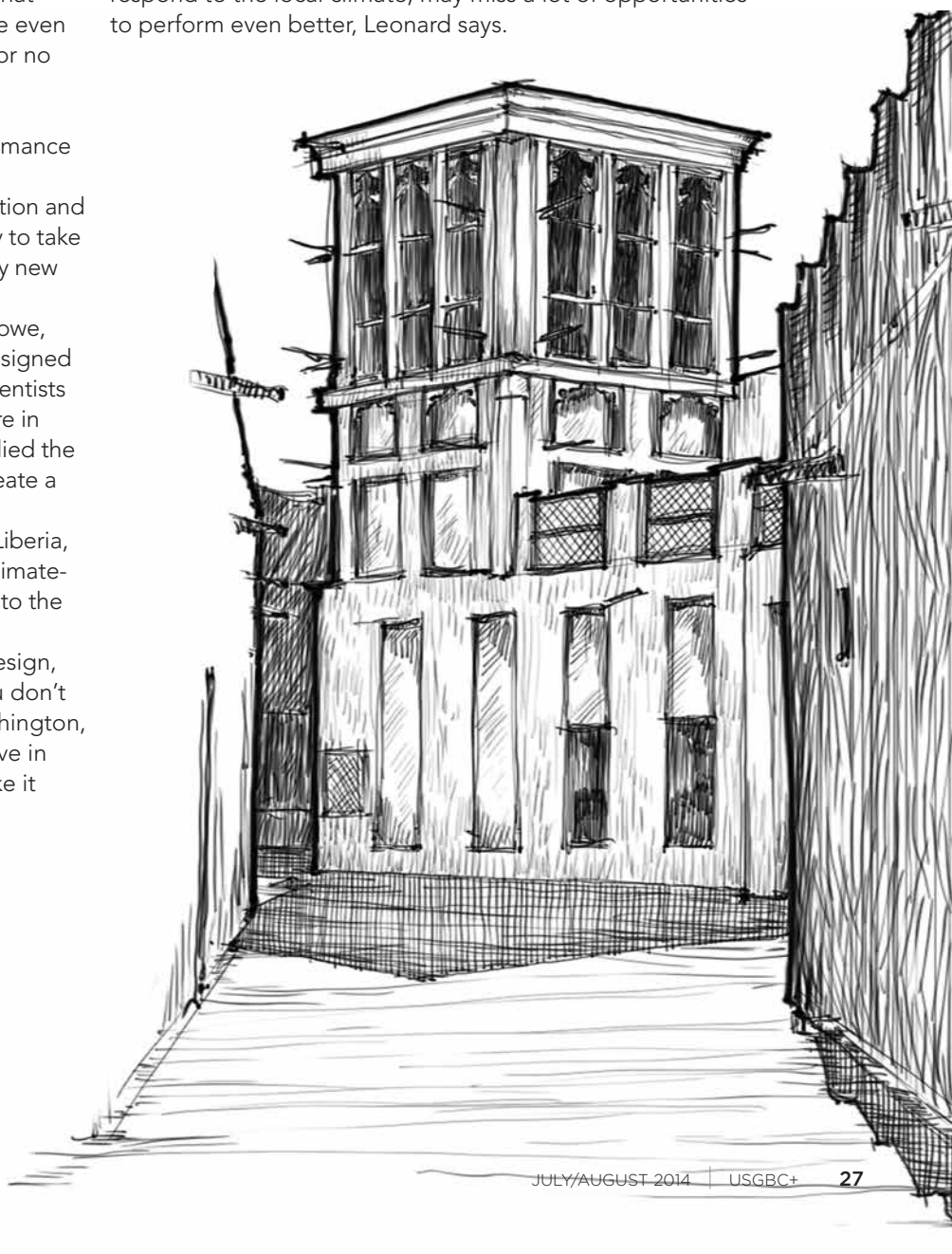
Another recent case is the U.S. Embassy in Monrovia, Liberia, which could have been an example of the worst kind of climate-blindness, but instead the government chose to respond to the local climate in modifying its typical building prototype.

"The Department of State has a standard embassy design, which can be deployed anywhere in the world, but if you don't adapt it for climate, you're basing your design off a Washington, D.C., building," Leonard says. "So it was a really big move in Monrovia to take this standard embassy design and make it climate-appropriate and responsive to the location."

The embassy, which is LEED Gold, is located in a hot, humid, high-rainfall location, so it uses waste heat for cooling, rainwater for drinking water, and extensive photovoltaic electricity generation to enhance energy security.

"With fairly minimal modifications, you can make the building way more efficient," Leonard says. "Even things as simple as, while you insulate the wall cavity in Washington, D.C., in Monrovia we've found if you use less insulation in the wall, you get a more efficient building, because you don't want to retain any heat."

So even a "green" building, if it fails to recognize and respond to the local climate, may miss a lot of opportunities to perform even better, Leonard says.



Renderings: (left to right) Traditional architecture in Sana'a, Yemen; a Scandanavian sod-roofed house; a mashrabiya and detail of the wooden screen; a wind tower from Al Bastakiya in Dubai.

Renderings: MGLM Architects. www.mglmarchitects.com

The sand dunes of the Algerian Desert served as inspiration for a new government building to be constructed in Northern Africa. Though the nine-story office building, which will serve as the headquarters for the *Autorité de Régulation de la Poste et des Télécommunications*, is in coastal Algiers, somewhat removed from the Algerian Desert, Mario Cucinella Architects of Bologna, Italy, studied the local climate carefully in designing the structure.

The three-sided, dune-shaped building is serving both as a cultural and geographic emblem of Algeria, but also as a prime example of bioclimatic architecture. The building's slightly concave southeastern side scoops up cool, fresh winds from the Atlas Mountains while the its convex sides to the northeast and southwest serve to deflect hot winds blowing from the direction of the sea, said Alberto Bruno, who handles environmental design at Mario Cucinella Architects. Office windows designed to be open enable the building to breathe, and warmer air rises and exits at the top. "The shape of the building was derived and defined according to wind analysis to get the maximum natural ventilation for indoor and outdoor spaces," Bruno says.

Another influence on the shape of the building was a desert structure used in antiquity in many arid parts of the world, called a tu'rat, Bruno says. These crescent-shaped structures, made of stones piled without mortar, captured moist winds and fog, which created condensation that percolated down to irrigate protected gardens.

"In the early morning, you can collect a little bit of water, and this allows you to grow plants," he says. The tu'rat-inspired structure includes the enclosure of a small oasis of palm trees and other vegetation on the south side of the building.

In a region where summer temperatures regularly reach 95 to 104 degrees Fahrenheit, the evaporative systems help to keep the air in the oasis comfortable and cool, a natural passive cooling technique frequently seen in the traditional architecture of Arab countries, Bruno says. "They designed buildings that were able to catch hot and dry winds, humidify air by evaporating a small amount of water, and provide fresh air without any other technology. You can cool the air by five or six degrees. Without needing to use energy or chillers, they were able to make a comfortable space in a very hot climate."

Above: Mario Cucinella of Mario Cucinella Architects in Bologna, Italy.
Photo: Luca Maria Castelli

Right: ARPT building during a dust storm.
Rendering: MIR, Engram Studio

The sand dunes of the Algerian Desert served as inspiration for a new government building to be constructed in Northern Africa.

Besides its structure, the second important bioclimatic feature of the building is its skin, Bruno says. "The southwest and northeast facades are like screens," he says. "They are made of crossbeams and perforated panels, and this system allows us to use shading to reduce by 80 percent the solar radiation with the facades, so it's very effective."

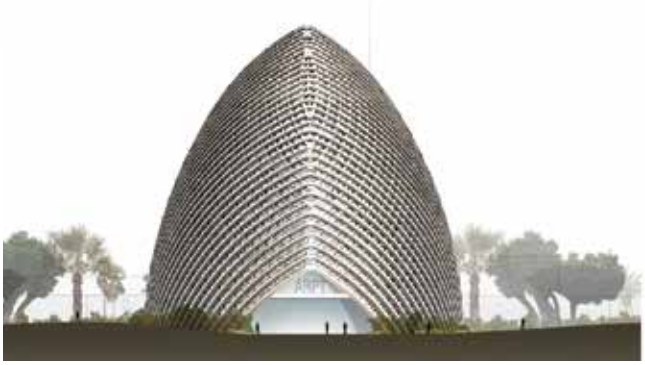
Besides reducing the risk of overheating in the summertime, the facades also serve as a reminder of the regional culture. "The facade is similar to a mashrabiya, a traditional Arab screen, so we tried to make something that is very empathic with the local culture, something connected with the people," Bruno says.

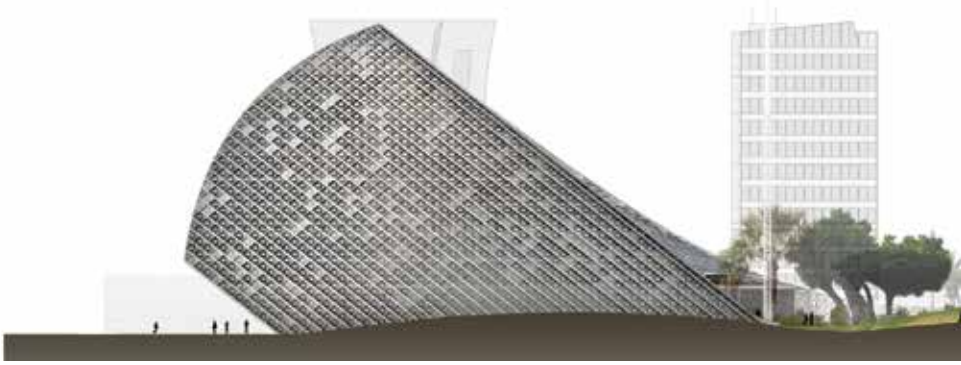
The building's southeast facade has photovoltaic panels that power the air conditioning. The panels are integrated into louvers that serve to shade the building's interiors, while a generous-sized hole in the facade creates a canon lumière, or lightwell, allowing sunlight to tunnel into the building's interior down to the ground floor. The lightwell will be angled so that, for warming purposes, solar radiation penetrates the building from the autumn equinox until the first day of spring, but is deflected

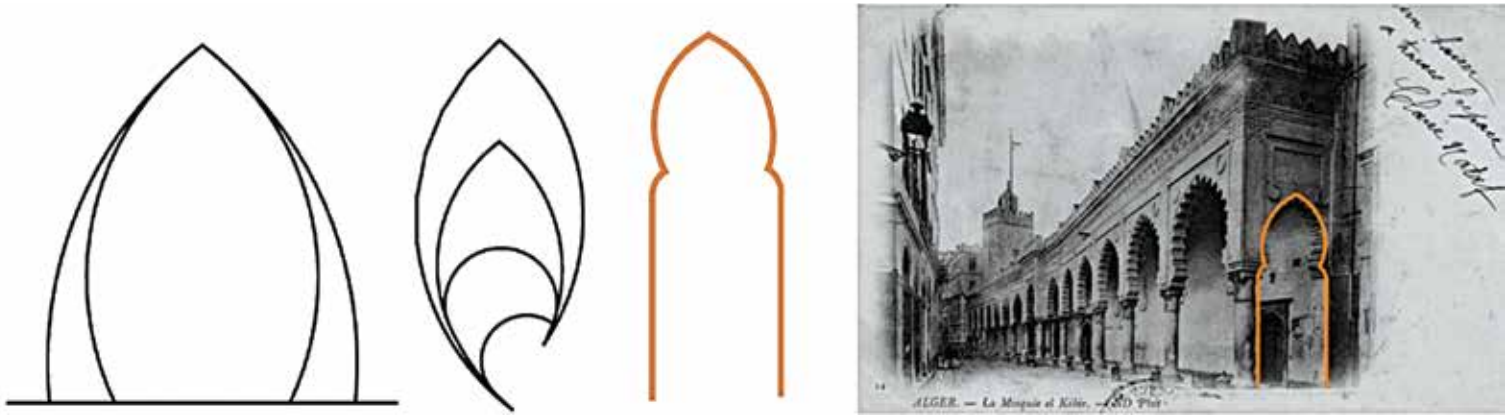
STRUCTURAL SHELL

FLOORS

INNER SKIN





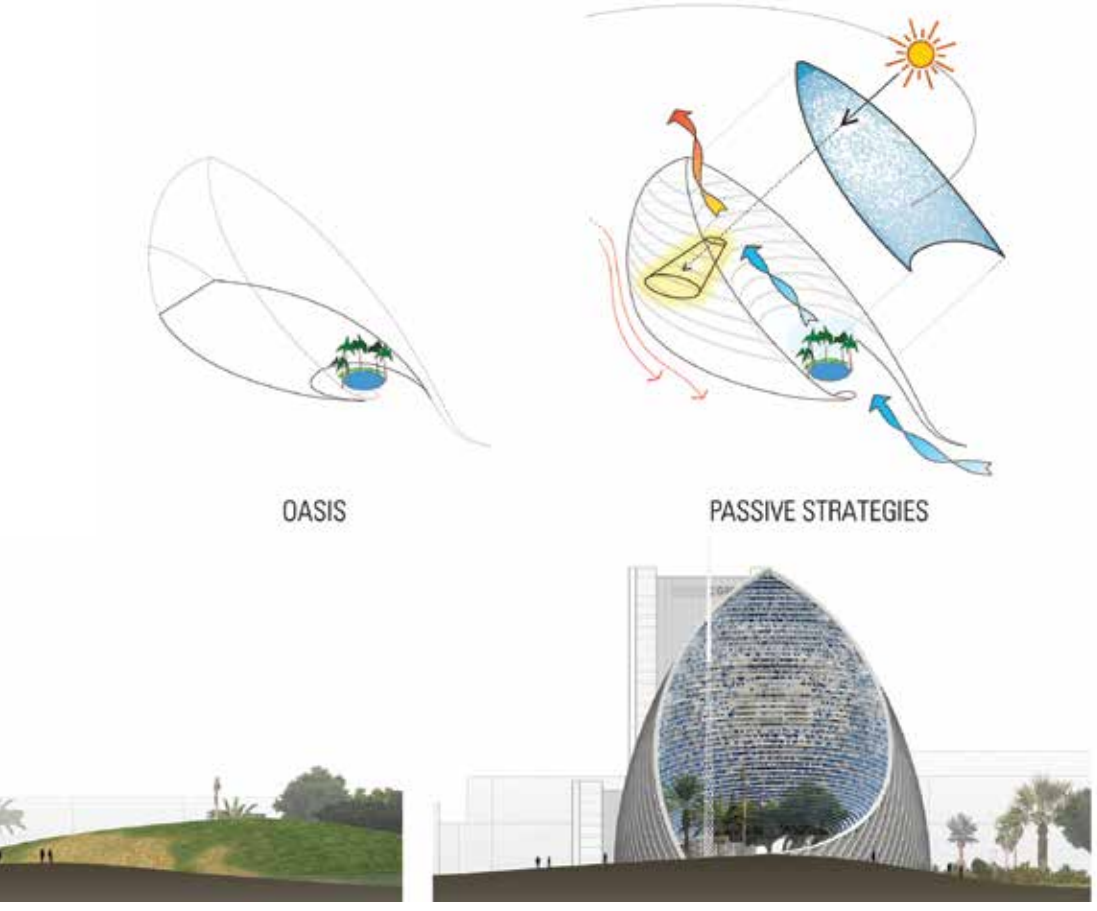


during the summer months to keep the building cooler, highlighting the deep connection between the building design and the local climate.

The building will cut energy consumption by 79 percent compared to a standard Algerian office building, Bruno says. Through the use of rainwater collection and phytopurification (a constructed wetland), potable water demand should be reduced by 77 percent, which is critical in a desert, he says. "We've just finalized the schematic design and, thanks to a thorough optimization, the building is performing better than we originally thought."

While Bruno says he couldn't yet comment on the total project cost, construction is anticipated to begin in 2015. Architects continue to analyze the building's predicted environmental performance, though it's safe to say that any bioclimatic strategies they use are above and beyond what is required in Algeria at the moment.

"In Algeria, they're still working on regulations related to sustainability, energy and the environment, and also some tools to evaluate building performance," Bruno says. "We've been told in the next few years, they'll have these regulations."



Images above and left: The building was conceived as an icon where tradition and modernity, both in form (derived from the pointed arch typical of Mediterranean architecture and the incline of the solar diagram) and in the treatment of the surface of the envelope.

The project emerges from the desire to create a building that works according to the principles of bioclimatic architecture, and in particular by the natural cooling techniques of the past, such as the tu'rat, has suggested an aerodynamic shape, convex on the North to divert hot winds at midday, and concave to capture the cool breezes at night, and thus promoting the natural ventilation of the building.

Renderings: MIR, Engram Studio

Rio Branco 12 is set to be one of the most sustainable buildings in Rio de Janeiro. The sustainable strategies include bioclimate facade, solar, and fuel cells.

Immersed in the heat and humidity of the jungle and the sea, an old building in Rio de Janeiro is being completely rejuvenated using bioclimatic and other green strategies to transform it into one of the most sustainable office towers in Brazil.

The project, called RB12 after its address at 12 Rio Branco Avenue, is a 21-story conversion that began construction in January in Rio de Janeiro's Porto Maravilha district, an area that's undergoing a renaissance of its own with more than five million square feet of redevelopment. Designed by the French-Brazilian architectural firm Triptyque and constructed by Natekko of France, RB12 will have a façade that can be opened to the elements, in contrast to other office buildings in the city that are fully sealed off from the climate.

A façade of double-glazed glass will optimize the use of daylighting with angled windows that should make the building glitter like a diamond, while louvered stainless steel panels control the amount and quantity of sunlight, explained the architects at Triptyque in a joint email response to questions. Suspended gardens integrated into the façade, along with a green rooftop, also help control lighting.

"The building is located in an avenue lined with buildings very closed in on itself," the architectural team says. "The heat tends to stagnate between buildings, and the sun is directly on the windows because of their height."

The glass façade is strategically shaded to reduce the heat gain in the building from direct solar radiation, but is transparent enough to allow high levels of natural light to enter indirectly and illuminate the building. The façade system "allows a reduction in the use of artificial lighting along the walls, and therefore power consumption and internal temperatures are also reduced," the architectural team says.

The building will be the first to use photovoltaic panels for its own electricity production.

Renderings: Triptyque Architecture

At night, the building's windows are opened to provide ventilation and cool down the building.

"The project provides a system for automatically opening windows during the night, which makes it possible to take in the fresh air and keep it all day, thanks to the insulation of the building," the architectural team says.

Though not necessarily considered by purists to be a bioclimatic strategy, a convection HVAC system of active chilled beams will be used to moderate the building's temperature during the day and provide thermal comfort for workers in the building. The primary advantages of the system are lower operating costs.

"The system of chilled beams is becoming a worldwide trend in air conditioning, having been selected by *ASHRAE Journal* in September, 2007, as the best option for ambient air conditioning when considering the optimization of energy consumption and generating a comfortable environment for the user," the architectural team says.

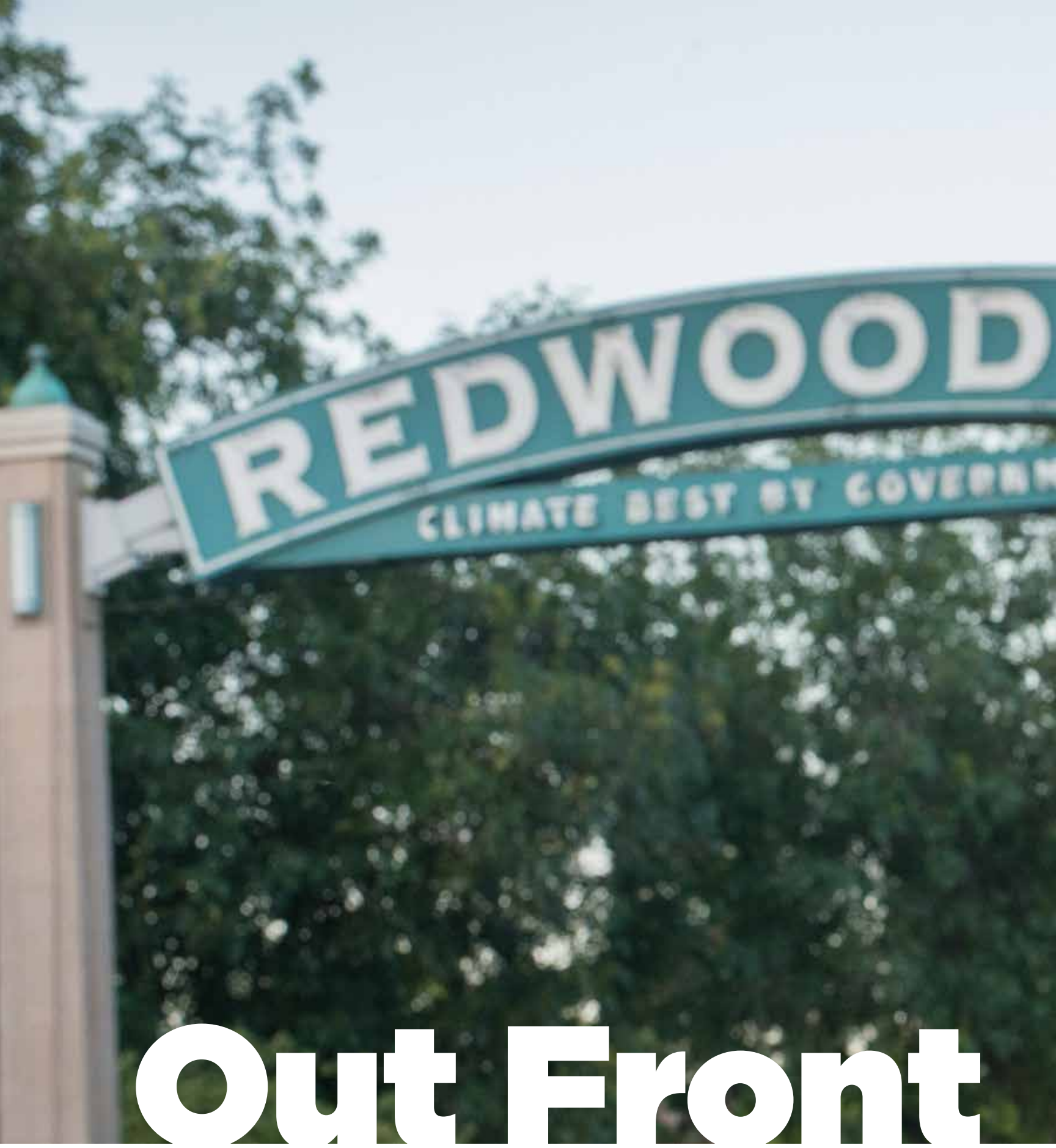
The developers of RB12 claim that it will be the first commercial building in Brazil to use photovoltaic panels, and a small vertical installation will meet about 18 percent of the building's energy demand. The tower will also use a regenerative brake elevator that harvests thermal energy from its braking mechanism. And, subject to the approval of local authorities, RB12 will also incorporate fuel cell technologies to convert excess methane gas from the streets into electricity.

Upon analyzing all the green strategies used in RB12, architects say they estimate the building will use about 60 percent less energy than a typical office building. And since the building will be producing energy 24 hours a day, but consuming it for about eight, excess energy will be sold back into the electrical grid.

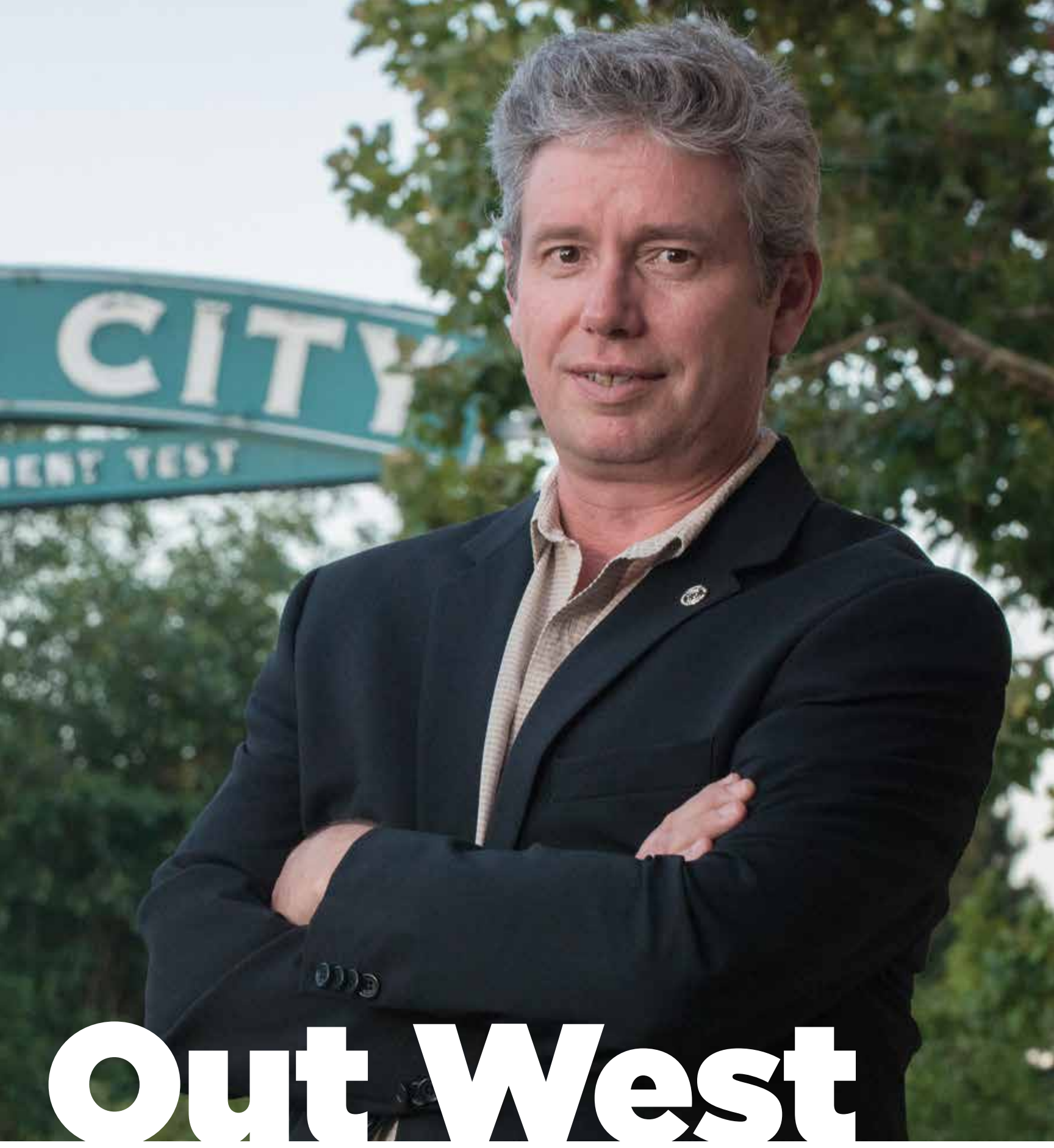
"The law to allow this process is currently under discussion," architects say. "The proposed RB12 is indeed a trendsetter in Brazil, preceding the legislation of the country and generating national changes."

Reduction of water usage is also an objective of RB12, where low-flow faucets will minimize water use, and greywater will be recycled for irrigation of the building's rooftop and green walls. Triptyque architects say that greywater treatment should supply about 60 percent of the building's daily water needs.

The total construction costs of RB12, which is anticipated to be completed by March 2015, will be about 23 million Brazilian reais, or about $10.4 million, architects say. While RB12 will cost more than a conventional office building, "The project was designed to have an extremely short payback," architects say.



Out Front



Out West

As the state continues to experience the effects of climate change, green advocates in California are pushing for increased resource efficiencies through a series of pioneering new laws and regulations—and they're succeeding.

WRITTEN BY **Calvin Hennick**

In early June, in the days after President Barack Obama announced plans to reduce carbon emissions from power plants by 30 percent by 2030, USGBC California chair Dennis Murphy noticed that much of the news coverage surrounding the announcement focused on the location of the speech.

Instead of outlining his executive order from behind a podium or in front of a smokestack, Obama delivered his address from Children's National Medical Center in Washington, D.C., where the president said he was visiting with children who had asthma and other breathing problems. Obama linked their illnesses to air pollution and said that the country needed to reduce emissions, not for the sake of the environment, but "for the sake of all our kids." Instead of reciting statistics about climate change, he talked about creating solar energy jobs that "cannot be shipped overseas." And rather than issue warnings about rising thermostat readings and shrinking ice caps, the president said the new emissions standards would prevent 2,100 heart attacks during the first year of implementation.

Dennis Murphy listened to the news as pundits like Democratic strategist Chris Lehane talked about how Obama's address represented a pivot in the national conversation about the environment. The president could win over voters, Lehane argued, if he succeeded in framing the climate debate in terms of "kitchen table" concerns like energy bills and kids' health.

The argument had a familiar ring to Murphy. "It was stuff that we've been talking about for years," he says. "It's important to understand climate change, but it's complicated, there's a lot of nuance—weather isn't climate." It's easier, Murphy says, for most people to relate to the issue when they've experienced the impacts firsthand. "Last year in Dallas, they had 30 days in a row over 100 degrees," he says. "Just imagine somebody's 85-year-old grandma living alone in an apartment and basically burning up."

A transplant from New Jersey who retains the self-described "zeal of the convert," Murphy is unapologetically boastful about California's environmental record, and so it's no surprise that he gives the state a bit of credit for the president's new political strategy on environmental issues. Innovation, Murphy is fond of saying, is like the wind, blowing from the West to the East—starting in California and then making its way across the rest of the country.

While green advocates in a number of other states might dispute that notion, there's no denying the Golden State's long history of leadership on environmental issues. In 1884, a state judge outlawed the dumping of gold-mining rubble into waterways, a decision that predated the federal Rivers and Harbors Act by 15 years. In 1959, the state developed its own air quality standards, and when the Federal Air Quality Act was passed in 1967, California received a waiver allowing it to enforce tighter emissions regulations than called for by the law. The state is home to the country's first carpool lanes, and passed the first law requiring smog checks for cars.

Even the U.S. Green Building Council itself was founded in San Francisco. The organization is now headquartered in Washington, D.C., but—like the wind in Murphy's metaphor—it originated out West.

Advocacy in Action

In 2010, when opponents of California's landmark Global Warming Solutions Act of 2006 tried to suspend the law, a new-on-the-scene group was there to help fight to protect the legislation: USGBC California. Murphy helped start the statewide group in 2009, giving the California's eight individual USGBC chapters an umbrella organization that could advocate for their shared values in precisely moments like this one. The 2006 climate law created a state cap-and-trade system for carbon emissions, and although supporters conceded that California's actions would have only a very minor impact on a worldwide problem, the legislation was designed to help mitigate the state's outsized contribution to that problem (then-Governor Arnold Schwarzenegger said in 2006 that the state was the twelfth-largest emitter of carbon worldwide).

The 2008 AB 32 Scoping Plan identified several actions to help California reduce GHG emissions from both new and existing buildings. Original estimates indicated that 26 MMT CO2e of emission reductions could be achieved from the green building sector, which represented 15 percent of California's 2020 greenhouse gas emission reduction target.

Executive Order S-20-04 outlined guiding policies that called for reducing electricity consumption in existing and new state-owned buildings 20 percent by 2015, through designing, constructing, and operating all new and renovated state-owned facilities to LEED Silver or higher certified buildings.

The Green Building Action Plan, included in Executive Order B-18-12, provided additional details and specific requirements for reducing greenhouse gas emissions for 2020 to 1990 levels and 80 percent below 1990 levels by 2050. It also includes requirements to reduce grid-based energy purchases by at least 20 percent by 2018, achieve LEED Silver certification for new or major renovated state buildings, retrofit half of existing buildings to be Zero Net Energy (ZNE) buildings by 2025, and implement electric vehicle charging stations to accommodate future infrastructure demand.

Left: 707 Wilshire, reflecting 550 S. Hope and the U.S. Bank Tower.

Photo: Adeeb Howrani. AFHPHOTO.com

Previous spread: Dennis Murphy, Chair, USGBC California.

Photo: ES Creative Photography

LEED Silver property Westin Bonaventure Hotel & Suites in downtown Los Angeles.
Photo: Adeeb Howrani. AFHPHOTO.com

Opposite Page: Dennis Murphy and Jeremy Sigmon, USGBC Director of Technical Policy, in Sacramento, California.

Proponents also hoped that the law would continue the state's tradition of leadership, showing people in other parts of the country that meaningful carbon regulations did not have to signal a death knell for industry.

Although the legislation was a little outside of USGBC's usual green-building wheelhouse, it spoke to the larger environmental concerns that are shared by nearly all of the organization's members. "If this law went away, it almost wouldn't matter what we were doing on more narrowly defined green building issues," Murphy says. "We realized that we needed to be part of a broad coalition."

Murphy set up phone banks where volunteers called USGBC members and urged them to vote against Proposition 23 that would have suspended AB-32, the Global Warming Solutions Act of 2006, requiring greenhouse gas emission levels in the state be cut to 1990 levels by 2020. Ultimately, the proposition was defeated by more than 2 million votes.

While USGBC California was only one of a number of groups fighting against the proposition, the election gave the young organization a chance to test out its fledgling voice on an important statewide issue. Before the state umbrella organization was founded, Murphy says, it was impossible for the different chapters to speak as one.

"A bunch of us would go up to Sacramento, and we would explain what we were doing, and we met with a number of legislators and staffers," Murphy recalls. "And they would say, 'Oh, this is really great, but you guys are the Northern California Chapter. Where's the rest of you?' If you're dealing with state policy, you need a state organization."

Candice Wong, chair of the California Central Coast Chapter, says that the creation of the statewide group has helped connect her small branch, which has no paid staff, to the other chapters in the state. "Instead of all of us individually doing our advocacy, that's what USGBC California was built to do. It's a good thing," she says. "They're much more connected to Sacramento than the rest of us."

"In the past," says Wes Sullens, vice chair of USGBC California, "one chapter would advocate on an issue or bill, and then another chapter would contradict that. So it's been good to have a consistent voice." Sullens calls the organization Murphy's "baby."

"He's got the vision, the history, and sets the tone on things," Sullens says of Murphy. "I think his strength is in pulling the right kinds of advocates together at the right time. If there's a water issue, or an energy issue, he knows the players to pull in."

Since the fight over Proposition 23 Murphy has focused the state organization's efforts on legislative and regulatory battles

"Across the country, nobody has the irrational sense of hope and optimism that we do."

– Dennis Murphy

ranging across a broad swath of issues, from getting health-hazardous flame retardants out of furniture foam and home insulation to ensuring that more recycled water is used to mix concrete for construction projects. Each year, the group organizes an Advocacy Day in Sacramento where USGBC members from around the state lobby legislators on environmental issues. "That's exciting, because legislators realize when we go to Sacramento that we're real people, not just a professionally staffed organization," Murphy says. "That's a big difference. Volunteer-driven advocacy takes extra work, but it's very powerful."

More often than not, Murphy has found himself on the winning side of debates, thanks in part to California's environmentally friendly executive branch. In the same 2010 election in which voters upheld the state's climate law, they also returned Jerry Brown to the governor's office. Brown, who is up for reelection this November, was already a hero to many green advocates for the environmental legislation he championed as governor in the late 1970s and early 1980s, and he's largely picked up where he left off, forcefully advocating for national action on climate change.

At USGBC's Advocacy Day in 2012, Brown announced Executive Order B-18-12 that Murphy and the state organization had pushed for, requiring state agencies to reduce their greenhouse gas emissions and requiring all new or substantially renovated state buildings larger than 10,000 square feet to obtain LEED Silver certification or higher.

"That same year, USGBC California's advocacy contributed to the victory of Proposition 39, which closed what supporters called a tax loophole for out-of-state companies. The proposition changed the way that out-of-state corporations calculate their state taxes, essentially raising taxes on corporations that have high sales figures in California but no physical presence there in the form of property and employees.

The change is expected to generate around $1 billion per year in new tax revenue. For the first five years of the new law's implementation, half of that money is going to the state's general fund, and the other half to the Clean Energy Job Creation Fund which will pay for energy-efficient school building projects.

Currently, Murphy is pushing for the state to pass "purple pipes" legislation requiring new buildings to include infrastructure for utilizing recycled water. "We get involved in a lot of stuff," Murphy acknowledges, laughing. "Across the country, nobody has the irrational sense of hope and optimism that we do."

Above: (left to right) Dominique Smith with Nicos Katsellis and Michelle Saquilayan at the office of USGBC's Los Angeles Chapter.

Right: Being outdoors is central to Californian living; (top) children playing on a swing set in Huntington Beach; (middle) kids at a sand playground in Laguna Beach; (bottom) young boys on skateboards in downtown Los Angeles.

Photos: Adeeb Howrani. AFHPHOTO.com

Healthier Communities

Central to these advocacy efforts has been a focus on the human effects of sustainability, much like the impacts Obama discussed in his emissions announcement. Opponents of environmental regulations have long argued that they result in job losses, but now green advocates are flipping that line of argument on its head—pointing, for example, to the green-energy jobs that will result from the school projects that the new Proposition 39 tax money funds. And instead of pointing out the environmental benefits of these green schools, advocates have largely focused on the health of the kids inside them. This is the dirty little secret that clean energy advocates have stumbled on: People don't need to care about the environment to help save it; they only need to be told what's in it for them.

"If you say, 'Green schools have cleaner air, more daylight, less absenteeism,' people get it right away," says Dan Geiger, executive director of the Northern California Chapter of USGBC.

"The school districts that we're working with are not focused on climate at all," says Ted Flanigan, president of the environmental consulting firm EcoMotion. "They see this new tax money, and they want to not only upgrade their antiquated equipment, but they also want to reduce their bills so more of this money can go into education."

Dominique Smith, executive director of USGBC's Los Angeles Chapter, says she's seen a "huge movement" toward including human health issues as part of environmental advocacy. "When you talk to somebody about a solar panel, or green building, they can sometimes kind of glaze over," she says. "But when you talk about how it affects people —their health, their happiness, their well-being—everyone has a connection to that."

If Californians have been quicker than others to connect climate change and other environmental issues to real-life human impacts, perhaps it's

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>
> – Dominique Smith

because they've long been able to see the evidence of those impacts simply by looking out their windows.

There's nothing theoretical, for example, about the smog that has plagued Los Angeles for decades, and it's not difficult to see how breathing in brown air might turn someone into an environmentalist. Although smog is still a problem, the situation has improved through emissions regulations, a fact that—according to Jonathan Parfrey, executive director of the group Climate Resolve—makes Californians more receptive to further regulation. "We already have a regime in place for dealing with smog, and so it's not too much of a leap for us to take on carbon dioxide," he says. "It's one of those things where, when government succeeds, it gives people confidence in the government to take the next step."

Looking at the data, it seems that those next steps are needed. On the American Lung Association's list of most polluted cities (by year-round particle pollution), the top seven are all located in California. In Fresno County one in six children has asthma. A 2013 MIT study attributed 21,000 early deaths a year to air pollution in California, more than any other state in the country. The San Joaquin Valley is one of four areas the EPA has set as a priority for improving its air quality in the next 10 years. According to the EPA, its strategy includes reducing particulate matter (PM) concentrations by 7 percent annually through regulations to reduce levels by 34 percent next year (compared to a 2009 baseline). If the EPA can maintain the standard, it would prevent 640 PM-related deaths per year.

More broadly, California is experiencing a number of impacts associated with climate change, some of which are outlined in a 2013 state report titled "Indicators of Climate Change in California." Extreme heat events have become more common in recent decades; for example, by the year 2100 there could be one hundred additional 90-degree days in Los Angeles each year; long-term data shows rises in sea levels at 10 of 11 tracking stations along the state's coast; winter chill periods important to fruit and nut crops are shortening; and wildfires have burned up hundreds of thousands more acres in the last decade than in years past.

"We're really beginning to live these impacts," says Renée Daigneault, interim executive director of the San Diego Green Building Council. "The climate conversation in Los Angeles isn't about polar bears and ice caps; it's really about heat, wildfires, our water resources, and sea level rise and storm surge," says Krista Kline, managing director at the Los Angeles Regional Collaborative for Climate Action and Sustainability. "People can see the beach eroding, they can see their cliffs shearing off. They understand it. They see it. They know they have to do something about it."

Smith, the Los Angeles Chapter executive director, gives an even starker example: "If you've never seen a fire tornado, it's really something. I don't think you can put that image out of your head."

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Because of the gradual and complex nature of climate change—and the naturally erratic bounces of weather—it's nearly impossible to tie any specific storm or heat wave to a warming planet. In particular, many people argue that California's current drought is cyclical, a result of normal year-to-year variability in precipitation. But the fact is, these are the types of outcomes one would expect to see as climate change begins to manifest itself as something more readily accessible to average people than readings on Arctic thermometers. And, from an advocacy perspective, it simply may not matter all that much whether specific phenomena are the direct result of climate change. Climate and weather may not be the same thing, but even so, Californians are a lot more likely to listen to warnings about climate change when it's 105 degrees outside, water is being rationed, and a wildfire in the distance is filling the air with smoke.

As the impacts of climate change have begun to be felt, Murphy says, much of the advocacy surrounding the issue has shifted toward a focus on adapting to the reality of a warmer plant—meaning less talk about emissions, and more talk about utilizing resources efficiently.

One example is the ongoing effort to require recycled-water pipes in all new construction throughout the state. Another example is the 2013 Los Angeles "cool roofs" ordinance, which requires new and refurbished homes to be topped with reflective surfaces, keeping houses from heating up too much on sunny days.

Los Angeles is the first major city in the country to require cool roofs, but it likely won't be the last. As other parts of the country start to feel the effects of climate change, they'll likely look to replicate much of what California is doing now. And if they do, the smile on Dennis Murphy's face won't be any mystery: He'll have been proven right again. As with so many times in the past, he'll have watched innovation blow from west to east.

Health and the Built Environment

Last fall, USGBC's Northern California Chapter launched its Building Health Initiative, a partnership of more than 30 businesses, nonprofits, and government entities aimed at reframing green building as a human health issue.

Each partner in the initiative—which includes the state health and retirement benefits agency CalPERS, the healthcare consortium Kaiser Permanente, and companies like Facebook and Google—has pledged to take specific steps like making their own buildings healthier, using their clout to push for healthy building materials and practices, or studying the relationship between health and the built environment.

"We realized there's lots of great people doing great work around health and buildings, but they tend to be siloed," says Dan Geiger, executive director of the Northern California Chapter. "The idea was to get people out of the silos and help them collaborate."

Some of the partners, like Google, have pledged to develop procurement practices that take into account materials transparency and product declarations about health and the environment, to help show suppliers that demand exists for healthy and sustainable products. Adobe is studying its LEED-certified workplaces to determine whether the buildings have an impact on employee health and creativity. Other partners are developing health standards for affordable housing, educating clients about the relationship between health and sustainable building practices, and creating wellness programs for their employees.

"We're talking about everything from toxins to walkable communities," says Geiger. "Once you start talking about health and the built environment, it's a huge issue."

Illustration: Karl N. Edwards. www.karledwards.com

Mission Accomplished

The future of large-scale net-zero buildings is already here.

WRITTEN BY **Judith Nemes** BUILDING FEATURED **Department of Energy Research Support Facility, Golden, Colorado**

Architect RNL Design | **Contractor** Haselden Construction | **Cost** $91.3 Million | **LEED Certification** Platinum

The architects and builders of the Department of Energy's new Research Support Facility (RSF) in Golden, Colorado, were confident they could design and build the world's largest net-zero energy building. The new structure, within the campus of the National Renewable Energy Laboratory (NREL), was expected to be a trailblazer for the green building industry and a model for others to follow when the project got underway in 2008.

"Part of our mission is to be national leaders in energy efficiency," says Shanti Pless, top efficiency champion at NREL and one of the facility's project leaders. "Costs and efficiencies of many energy technologies have improved significantly in recent years, and we had the opportunity to walk the talk and show the industry how to do it."

Still, they held their collective breath. They had to wait until the first full year energy consumption data was tallied with all systems up and running to see if they could really achieve net-zero energy. That way, they could verify whether the total energy the building produced through its own renewable energy sources was greater than the energy the structure consumed over a 12-month period.

The verdict? Mission accomplished. In April 2014, the Department of Energy announced it had collected real-time verifiable data demonstrating the Research Support Facility produced more energy than it consumed between April 2013 and April 2014.

Page 44: Melting snow from the roof of the RSF flows into containment structures and then into landscaping around the building.
Page 45: Shanti Pless, senior engineer at NREL. Left: Courtyard area at the RSF. Top: SunPower PV array atop the parking garage overlooking the RSF.

Photos: Dennis Schroeder / NREL

Even though the first 800 occupants of the building moved into the 220,000-square-foot building after construction of Phase One in 2010, the ambitious project wasn't fully completed until 2012. That's when an additional wing was added for a combined total of 360,000 square feet and 500 more NREL and Department of Energy staffers moved their operations to the new building.

The primary source of renewable energy was drawn from the building's 2.6-megawatt solar photovoltaic (PV) system that blankets the roof and stretches onto a canopy over the adjacent parking areas. What's more, the building was designed with a multitude of energy efficiency features—some high-tech and others pretty basic—so the structure could operate using at least 50 percent less energy than most other Class A buildings of the same size.

Of course, operational efficiencies have to occur year after year for a true net-zero energy success, compared to sustainability design goals that are measured as a one-time accomplishment, Pless notes. The RSF also was awarded the U.S. Green Building Council's (USGBC) top Platinum rating for Leadership in Energy and Environmental Design (LEED) for each completed phase of the complex.

"Net-zero energy is the holy grail of all targets on the sustainability side of creating large-scale buildings," asserts Pless, who spent the first decade of his 25-year career in the commercial sector as a mechanical engineer meeting energy goals for high-performance buildings, including the Lewis Center at Oberlin (Ohio) College. "It's only in the last five years that large-scale buildings can be thought of as a realistic goal."

Climate Change—a Catalyst

Concerns about climate change have been mounting in both the public and private sectors and many experts point to buildings as a major contributor to greenhouse gas (GHG) emissions. In the U.S., buildings account for 30 percent of all GHG emissions, according to the U.S. Environmental Protection Agency. That should come as little surprise, considering buildings are responsible for about 36 percent of total energy use and 65 percent of all electricity consumption domestically, the EPA says. Since NREL aims to be at the forefront of energy efficiency ideas, administrators there figured attaching aggressive criteria for energy reductions to its planned Research Support Facility was a way to combat the growing threat of climate change as well, says Pless.

"Decisions made today in building design will impact emissions of our buildings for the next 30 to 40 years," he observes. "You've got one chance to get it right because once you have an existing building it becomes difficult to change."

The team that designed and built the new facility factored in operational carbon emissions as part of its definition for the net-zero energy goal because minimizing GHG emissions was just as important as the

Left: The library in the RSF is designed with energy saving appliances and recycled materials. Right: Natural light fills the cafe.

Photo: ©Ron Pollard, courtesy of RNL.

Center: Each workstation in this open work space uses a maximum of 65 watts.

Photo: Dennis Schroeder / NREL.

energy efficiency component from an environmental standpoint, asserts Tom Hootman, director of sustainability at RNL Design, a global design firm specializing in sustainable, integrated design, and one of the partners on the team that won the competitive bid for designing and building the new facility. "It forces you to think through the design problems in terms of operational carbon emissions, which can influence design strategies and energy sources," he explains.

To that end, the designers opted for onsite generation of clean, renewable energy and passive design strategies as the primary sources for powering the building's operations and keeping energy needs at a minimum, says Hootman. "These strategies add resilience to our built environment, which can help mitigate future impacts to our changing climate," he adds.

What's more, one requirement for the design/build team was to guarantee all materials used met the criteria of a 50-year life span to stretch the time that a major renovation or demolition would be required, says Brian Livingston, a senior project manager at Haselden, the Centennial, Colorado, general contractor that was awarded the design/build contract for the project with RNL Design. Life span requirements for buildings are typically 30 to 40 years.

"A building with a 50-year requirement rather than a 30-year would have stricter structural requirements because concrete deteriorates over time," explains Livingston. "We had to prove either through examples of in-place construction or through a testing data mechanism that materials would meet that durability standard."

Livingston adds: "When you demolish a building, you emit carbon dioxide with equipment that's used and some of those materials end up in a landfill," which produces methane, a potent GHG. "This requirement was about being mindful to the future and not contributing to climate change."

Performance-based

The project leaders at NREL knew they were raising the stakes in their quest for a net-zero energy structure on a scale that hadn't yet been achieved, so they took a dramatically different approach in the criteria for the request for proposal (RFP) they put out to the green building industry. They sent out a performance-based design/build RFP that placed energy criteria for the building's operations as a required top priority requirement alongside cost and schedule, explains Pless. For example, the RFP said they required design and construction that results in a building that uses 25,000 BTUs per square foot for the first two years.

"What we learned is that when energy efficiency is a requirement from the beginning, energy efficacy decisions can be made early on and integrated cost-effectively," asserts Pless. "That wasn't really done before. Early energy efficiency goals can inform the design delivery process, rather than extra efficiency measures that are bolted on after the design has been developed."

In addition, NREL for the first time wanted a design/build team to create the building instead of the typical two-step process. In this instance, a partnership of architects and a contractor design the facility and begin building it in an integrated manner instead of first having one team design the entire structure and then soliciting RFPs for the building

phase, explains Pless. The integrated team saved money and slashed about 18 months off the total project's start-to-finish time, he estimates.

"Performance-based design/build with energy efficiency integrated into the design is the one key replicable strategy that we've used in nine of our own projects since then," he says.

Hootman, who was one of the main designers of the RSF and authored a book about the process, notes there was a requirement for LEED Platinum in the project, which was not new for his firm. However, it was the first time the energy goal was expected to be a deliverable as well, instead of having it on the wish list of hoped-for outcomes, he recalls.

"It changed the dynamic and seriousness of the project," he says. "It aligned the entire theme of energy efficiency in a more profound way because now it was a contract requirement instead of a goal. Goals sometimes get lost when suddenly the budget gets tight or you're running out of time. Here it wasn't allowed to happen."

Mix of New and Old

Improvements in some newer technologies and dramatic reductions in cost inspired Pless and others at NREL to view a net-zero energy building as a realistic possibility. Cheaper LED (light-emitting diodes) lighting, which requires far less energy than standard lighting, suddenly made that an option building-wide. Less expensive PV panels also enabled the design team to add solar as the primary renewable energy source. Colorado is known for its days of sunshine year-round, so that energy source was a good choice for a building there, he says.

In addition, some of the energy efficiency solutions were passive strategies based on simpler technologies that have been employed for hundreds of years. Those elements also are expected to contribute to the improved health and productivity of employees working there.

Two of the best examples are an emphasis on natural daylight and natural ventilation. A hundred years ago when buildings were designed, most were naturally ventilated and naturally lit, says Pless. "There was good shading, good insulation, thermal mass, lots of precast concrete and ventilation and daylighting," he explains. "Now we're learning how to integrate these simpler technologies into modern, high-performance buildings."

At the RSF, the building's operations will never turn on a light for an employee, except in the restroom, says Hootman. When employees enter their workspace, they decide whether they need more lighting beyond available natural daylight and they have the option of flipping their own dedicated light switch.

"Once the occupant turns a light on, the building finds a way to turn it off," explains Hootman. "Sensors detect when you leave your space and your lights will be turned off automatically. The same will happen when the sun comes out, and at 6 p.m. there's a hard lights-off again. This building only uses 15 percent of what a regular building would use in lighting energy."

An open floor plan also enables workers to benefit from the natural daylight streaming in through the windows. There are no carved-out private offices blocking access to outdoor lighting. In addition, open work areas allow natural ventilation because there aren't walled-off spaces that interfere with air flow.

Light enters through louvered shades into the lobby and first floor of the new Research Support Facility at NREL in Golden, Colorado.
Photo: Dennis Schroeder / NREL

Initially, employees had to get used to working in an open-space environment since many previously had secluded offices. The new layout includes private call rooms and conference rooms for meetings, plus a lot of attention was paid to good acoustics to minimize noise travel. Pless notes the way for these passive features to work best is to change office culture and get buy-in from workers.

For example, the building was equipped with operable windows for natural air ventilation that can easily be opened by people working there, says Livingston. "From a construction perspective, we considered the building 'delicately simple' because much of the work didn't need specialty engineers or workers," he says. "Anyone can install a window that opens."

In more complex "smart" buildings, numerous problems crop up when sophisticated systems break down, observes Hootman. "Fancy controls eventually stop working and it takes a specialist to come back and recalibrate," he says. "Or employees don't like what's installed so they circumvent it by covering occupancy sensors. Our building was brilliant in its simplicity."

The passive architecture served another important purpose: Those design features also were intended to maximize employees' health and improve their sense of well-being while at work. Fresh air from open windows (especially in Colorado) is generally better than sealed-off air that's continuously recirculated in a building, for example. Happier workers also typically are more productive and take fewer sick days, notes Pless. "We believe everyone has a right to daylight and the right to a good view."

Air quality was enhanced in the new building by rounding up all the printers and toners, which emit VOCs (volatile organic compounds), and housing them in a separate self-contained ventilated room. At their old workstations, every other NREL employee had his own desktop printer, says Pless. "That was a lot of VOCs to breathe, so we changed our standards (with the new facility) and bought high-speed multifunction devices and put much fewer of them in the closed-off rooms," he explains. "Now when I go into buildings that aren't naturally ventilated and day-lit, I feel like I'm in a cave."

Industry Impact

When the RSF design was on the drawing board, there were no large-scale net-zero buildings standing, recalls Pless. The largest were 10,000-square-foot structures and most were experimental, he says. The objective of the RSF project was to demonstrate the scalability and replicability of the concept so others could follow, he notes.

"The industry has now recognized that it can be done on a large scale and they're learning how to do this," says Pless, who spends time on the lecture circuit sharing his experience with industry professionals. Project leaders also developed a manual with design details that is shared publicly. Hootman describes the experience of this project as "transformational."

"Net-zero building today is where LEED Platinum was 15 years ago—a few leaders were trying to go all the way and soon after others followed. I'm pretty excited to see this happening."

– Shanti Pless

"It changed the way I work and the way I think about design," he admits. "Given that I've always been a LEED AP sustainable designer, this was a far more radical approach to designing around energy. It vaults you to the next level."

Historically, architects weren't trained in the details of BTUs of energy and other energy minutiae, notes Hootman. But that's changing, he says—noting that some architectural programs are even incorporating net-zero energy into design class curricula. For his part, Hootman is pushing other architects to adopt these new approaches and insists the industry is on the cusp of a growing trend.

There currently are a couple hundred net-zero commercial buildings in various stages of design and construction. Many large-scale retrofits with net-zero energy goals are underway as well, says Pless. The majority of new construction is found in the government and education sectors, while retrofits are occurring across the board.

"Net-zero building today is where LEED Platinum was 15 years ago—a few leaders were trying to go all the way and soon after others followed," he says. "I'm pretty excited to see this happening."

Green building visionaries like Pless, Hootman, and Livingston applaud net-zero building as a vital component to mitigating the impact of climate change, but they are realistic about what will motivate others to jump on the bandwagon. "When commercial developers figure out how to build it, sell it, and create a marketplace for it like they've done for LEED, that's when you'll know net zero has become mainstream," Pless predicts.

RNL Design team: (left to right) Tom Hootman, director of sustainability; Rachel Fitzgerald, senior associate, lighting designer; Richard L. von Luhrte, president, principal-in-charge (NREL); Brian Nicholson, associate, landscape designer. Photo: ©Ron Pollard

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And the Beat Goes Green

The San Diego Green Building Council matches volunteers seeking hands-on project experience with nonprofits looking to green their facilities.

By Calvin Hennick

When volunteers brainstormed ways for the WorldBeat Cultural Center to conserve water, they didn't recommend installing any fancy new toilets or complicated recycled-water systems. Their proposed solution was decidedly lower-tech. "We realized that the center was actually saving a ton of water by bringing porta-potties in for events," says Tanya Goyette, a volunteer who worked on the WorldBeat project. "We just said, 'Bring in more porta-potties. You're doing a great job saving water.'"

Several dozen volunteers like Goyette helped WorldBeat, a multicultural arts organization located in San Diego's Balboa Park, to examine not just their water usage, but also their energy consumption, their waste and recycling processes, and other practices as part of the center's application to obtain LEED for Existing Buildings certification. The San Diego Green Building Council connected the volunteers to WorldBeat through its Green Assistance Program (GAP), which helps under-resourced nonprofits to incorporate sustainable elements into their existing buildings.

The program also gives volunteers the chance to work on a green building project—experience that can be invaluable for people just beginning their careers or making a shift toward sustainable development. "We've

The WorldBeat Center provides ongoing programs and services that nurture the spirit of children, the elderly, and everyone in between to create unity within diversity.

Photo: WorldBeat Center

Makeda Dread Cheatom (left) is the executive director of the WorldBeat Center in Balboa Park (right).

Photos: World Beat Center

> **"Instead of being a bunch of people trying to save the earth, they put us on track."**
>
> — Makeda Cheatom

had an overwhelming interest in the program," says Renée Daigneault, interim executive director of the San Diego chapter. "We have a mix of people who have been doing this for 20 years and want to give back, people transitioning careers, and students or emerging young professionals that want to get hands-on experience working on a project."

Until recently, that sort of project experience was necessary to even sit for LEED professional credential exams. As of this summer, that requirement has been waived, but the newer test directly assesses knowledge about project skills, meaning that hands-on experience is still a near-prerequisite to obtaining LEED credentials. Ravi Bajaj, education manager for the San Diego chapter, says he expects volunteer interest in the program to remain high, despite the change in the testing requirement.

Since GAP was started in 2010, volunteers have worked with five different nonprofits. WorldBeat, the first, has already received LEED certification, and another project has been submitted for certification. The San Diego chapter's staff is only large enough to lead volunteers through one project at a

time, and, Bajaj says, the process is more like three projects at once: educating a nonprofit about the importance of LEED certification; educating the volunteers about the LEED process; and managing the actual project.

Bajaj says there have been inevitable hiccups—the largest occurring when a food bank participating in the GAP program couldn't obtain LEED certification because a tenant in its building wouldn't cooperate with the process. "It's really important to have your ducks in a row when you get started," Bajaj says. "We learned that lesson the hard way."

But the volunteers' efforts on the food bank project weren't wasted. Although the building couldn't be certified, volunteers still helped the organization to formalize its operations policies and tweak them to make them more efficient and environmentally friendly. The food bank reduced its waste output by obtaining a machine that automatically opens cans of expired food and empties them—keeping the recyclable cans out of landfills.

Even before perusing LEED certification, the WorldBeat Cultural Center had some solar panels, and staffers took great pains to recycle as much as possible. But the GAP program helped the center to formalize its processes and make decisions on upgrades," says Makeda Cheatom, executive director and founder of the organization. "Instead of being a bunch of people trying to save the earth, they put us on track."

As a result of the program, WorldBeat installed LED lighting and solar tubes, cut down on bottled water, and began purchasing more recyclable materials—moves that have lessened the center's environmental impact and have saved it thousands of dollars per year. Although the nonprofit organizations are responsible for their own capital upgrades, volunteers do what they can to point them in the direction of rebates and potential sources of donations. And so, WorldBeat did end up getting a fancy new toilet, after all—a waterless urinal donated by someone who worked on the project.

"You get 50 to 70 people working together, and they know people," says Goyette. "They have resources that they can tap into, and they can help organizations get the things they need." ●

Hitting the Mark

Benchmarking continues to sign on new cities. How can you win yours over?

By Eric Butterman

Measuring or "benchmarking" energy and water conservation performance of any building can increase awareness as to how to make that building more efficient. And when benchmarking becomes mandatory for cities' commercial buildings, this enables owners to improve decision making around energy use.

Passing a benchmarking bill seems to be almost an art in which only 12 cities or counties have succeeded. Still, for the areas that took the plunge, the results have been encouraging. But what is the best chance to pass the law in your area?

Philadelphia, able to benchmark energy use for 50,000-square-foot buildings and higher, was the sixth city to adopt tracking. Holly Shields, advocacy coordinator for the Delaware Valley Green Building Council, says it was a sweet victory—but not one that came easily. Before legislation was introduced, it was important to form the Coalition for an Energy Efficient Philadelphia. "It was about talking to contacts in different sectors," Shields says. "We needed enough people whose experiences would allow them to hit enough areas."

Still, once the law was passed, the work was just getting started. "We worked with building owners and managers on figuring out how to benchmark buildings," she says. "It partly covered helping them to understand how to use Portfolio Manager (an EPA online tool) to find input data. There's been a good compliance rate of 86 percent of buildings and we've extended our work to hotels, universities, some K-12 schools, and houses of worship."

Katie Kaluzny, associate director of the U.S. Green Building Council Illinois Chapter, was part of making Chicago the ninth city to incorporate benchmarking. "We received help from within the mayor's office and worked hard with building professional stakeholders," she explains.

A key to influencing, Kaluzny says, was drafting ordinance language which made sense to building owners. "In the letter we showed what it would do for the city and around 85 companies signed it," she says. "We took that letter to the local aldermen with why the ordinance was important and it passed in September of 2013."

The official release from the mayor's office said it would affect approximately 3,500 buildings and estimated 5 percent in energy savings would result in a $250 million investment. The release also cited an EPA finding of 7 percent savings for buildings that utilized Portfolio Manager from 2008-2011.

But, again, implementation was as important as passage. "Everyone has been working together to focus on education—we led 16 ordinance trainings between March and June of this year for the general public and held Benchmarking 101 talks," Kaluzny says, "We had over 375 people attend courses. We also launched a call center for people who had questions after attending our training."

Buildings 250,000 square feet and over had their first reporting deadline in June and next year will be the first reporting for 50,000 square feet and over. "This was crucial to pass because the ordinance covered only around 1 percent of buildings yet it accounts for around 20 percent of the energy used." she says. "We're looking forward to seeing the results of reporting."

Atlanta may not be one of the select cities yet but their Better Buildings Challenge can be seen as a strong start, says David Freedman, executive director of the Georgia Chapter of the USGBC. It asks for a pledge from building owners and managers to save 20 percent on energy and water consumption by 2020. But it also encourages being an information leader, asking participants not only to share statistical information with the EPA but also to educate others on the technology and other tools they used to achieve their goal.

"Building owners have seen this designation as a status symbol," Freedman says. "They're clearly proud of it. I think they feel it can only be a positive for them." Still, Freedman remains cautiously optimistic. "You'll still have to go before the Atlanta City Council and it's about educating the councils and constituents and making them feel comfortable supporting this. No matter what city, many people care about being green and you have to keep finding ways to appeal to them."

Christina Kuo, who manages local advocacy campaigns at the USGBC, sees these efforts creating the momentum. "The early-adopting jurisdictions help open the door for three or four more other communities to begin thinking about it," says Kuo. "We want to be sure we're doing our best to seed that local conversation so this important green building policy begins to sprout up everywhere."

Even though we wait for more city data, there have been other strides to celebrate. For example, BuildingRating.org, an exchange for information on building rating disclosure policies and programs, has already signed on 24 areas of the country. With continued mobilization, the amount of benchmarking bill cities may equal it in time. ●

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The Future of Energy Efficiency

An interview with Jones Lang LaSalle's Dan Probst on machine-to-machine technology.

Interview by Jeff Harder

Dan Probst, chairman of energy and sustainability services at JLL.

Photo: JLL

It turns out that machine-to-machine (M2M) technology isn't something out of a dystopian future. By harnessing breakthroughs like wireless sensors, cloud computing, and cutting-edge analytics software, M2M technology transforms a building's lights, air conditioning, and other components into a single complementary system—one that regulates itself around the clock and pinpoints energy-wasting defects that can escape the most astute human observer. Dan Probst, chairman of energy and sustainability services at Jones Lang LaSalle (JLL), a commercial real estate services firm operating in 75 countries across the globe, explains the basics of M2M technology—and how it can still bring energy savings to the most eco-conscious buildings.

In its simplest form, M2M technology is where systems that are part of a bigger infrastructure directly communicate with another, making changes based on data like temperature and daylight without human intervention. They become self-controlled, self-optimizing systems that can pull in real-time data and make real-time changes.

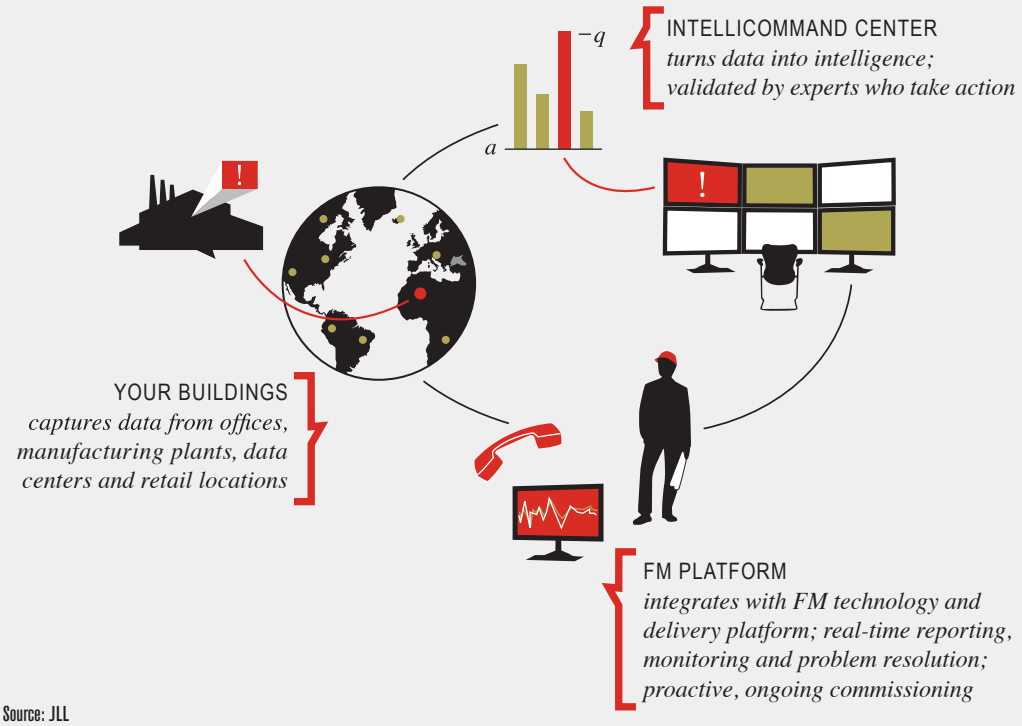
Throughout history, buildings have always had some level of automation and control, but they aren't always reactive to things going on in the building—changes in occupancy, changes in usage, changes in the weather outside. They might have achieved the right space temperature, for example, but maybe not in the most energy-efficient way.

M2M technologies are converging to make smart buildings—and their owners—even smarter. We can now perform real-time remote monitoring, commissioning, and control of entire portfolios of buildings, leading to dramatic improvements in building performance and meaningful energy savings. Specifically, smart building technology can generate energy savings of 8 to 15 percent annually almost immediately after deployment, with the potential for incremental improvements over time. M2M building systems generate profound reductions in a building's energy consumption because the carbon footprint of the building literally shrinks with every equipment data sensor.

When you get down to smart building and M2M technology, two things happen. One, the performance of the system responds in real time, so the HVAC, for example, is constantly adjusting and fine-tuning—things get more dynamic. And two, the different parts interact with each other: the building automation system controls the HVAC, the lighting system might interact with the security system, the security system might tell the HVAC how many people have badged in. All of these systems start to talk to one another.

In our experience, there aren't too many buildings that aren't good candidates for smart building technology. Certainly, big complex buildings are going to see bigger energy savings faster. Things get out of calibration with time—in a big building that can have a snowball effect: If one thing isn't

How Smart Technology Works



Source: JLL

Smart technology captures information from each building's systems and sends the data to the IntelliCommand Center. Advanced algorithms developed by engineers identify and diagnose trends and patterns in the data, indicating possible equipment or operational issues. At the IntelliCommand Center, engineering professionals review and validate the information through a comprehensive facilities management platform to quickly address the issues before they become problems and constantly fine-tune operations to ensure buildings operate at optimum performance levels at all times.

working right, other things will modify to make up for that. But there are some operational benefits that can translate to smaller buildings. Smaller buildings typically don't have their own engineering staffs. With this kind of technology, if someone calls to say they are too hot or too cold, M2M technology can validate that there is a problem, do some diagnostics, and send a technician with the right skills and experience, and they can pick up the parts on the way.

Some of the things driving the interest in this technology are the desires to reduce energy expense, to reduce greenhouse gas emissions, and to improve environmental performance. In some cases, there are regulatory drivers: More and more buildings have to report their energy performance. And there's the fact that these can have such short payback times—we're consistently seeing payback times around 18 months, but in some cases, it's less than six. And as M2M technology continues to evolve, the sensors are going to get lower in price, the installation will become faster and easier, and the payback time will become quicker.

There are a lot of things you can do to green up your building that aren't technology-focused—better insulation, better windows, better roofing, better weather stripping. But if you have an energy efficient building with the right envelope, the right lighting systems, the right HVAC system, how do you optimize the performance of those systems and equipment, in real time, all the time?

Over and over again, we see energy savings and performance improvements in smart buildings—we've installed the technology in a LEED Platinum building and still achieved more than 10 percent savings. However, despite how well designed a building might be, there's a level of performance optimization that new technology can bring that older, less automated systems just can't quite achieve. And this is a new tool for engineering teams to get new insight into how everything's performing: Unless you have an engineer who can monitor every sensor and control in the building, you just can't replicate what this technology can do.

Some of the things driving the interest in this technology are the desires to reduce energy expense, to reduce greenhouse gas emissions, and to improve environmental performance.

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