

NZB

NET ZERO BUILDINGS

November 2017 • Volume 6, Number 5

A moderate window-to-wall ratio and context awareness can be sufficient in providing a well-daylit space, particularly if paired with sensible floor plate depths.

STRATEGIC



SUNLIGHT

WATER: FACTOR IN FLOW FORMULA 34

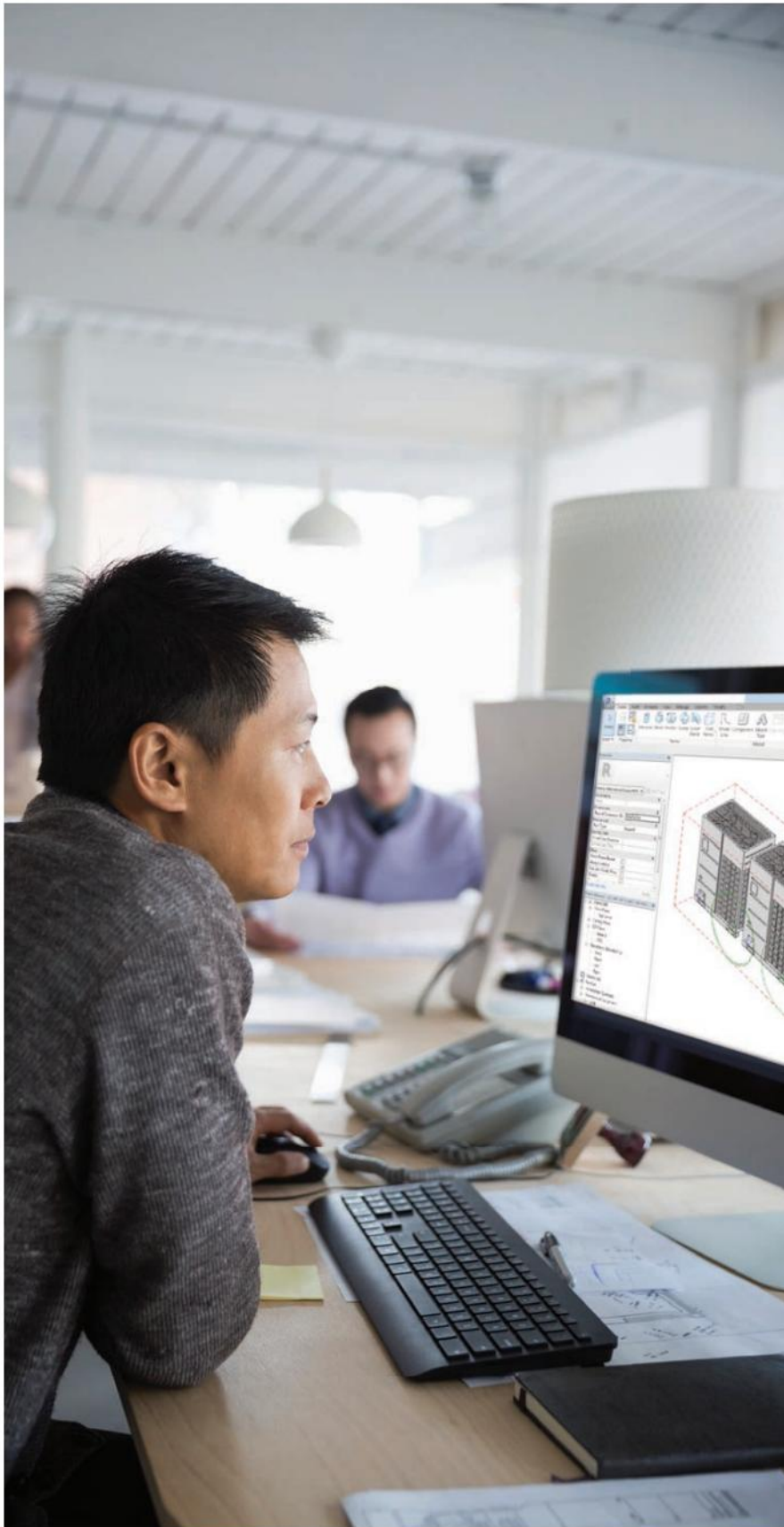
POWER: MICROGRIDS MAKE GAINS 40

ENVELOPE: EMBRACE CHARRETTES 28

| NZB: DAYLIGHTING |

Thoughtful window size and placement are often more significant considerations than pure volume of glazing when planning for an effective daylight design.





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Occupying a full city block in London's Financial District, Bloomberg's European headquarters achieves high marks—a 98.5 BREEAM Outstanding rating—the highest design-stage score ever achieved for a major office development.



ON THE COVER

Strategic window size and placement makes a major difference in delivering effective daylighting designs. Specialized software makes the process a little easier.

project zero

Bloomberg European Headquarters

London, UK

Located in the Financial District of London, the Bloomberg European headquarters pushes the boundaries of sustainable office design that functions as a work environment that inspires its employees.

By Vilma Barr

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Is the net zero community too divided or even isolated? What has to change?

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NIMBYism vs. true benefits. The wind farm debate continues.

By John Mesenbrink



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Strategic Sunlight

Size and placement of windows is important for net zero, but good daylighting can only occur within the context of the building and its environment.

By Barbara Horwitz-Bennett

- ▶ Glazing
- ▶ Doors
- ▶ Curtainwalls
- ▶ Clerestory Windows



HVAC



ENVELOPE



WATER



POWER



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Integrated Build

The architect brings various trades together to create a finished, curated project. The individual trade does not stand alone; it must be integrated with the architecture. Collaboration among all disciplines is key to the long-term of the health of any project.

- ▶ Passive Ventilation
- ▶ Geothermal
- ▶ HVAC to Acoustics
- ▶ VRF Technology

By John Mesenbrink

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Charrette Check

While often seen as unrealistic and frustrating to some, there are those that embrace early design charrettes and have seen noticeable improvements on their projects as a result of them. Early and often design charrettes can culminate into an efficient and balanced building.

- ▶ Roofing
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- ▶ WTW Ratios
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By Alan Weis

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Spec'ing Efficiency

Building owners and designers alike take note: today's buildings—whether retrofit or new construction—demand closer attention to detail when considering higher-efficiency plumbing fixtures. What's more, the social and financial benefits are attractive, as well.

- ▶ Efficient Toilets
- ▶ Restroom Design
- ▶ Dual Water Strategy
- ▶ Rainwater Capture

By John Mesenbrink

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Microgrids can support both net zero and resiliency goals by pairing renewables with additional, less-intermittent resources to enable full off-grid operation. Microgrid technology is one approach to meeting resiliency goals gaining more attention.

- ▶ Fuel Cell Technology
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- ▶ Backup Generation
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By Chuck Ross

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Lighting Decisions

With a surplus of information, including web-based tools, the face of lighting design is changing. There's no reason not to democratize lighting design to include future occupants directly into the design process, as feedback will always supersede assumption.

- ▶ Downlighting
- ▶ Outdoor Lighting
- ▶ Preference and Cost
- ▶ Lighting Drivers

By Kevin Willmorth

Re-Introducing...

THE ANNUAL NZB AWARDS



One of the major criteria that differentiates net zero projects vs. say, a LEED-certified project, is that net zero certification typically requires verification of performance for at least a year's worth of operation. In that spirit, for NZB's inaugural awards program later this year, we'd like to highlight outstanding examples of **product and technology in application**, whether included as part of an efficient system or for more singular performance.

In concert with our established "pillars," we'll be looking at technology applications within the categories of the building envelope, daylighting, lighting, HVAC, water/plumbing, and on-site power/renewables. These system-level entries do not necessarily have to be associated with a net zero project, but should be associated with a high-performance design.

On the net zero level, we will also recognize a net zero project of the year, which may be a project already certified, or one under consideration. And to recognize the effort and work that goes into creating a net zero project we will also be issuing citations for:

- ▶ **BEST INTEGRATED PROCESS**
- ▶ **BEST ENERGY MODELING EFFORT**
- ▶ **BEST CONTINUOUS COMMISSIONING EFFORT**

On a product level, we'd also like to recognize R+D and efforts to create products that will help further the net zero movement, in the following categories:

- ▶ **MOST PROMISING NEW TECHNOLOGY**
- ▶ **BEST HYBRID PRODUCT PARTNERSHIP**—Where two or more manufacturers have worked together to develop a single product that will better serve the design community
- ▶ **MOST PROMISING ELECTRONIC DESIGN TOOLS**

Details and deadline information will be available soon. Questions should be directed to Jim Crockett: jcrockett@cbmedia.us.com



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The ICL logo is displayed on a blue, textured wall panel. It consists of the letters "ICL" in a white, stylized, sans-serif font. Above each letter is a small, white, three-pronged fork-like symbol.

DMACC Culinary Institute
Shive-Hattery Architecture

It's Always Sunny in Philly...

The Net Zero movement is still in a fledgling state; but if it is to soar like an eagle, its constituents must learn greater diplomacy.

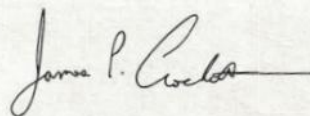
Being Mister-turn-off-the-lights guy, ironically, as I sit before my laptop on a gloomy day as autumn overtakes an unexpected Indian Summer, I'm debating turning the lights on—it's not so much that I need them, but rather because I'm experiencing a funk making it difficult to rouse my muse. Of course, it could also be a vitamin-D deficiency... Whichever factor—physical, mental or emotional—"feelings" don't regularly equate into the world of net zero design, yet maybe they should. In the lighting section this issue, Kevin Willmorth touches on the idea of the democratization of design. Inspired by the work of a French educator using virtual reality to gauge preferences on lighting and daylighting options, Kevin created an experiment of his own. Turn inside for more on that, but the notion of human feeling and choice reminds me of a near-net-zero facility I visited, which included the offices of a green think tank, as well as

those of the building's architect. In the former, uniform natural light permeates the space so that little electric light is necessary—a stark contrast to the sundial effect in the architect's offices, which its designer very much wanted so that people could feel the passage of the sun each day. So, even in a community where everyone appears to be on the same page to deliver high-performance structures, the "how" and "why" can differ significantly. It foretells speed bumps on the road to design democracy. But listening to many voices—especially those more versed on a given subject—is essential. In the HVAC pillar story, John Mesenbrink talks to MEP contractors who don't quite feel "integrated" into the process. In fact, some internal discussions occurring are rather contentious. It reminds me of some of the things I saw and heard on a recent visit to Philadelphia, including a visit to Independence

Hall, where many debates ensued over the construction of the Constitution. Things got so bad at one point, that Benjamin Franklin, commenting on a detail of a half sun carved into the chair from which George Washington presided, couldn't tell if the sun was rising or setting, alluding to the future of the newly created United States.

Franklin, a newspaper man after myself, fired out a re-purposed cartoon from his print shop of a cut-up snake representing a divided 13 colonies. Like wise Poor Richard, I worry the net zero community remains too divided, even isolated. Net zero is very much a process and that includes thinking about not only the people that will occupy the space, but the people who build said spaces. But it's also about gaining needed, but perhaps, unwanted, allies as Franklin did with France in the Revolution. Net zero now, in fact, may be too much like colonial Massachusetts; the

shot heard around the world to change the way buildings are designed and constructed may have been fired from this community, but can it stand alone against the British, so to speak? Whether we like it or not, we need more buy in from our political leaders and "the people" as a whole. But that's on us—we need to start at a community level with serious discussions with our trustees and neighbors. That said, a little contention—and indigestion—may be good for our mettle. Franklin knew this, and after the constitution was approved, issued another cartoon: "I have the happiness to know that it [the sun on the chair] is rising." I second the motion. ☑



Jim Crockett,
Editorial Director
jcrockett@cbmedia.us.com



I have the happiness to know that it is a rising, and not a setting sun.



BENJAMIN FRANKLIN
Philadelphia Gazette
May 9, 1754

The Franklin Chair Musing Upon Its Ruler
Independent National Executive Park
Philadelphia, PA

The Emery contemporary apartments signals Portland's South Waterfront's urban future.



Full Metal Jacket

APPLIED SCIENCE

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CIRCLE 26



Bloomberg European Headquarters

London

Market: Office

Size: 1,100,000-sq.-ft.

Architect:

Foster + Partners

Development Advisor:

BNP Paribas

Development Manager:

Stanhope

Construction Manager:

Sir Robert McAlpine

Structural Engineer:

AKT II

Services Engineer /

Lift Consultant / Fire

Engineer:

Sweco

Cost Consultant:

AECOM

Lighting Designer:

Tillotson Design Assocs.

Acoustic Consultant:

Sandy Brown Assocs.

Landscape Consultant:

Charles Funke Assocs.

Art Consultant:

Nancy Rosen Inc.

Accessibility Consultant:

David Bennett Assocs.

Façade Consultants:

FMDC; Optis; BMT Group

Natural Ventilation

Consultants:

Breathing Buildings;

With Research; Price

Industries

Wayfinding Consultants:

Whyrow

Façade Access

Consultant: Reef Assocs.

Right of Light Surveyor:

Gordon Ingram Assocs.

Text: Vilma Barr

Photos: Courtesy,

Foster + Partners

| PROJECT ZERO |

BLOOMBERG EUROPEAN HQ

OCCUPYING A FULL CITY
BLOCK IN LONDON'S
FINANCIAL DISTRICT,
BLOOMBERG'S EUROPEAN
HQ ACHIEVES A 98.5 BREEAM
SCORE—THE HIGHEST
YET FOR A MAJOR OFFICE
DEVELOPMENT.



A Mutual Vision

The design brief for the project states the personal objectives of its two primary decision makers, Michael Bloomberg and Norman Foster—from the beginning—was to create an exemplar of sustainable development, inside and out, for a new enlightened era in the heart of London.

Located between the Bank of England and St. Paul's Cathedral, Bloomberg's European headquarters responds to its historic context, yet is uniquely of its place and time. "From day one, we had a shared belief that we should create an elegant stone building that would be a good neighbor in the City of London, and make a significant contribution

a competitive advantage in attracting and retaining the brand of employee that collectively drives the firm's worldwide success. Earning a BREEAM Outstanding rating—the highest design-stage score ever achieved by any major office development, the project occupies a full city block on a 3.2-acre site. The office is actually two buildings united by bridges that span a pedestrian arcade that reinstates Watling Street—an ancient Roman road that ran through the site.

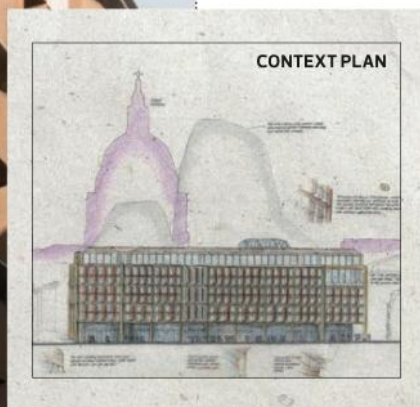
A major point of agreement between Foster and Bloomberg, was the building's profile. "There was an absolutely conscious attempt not to create another glass box," said Foster, referring to the recent bumper crop of surrounding curtainwall skyscrapers. Instead, structural sandstone was awarded the distinction as the basic façade material. "This is the biggest stone building project in the City for the past 100 years," affirmed Foster.

Its striking façade is defined by a series of large-scale bronze fins that shade the floor-to-ceiling glazing. The fins give the building a visual hierarchy and rhythm as they vary in scale, pitch and density across each façade according to orientation and solar exposure. The building height also protects key views of St. Paul's Cathedral while respecting historic neighbors.

to the daily life of those who work here," said Lord Foster, the firm's founder and executive chairman.

Bloomberg's objectives followed a similar pattern. "We set out to push the boundaries of sustainable office design that functions as a work environment that inspires our employees."

In a city that has an abundance of talented and skilled professionals, Bloomberg also wanted to make sure that the lively atmosphere generated by the new building would give his company

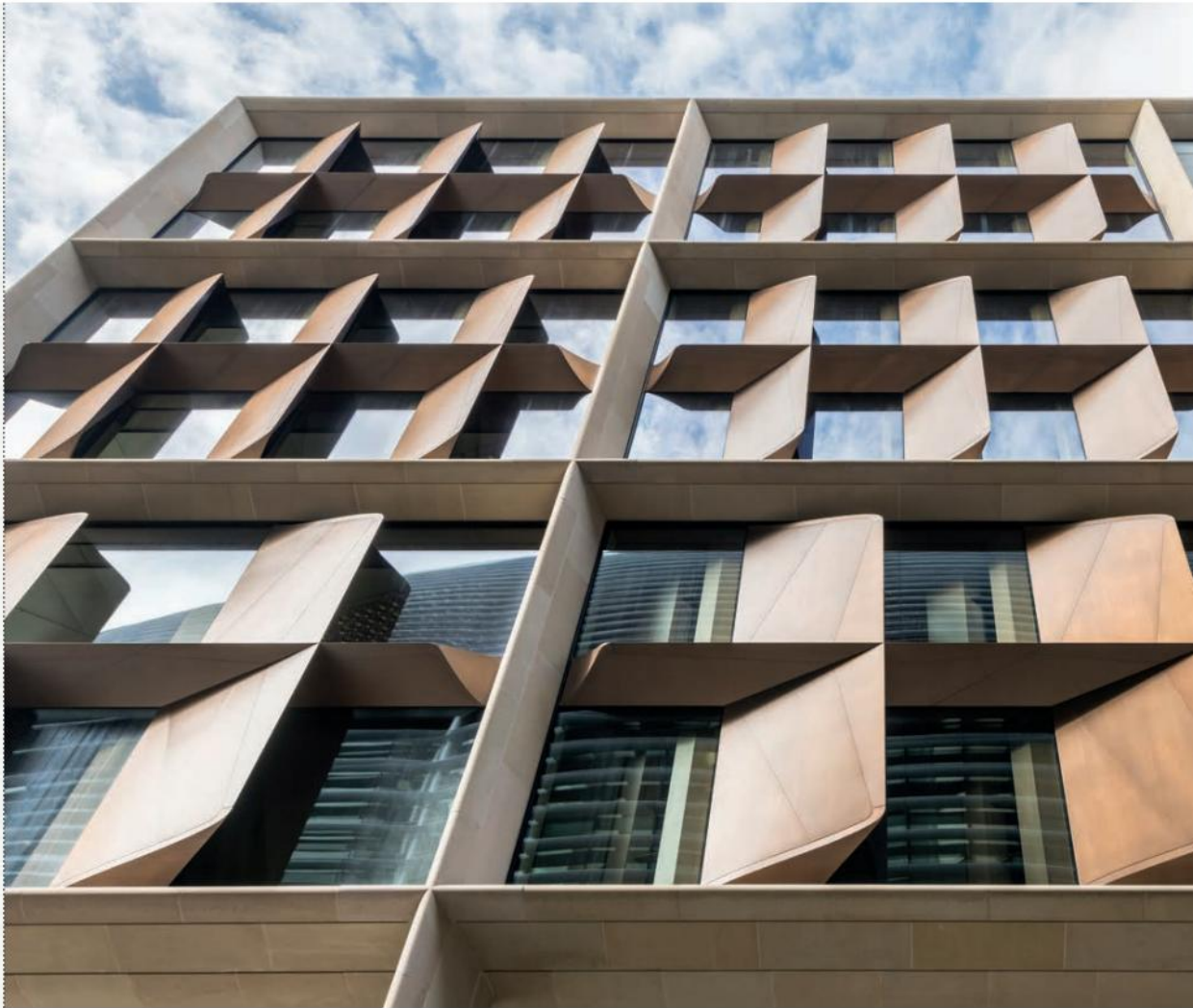


TIMELINE

- **2010:** Design and planning phase
- **2012:** Construction begins
- **Fall 2017:** Construction completed
- **Oct. 24 2017:** Opening ceremony

Construction commenced in 2012 for the two triangular-shaped, nine-story structures. To establish the interior environment feeding into work areas and support spaces, an on-site combined heat and power generation center was created. The result of the proactive action is a predicted overall 35% energy savings in comparison with typical utility usage. The combination of passive and active environmental strategies incorporated into the project is expected to yield even more impressive results: Translated into savings of CO₂ emissions per year, the estimated total is more than 1.3 million pounds. Combined with sensing controls that open and close the bronze exterior fins that adjust airflow to the interior, an additional savings of 600,000 pounds of CO₂ will be saved.

Beyond its BREEAM rating, the project also has been certified LEED Platinum. "What sets the building apart is the result of its all-pervading focus on innovation and its holistic, integrated approach to sustainable construction and design," said Alan Yates, technical director of the BRE Global Sustainability Group, parent company of BREEAM. "Projects like these are really important to give the building industry confidence to experiment," Yates believes.



ENVELOPE

The main entrance is defined by a substantial porte-cochère, where the building forms two sides of a new formal city square. Beneath this square is a new entrance to the local underground station. The envelope, however, is highlighted by its unique "fin" system. Several of the bronze fins contain openable panels in the face of the blade. When ambient weather conditions are temperate, these blades can

open and close, allowing the building to operate in a "breathable" natural ventilation mode. Natural air flows through the building, up its atrium and out of the roof with the central ramp acting as a chimney. Reducing dependency on mechanical ventilation and cooling equipment significantly reduces energy consumption.

The ability to dynamically adjust airflow in response to occupancy hours and patterns results in significant energy reduction. Smart CO₂ sensing controls allow air to be

distributed according to the approximate number of people occupying each zone of the building at any given time. A typical floor, where there are circa 775 workstations, has 68 such CO₂ sensors. Power saved by adopting this approach is expected to be 600–750 Mwhr per annum. As a result, projected CO₂ emissions resulting from Bloomberg's occupancy are reduced by 250–300 tons per annum.



PUBLIC WELCOME ▲ Plazas, at each end of the arcade, and in front of the building's entrance, provide new civic spaces.



ABOVE THE NOISE ▲

The internal section of the fin contains an acoustic lining that attenuates the external sounds of the city.

▼ OPEN CULTURE

The clear site lines of the open floors are representative of the firm's corporate image, notes Foster Senior Partner Michael Jones. The cores, in fact, he adds, have been pushed to the edges of the building to visually open all of the floors.



HVAC

Beyond natural ventilation, the project's integrated ceiling contains 2.5 million individual "petals," which are chilled, with their increased surface area producing the same amount of cooling as a flat ceiling. The bespoke ceiling panels integrate the various elements of a typical office ceiling into a 150mm-deep zone to maximize the floor-to-ceiling height of the workplace. It is a unique and innovative element developed for the building, inspired by the pressed metal ceilings of New York.



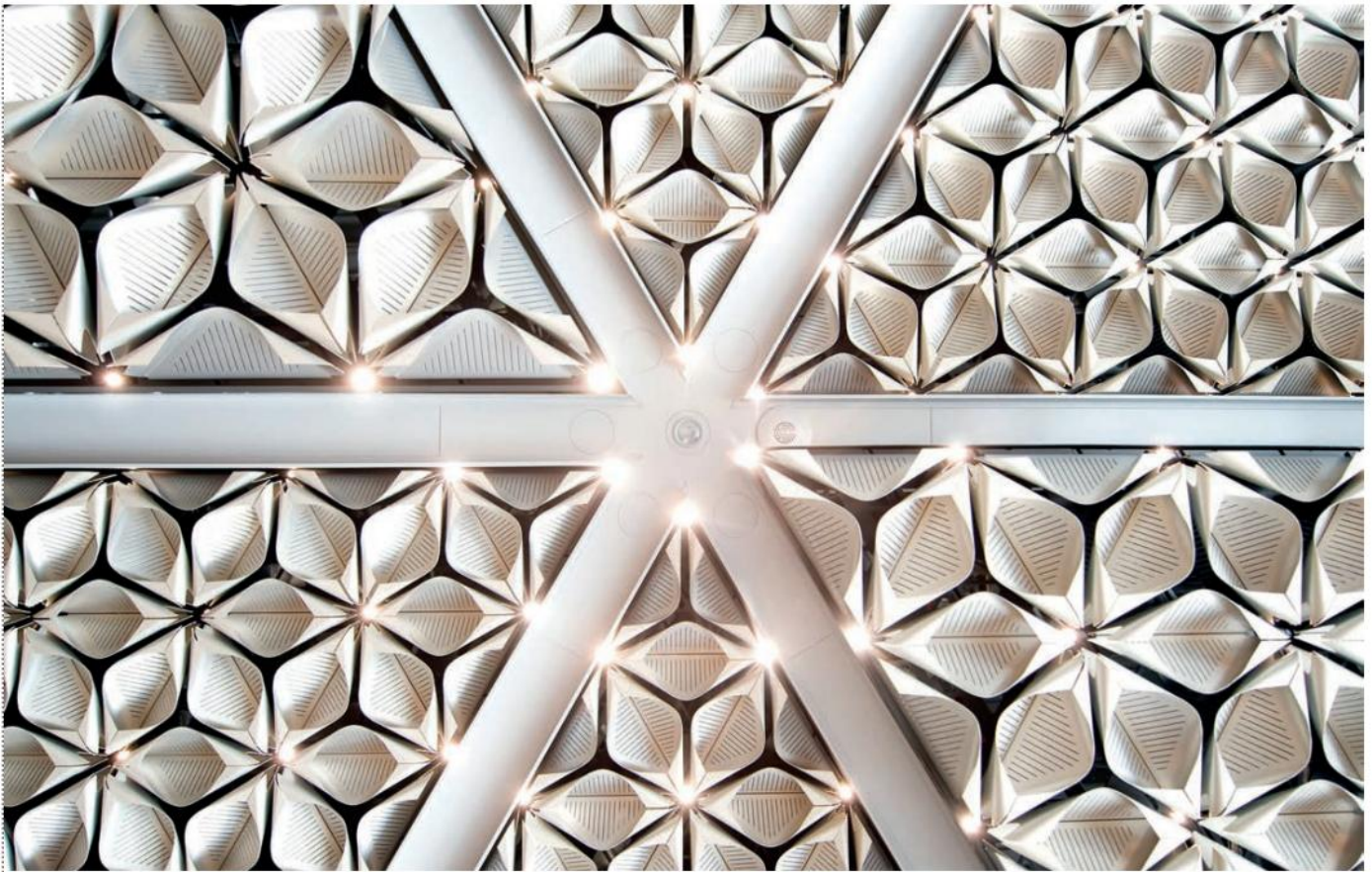
Its distinctive polished aluminum panels of 'petals' perform multiple roles—ceiling finish, light reflectors, cooling elements and acoustic attenuation—combining various elements of a typical office ceiling into an energy-saving integrated system.

ENERGY SAVER ▲

The large surface area of the petals, with their high heat-transfer efficiency, allows the use of elevated chilled water temperatures.

An Alternative Lunch Philosophy

Michael Bloomberg, who built his privately-held financial services information company into a worldwide enterprise with 192 offices and an annual estimated revenue of \$9.5 billion, says that his employees are his most valuable asset. He looks on one hand at the bigger picture, with a new co-authored book, *Climate of Hope: How Cities, Businesses, and Citizens Can Save the Planet*, and on the other hand, encourages interaction between individuals wherever feasible. When discussions with architect Norman Foster turned to the topic of food service for the employees who would occupy the new European headquarters, Bloomberg emphasized his belief in workplace openness encouraging thoughtful collaboration that in turn spurs productivity. His double-prong rationale for the providing of food for the staff took two forms: an architecturally important space that possesses its own sense of place within the new building; and an edited menu that encourages staffers to leave the building at midday to patronize nearby businesses. For the latter, he wanted to avoid what he termed "the Google Syndrome," adopted by the electronic giant and other high-tech firms where free meals and near-residential décor and recreational options can result in work-life addiction. His approach was a "no-cafeteria zone" that encourages workers to leave the building at lunch time. "I want people to get out and enjoy the local economy," he stated.



LIGHTING

Bloomberg staffers in the 1.2-million-sq.-ft. London European headquarters are going about their assigned tasks at workstations illuminated by daylighting plus a lighting program that blends integrated technology and art.

In their objectives for the building conveyed to the various design teams, Foster and Bloomberg, wanted "to push the boundaries of sustainable office design ... to what an office environment can be." They went on record to express their joint visualization that work areas for groups and individuals avoid the typical office appearance and resultant ordinary atmosphere.

Rather, a distinctive design sensibility for furnishings, finishes and lighting that would adhere to the building-wide sustainable environment guidelines should also reflect an inspiring singular approach not achievable in multi-tenant buildings.

Charged with integrating the lighting design was Tillotson Design Assocs., New York, which had previously served as consultants to Foster for the Winspear Opera House in Dallas. Ultimately, the lighting program for the nine-story Bloomberg building makes use of over 500,000 LED lamps.

The overhead lighting for the deep-plan interior breaks with the standard palette of suspended, recessed, and accent fixtures. Instead, ceiling panels in a repetitive petal-leaf design integrate combined lighting, heating, cooling and acoustic functions. Firm head Suzan Tillotson explains that each petal is hand-bent metal, not extruded. The LEDs are embedded to achieve maximum reflectivity that produces multiple points of light on the white desk tops. Mock-ups produced a 30 fc reading on the horizontal work surfaces. Where needed, task lights are provided for workstations, all of which have tiltable double screens and desk tops that raise and lower.

"We were all well-aware of the city's stringent energy use code, and so we worked backward from there with our suppliers to develop the final specifications," she affirmed. Tillotson called on such lighting fixture brands as We-Ef, Zumtobel and iGuzzini to meet the project's customization requirements.

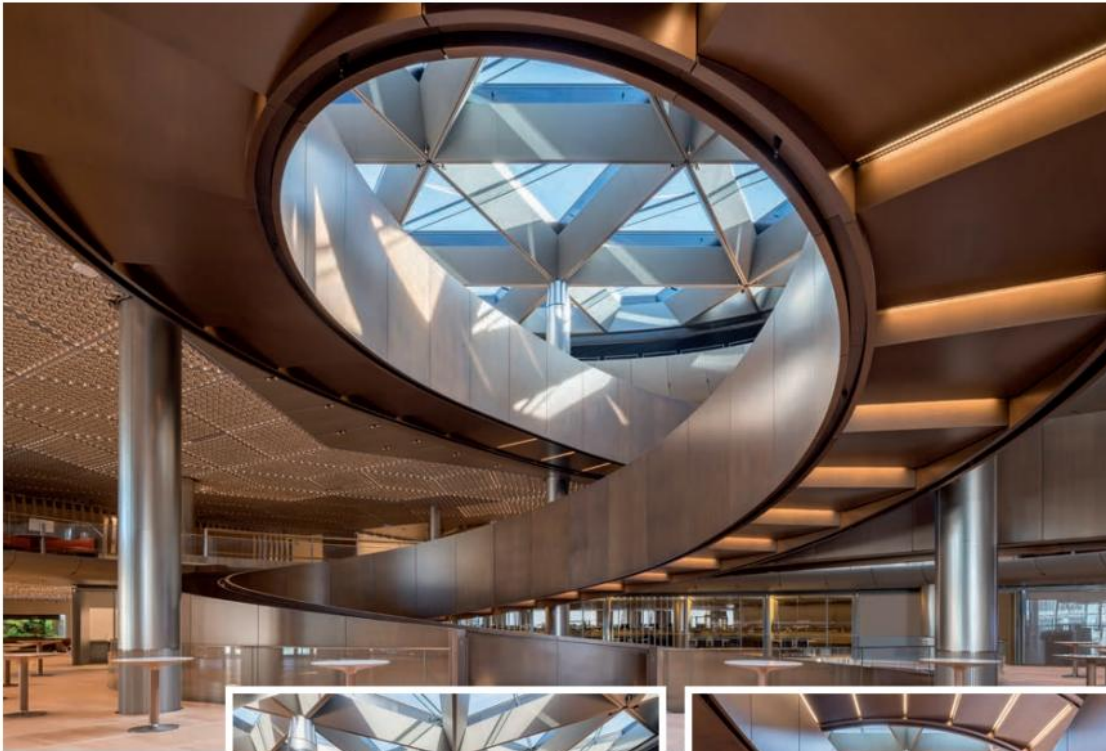
Bloomberg, who was mayor of New York City for 12 years, was not in favor of a full-service cafeteria for the building. Instead, he felt it was important that staffers get out of the building whenever possible at lunchtime and patronize local food establishments.



▲ SIGNATURE CEILING

Approximately 4,000 modular, bespoke ceiling panels combine 2.5 million metal 'petals' with half a million LED lights.

The solution is the double-height sixth floor Pantry, placed between the building's two wings that offers a classic view of St. Paul's Cathedral. Daylighting is supplemented with uplights in soffits and recessed LED spots in the seating area.



INTERACTIVE DESIGN

The ramp is designed and proportioned as a place of meeting and connection, allowing colleagues to hold impromptu conversations without impeding the flow of people.



GATHERING SPOT

The upper level of the "pantry" is formed by a crescent of meeting booths that overlook the central space, known as the Ha-Ha, referring to the classic landscape device that inspired its design.



Taking advantage of the city's dense environment, the building's façades are naturally shaded by neighboring buildings. To draw in daylight, Foster + Partners looked to open up the space above. A distinctive hypotrochoid-shaped stepped ramp, characterized by its smooth continuous three-dimensional loop, flows through the full height of the building, adding to the drama of the space. Clad in bronze, the ramp is designed and proportioned as a place of meeting and connection, allowing people to hold brief impromptu conversations with colleagues, while not impeding the flow of people.

Michael Jones, senior partner at Foster + Partners, and project architect of the building, said the design of the building supports the values of Bloomberg as an organization and the way it operates. "The cores have been pushed to the edges of the building to visually open the floors and reveal a spiraling ramp, the heart of the building, bringing together the people who work in it. In a sense, it is all about community and collaboration—both within the building and the way it embraces its surroundings."

Daylight also enters via the core central to Bloomberg's ethos—a double-height "pantry" on the sixth floor, that is the heart of the building, according to Jones, in that it reflects the importance of sharing and collaboration at the company. "Everyone passes through this animated space, increasing the likelihood of chance meetings and informal discussions."



▲ AN EYE ON WATER

Collectively, water conservation strategies result in roughly 70% less potable water being used than in a typical office building.

WATER

Rainwater from the roof, cooling tower blow-off water and greywater sources, like basins and showers, is captured, treated and recycled to serve vacuum flush toilets. Vacuum toilets use very little water (approximately 0.6 to 0.8L vs. the standard 5L), and since the Bloomberg toilets are serviced using recycled water, they effectively use net zero mains water for flushing. Collectively, thanks to these water conservation strategies, the Bloomberg building uses roughly 70% less potable water than a typical office building. It also has a reduced impact on the surrounding drainage utility infrastructure.





POWER

An on-site combined heat and power (CHP) generation center supplies heat and power in a single, efficient system with reduced carbon emissions. Natural gas is converted to power and the waste heat generated in the process is also used in the building either for heating and hot water, or to generate cooling, via an absorption chiller for Bloomberg's technical facilities.

In use, the CHP system is expected to save 500–700 metric tons of CO₂ each year. Photovoltaic cells on the roof of the building also supply additional power. Power/heat/water conservation has resulted in a 73% saving in water consumption compared to typical office building.

▼ Power/heat/water conservation has resulted in a 73% saving in water consumption compared to typical office building.



▲ RENEWABLE FOCUS

In use, the CHP system is expected to save 500–700 metric tons of CO₂ each year. Photovoltaic cells on the roof of the building also supply additional power.

A Green Process Throughout

Sustainability has been central to the Bloomberg building from day one, from site selection to design and construction practices. During the six-year construction process, Bloomberg worked with contractors and subcontractors to minimize environmental impact. Key strategies included a 95% recycling rate of demolition and construction waste. The operation, in fact, has been a zero-landfill facility since 2010 as waste is composted or converted to energy. Better waste streaming during the operation of the building will enable Bloomberg to take this commitment further, allowing a greater proportion of waste products to be recycled into functional products. Globally, Bloomberg currently diverts 75% of its total waste away from landfills and is targeting 90% diversion by 2020. With the addition of the new London building, Bloomberg has 34 LEED or BREEAM-certified projects globally. By the end of 2017, nearly 70% of the company's 19,000 employees will occupy an environmentally certified office. "We believe that environmentally-friendly practices are as good for business as they are for the planet. From day one, we set out to push the boundaries of sustainable office design — and to create a place that excites and inspires our employees. The two missions went hand in hand, and I hope we've set a new standard for what an office environment can be," said Bloomberg.



| NZB: DAYLIGHTING |



STRATEGIC SUNLIGHT

WINDOW SIZING & PLACEMENT MAKE A SIGNIFICANT DIFFERENCE IN EFFECTIVE DAYLIGHTING PLANS

In the grand scheme of achieving net zero energy designs, daylighting plays a major role. In fact, says Ryan Hess, LEED AP, partner, Mills Group, Morgantown, W.V., "it's critical."

The math is pretty straightforward. Buildings consume approximately 40% of energy in the United States, and lighting takes up 40% of that pie, according to the U.S. Dept. of Energy. So utilizing free light daylighting is essentially a no-brainer.

In fact, according to Jakob Strømmand-Andersen, PhD, Arch. Eng., LEED AP BD+C, and head of sustainability engineering and landscape design for Copenhagen-based Henning Larsen, the size and placement of windows is one of the most important parameters when it comes to architecture, in general. "And even more so when designing energy-efficient buildings."

At the same time, good daylighting can only occur within the context of the full building and its surrounding environment.



OPENINGS SHOULD BE EVENLY DISTRIBUTED TO PROVIDE CONSTANT LEVELS OF DAYLIGHTING THROUGHOUT TO AVOID PROBLEM AREAS.

◀ 17

Ideally, façade design should manage the solar influences of light and heat on the building in order to reduce energy demand while providing a comfortable and well daylight interior environment, says Elliot J. Glassman, AIA, NCARB, LEED BD+C, building performance specialist, built ecology, WSP, New York. While designers may be interested in fully glazed façades on all orientations, this may be a detriment to the quality of daylight in the space as perimeter zones may be overlit or allow too much direct sun into the space. Even so, if architects are seeking to maximize fenestration to achieve a certain aesthetic, they might want to consider changing the location and size of windows and skylights to achieve more passive performance goals. Still, Glassman thinks there's a better way.

"If the design was devised independently from the realities of the environment it is situated in, it really wasn't an appropriate architectural solution for the project in the first place," asserts Glassman. "A good designer will be able to use all the project and environmental parameters to generate the architecture—not try to reconcile them later with a preconceived design response that may not work."

A moderate window-to-wall ratio can be sufficient to provide a well daylight space, continues Glassman, particularly if paired with sensible floor plate depths. He also notes that the openings should be evenly distributed to provide constant levels of daylight illumination through the space to avoid areas of high and low illumination, which can cause contrast issues.



▼ A 127-ft. glass and metal tower serves as a beacon to University of North Dakota's new unmanned aircraft systems programs building.



UNIV. OF N. DAKOTA
Grand Forks, N.D.

Providing a new home for the University of North Dakota's unmanned aircraft systems programs, the ICON Architectural Group-designed 72,000-sq.-ft. aerospace research facility features large curtainwall and storefront systems from Tubelite. At the structure's entrance, a 127-ft. glass and metal tower serves as an eye-catching signature element. "It's the first thing you see when you arrive," explains Elias Tovar, project manager, Grin Contract Glazing. "It's a statement piece and it looks fantastic."

Tubelite's 400 Series screw spline curtainwall, fabricated with 11,261 sq. ft. of insulated glass with low-e coatings, brings in ample natural light by day and is backlit by night, radiating across the campus. "The floor-to-ceiling curtainwall and ultra-clear glass tower observation floor invoke the sense of expanse and are where some of the most remarkable views in all of the Red River Valley can be witnessed," relates Matti Roinila, AIA, ICON.

Inside the facility, four floors house a large auditorium, student study space, administration offices, classrooms, collaborative learning spaces and a hangar space for flight testing. The building's basement also includes an open research space with laboratories and simulators.

Additional Tubelite systems include 1,400 sq. ft. of 200 Series shear block curtainwall.

Tubelite
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CIRCLE 000

DAYLIGHTING

CASE STUDY

UNIV. OF CINCINNATI COLLEGE OF BUSINESS Cincinnati, Ohio

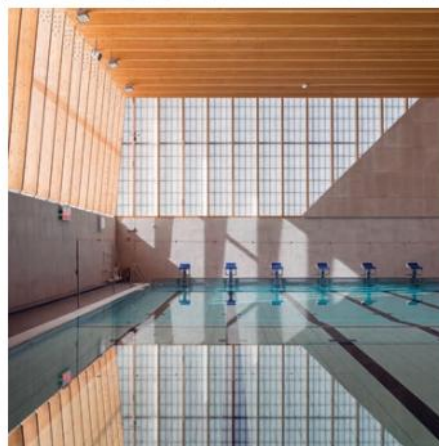
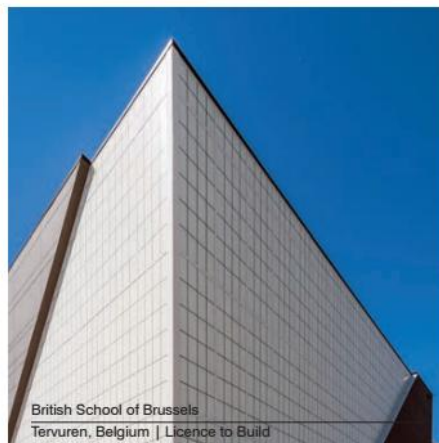
In performing parametric studies for the design of a building at the University of Cincinnati College of Business, Copenhagen-based Henning Larsen Architects evaluated different patterns and rhythms of components in an attempt to balance window-to-wall ratios with internal cooling loads in order to meet specific low-energy targets, and facilitate potential low-energy cooling systems and improve interior thermal comfort.

Ultimately, the majority of office areas were placed on the north façade to avoid overheating, reduce cooling demand and utilize what Jakob Strömman-Andersen describes as “stable daylight.” Alternatively, he says, classrooms were placed on the south façade to better deal with overheating due to higher air exchange rates. Situated deeper into the floor plate, the classrooms are also less challenged with solar heat gain.

“Working strategically with the façade, fenestration and systems of the building concept, we have managed to lower the energy cost savings by 24%, compared to similar buildings,” reports Strömman-Andersen.

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Vitro Architectural Glass

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CIRCLE 299

WINDOW HEAD HEIGHT DETERMINES HOW DEEP LIGHT CAN PENETRATE INTO THE FLOOR PLATE, SO ADDING GLAZING HIGHER UP ON THE WALL IS IMPORTANT.

Mills Group's Hess points out that while increasing the size of the windows can let more light in, not every additional area of glass will be equally effective. For instance, adding more glazing higher up on the wall is more important since window head height is what determines how deep light can penetrate into the floor plate. Similarly, toplighting can be very effective since it provides more light per glazed area.

Of course, thermal values are also a major variable as the larger the glazing area, the more thermal performance becomes an issue. Furthermore, in warmer climates, a higher solar heat gain coefficient (SHGC) is required as there are more cooling days than heating days. However, this thickens the window and lowers the opportunity to see in and out. Ultimately, when juggling light transmission, thermal U values and SHGC, compromises will have to be made somewhere. This is where the architects, lighting designers and energy consultants come in, to optimally design and tweak these values in order to deliver a well-lit, comfortable environment.

20 ▶

CASE STUDY

Divided Lite Design Preserves Historic Look for New Condos

Capturing the views of San Antonio's downtown skyline and nearby Pearl Park, Wausau Window and Wall Systems' terrace doors, patio doors and windows illuminate Cellars at Pearl's East and West Towers in Texas. A total of 460 window and door units—both 7000-FP series terrace doors and 8300-FP series fixed, projected and stacked windows—are engineered and fabricated with true divided lites to accurately replicate the historic, industrial look of the site's former 19th-century brewery's steel windows.

"Glassmaking technology in the years prior to World War II limited the size of individual glass lites, mitigating the use of putty-glazed muntin grids," explains Keith Lindberg, Wausau's regional sales manager. Only true divided lite design can reproduce this aesthetic with the fidelity required for rigorous historical preservation."

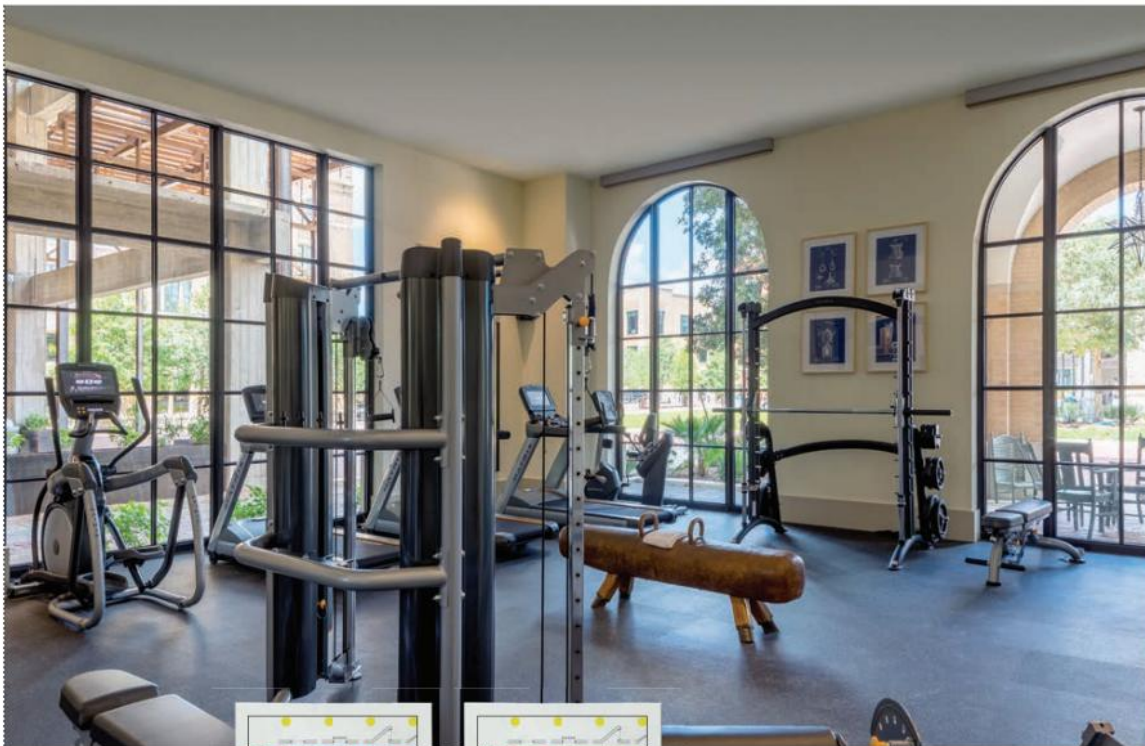
Wausau Window and Wall Systems
wausauwindows.com
 CIRCLE 298

DATAPOINT

LIGHTEN UP

According to DOE, 40% of a typical building's energy load. Good daylighting can reduce that number.

40%



◀ MODEL FOR A SOUTHERN CLIMATE

These models from WSP report the glare, daylight, energy results, Spatial Daylight Autonomy and Annual Sun Exposure metrics associated with a skylight, louver shades, light monitor and dispersed monitors.

◀ 19 Modeling Software

In order to deliver effective spaces, designers must start with a number of well-established equations. For example, the optimal head height, as compared to the depth of the room, is 2.5 times the head height of the window. With equations, "a trained professional can get pretty close, but then we utilize design software to take it from there," explains Hess.

For example, Mills Group uses Autodesk Green Building Studio and Lumion, which is a software tool that understands the geospatial setting of a structure, and can study shadows and the penetration of light into a space. Hess is a fan of Autodesk Insight 360, which helps users understand the building they're designing in relation to different standards. "Everything is right in the interface. It's an awesome simulation tool," he says.

Meanwhile, at the early stages of design, WSP uses a variety of parametric modeling tools within Grasshopper for Rhino to perform extensive sensitivity analysis of the façade design. "This allows us to determine which properties of the façade are most critical to reducing the loads of the building," explains Glassman. "It also gives us a number of different combinations of window-to-wall ratio, glazing types and thermal properties that perform well." For example, if more glazing is preferred, daylighting tools will demonstrate how higher performing glass will compensate for the loss of thermal performance. Then, using Grasshopper plug-ins such as DIVA, ArchSIM and Honeybee, integrated performance models are created where the daylight levels affect the amount of lighting energy being used in the energy analysis. In line with newer green building certification programs, Henning Larsen always uses the more dynamic modeling metrics like Spatial Daylight Autonomy and Annual Sun Exposure, which can be modeled on Diva for Rhino.

Nearly 30-ft.-high doors support the more than 400 corporate aircraft housed in the new 31,000-sq-ft. hangar at the DuPage Airport Authority in West Chicago, Ill.



Clerestory windows and surface-mounted skylights support natural daylighting efforts. Highly insulating clerestory windows and skylights from EXTECH bring in copious natural light to the large space.

DAYLIGHT IS A HUMAN RIGHT. IF A CHOICE HAS TO BE MADE BETWEEN WELL-BEING AND ENERGY EFFICIENCY, WE CHOOSE THE FORMER.

"In the early stages of our design process, we work strategically to use statistically and predictable weather data combined with simulation of estimated energy demand," explains Strømman-Andersen.

As an example, Denver-based RNL Design utilized LightStanza software to help determine the amount, size and placement of the glazing necessary for the LEED v4 Platinum-certified City of Fort Collins Utilities Administration Building. After analyzing location, sizing and configuration—then testing the building's massing and orientation—RNL, according to LightStanza Principal Daniel Glaser, was ready to focus on the main daylight goals for the project. "The first goal was to maximize interior lighting for all spaces of the building," explains Glaser, of the Boulder, Colo.-based software manufacturer. "The second—and most important part of the design efforts—was focused on mitigating glare inside the building."

DAYLIGHTING

CASE STUDY

THE RIGHT LIGHT

Home to a large concentration of corporate aircraft in Illinois, the DuPage Airport Authority sports a new 31,000-sq-ft. hangar. To better illuminate the facility 6,620 sq. ft. of highly insulating LIGHTWALL 3440 polycarbonate systems, clerestory windows and 2,480 sq. ft. of surface mounted and SKYGARD 3300 skylights from EXTECH, were mounted on the large, 29-ft.-high, hangar doors. "An airport really has two front doors," explains Mark Doles, director of the flight center—the one people see, and the one that aircraft crews see on the air side. "From both sides, we wanted the new hangar to be aesthetically pleasing and as efficient as possible."

EXTECH
www.extechinc.com
CIRCLE 297

In the end, RNL went with overhangs throughout the building's exterior, while redirecting light louvers positioned light upward and into the space throughout conference and open office areas.

Values to Live By

Context, as noted at the beginning of this piece, is an important consideration in building design. "I believe it is an essential role of the architect to create a building that is not only beautiful, but that also responds appropriately to the environmental forces acting on it and promotes the welfare of its occupants," says Glassman. At the end of the day, Henning Larsen' Strømman-Andersen believes that access to daylight is a human right, and if a choice has to be made between well-being and energy efficiency, the firm always compromises in favor of the comfort of the user. "If that requires a less energy efficient fenestration design, we must seek to make the building perform more efficient in other aspects," he concludes. ☐

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Integrated Design—and Construction

With integrated design comes integrated construction. Collaboration among all disciplines throughout the design process is key to the long-term success of any project. Better communication—and a synergy of understanding of all team members—is stressed from initial design to final completion.

John Mesenbrink has been covering the building and construction industry for more than 15 years, focusing his efforts on the plumbing and HVAC industries—including the launch of his website, which focuses on the installation side of mechanical systems.

To deliver net zero buildings, correct, detail-oriented, in-the-field installation is essential, or no matter how well a project is designed to perform, it won't. That said, for the net zero movement to progress, the design and construction team must be just that, and this may mean significant cultural change—a change that isn't always occurring.

"I have a sheepskin, you don't, so quit trying to change the designs." This was an exchange between an architect and contractor at an initial design meeting recently. "Typically, his way was the only way," says Jason Ridgeway, owner of Ridgeway Home Services, referring to one not-so-friendly exchange. "We would have meetings and the architects would send drawings for which I would tell them why, or why not it would work."

However, the ideal of cooperation fell on deaf ears. Often times, says Ridgeway, the contractor felt the only recourse was to make a heavy change order. "That, typically, was the only thing that made the architect see the day of light."

Integrated Architecture

Such clashes are contrary to the sometimes romantic notion of design teams working together with GCs, tradespeople and engineers to collaborate for a common goal—the health of the building. The love/hate relationship among disciplines still exists in many instances, and forward-thinking architects desiring to deliver high-performing buildings have to realize they'll encounter skeptics.

"We all know the architect is the conductor. He brings various trades together to create a finished, curated project. But our individual trade and work does not stand alone; it must be integrated with the architecture," says Dan Foley, owner, Foley Mechanical Inc., Lorton, Va.

According to David Jameson FAIA, David Jameson Architect, with whom Foley collaborates on projects in the D.C. area, when you are curating on how systems integrate into a project, you need outside-the-box thinking, and a contractor that fully understands the expectations of a project. "I rely on the contractor to figure the heat load calculation, for example, to match the aesthetic of the space, and when the job is done, the system performs as it needs to perform."

DPR Construction project manager Mike Messick shares similar sentiments, "Everything impacts everything else. Nothing stands alone," says Messick, when talking about its recent net zero project, DPR's San Francisco regional office.

24 ▶



▲ Getting all the players involved in the design and construction of a project "to the table" is critical when working on net zero or high-performance buildings. Collaboration is key.

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CASE STUDY

**VANDUSEN
BOTANICAL GARDENS
VISITOR CENTRE**
Vancouver, B.C., Canada

The goal of creating a symbiotic building was tangible, and even fated, early in the design process when both the design architect and landscape architect attended a preliminary design meeting carrying the same book: Karl Blossfeldt's "The Alphabet of Plants."

Inspired by the organic beauty of the site, both design architect and landscape architect found inspiration in the form of an orchid leaf, as photographed by Karl Blossfeldt. Blossfeldt was a German photographer, sculptor, teacher and artist who worked in Berlin, Germany.

At the time of project award and design, the Living Building Challenge had been in market place just over a year, and we saw it as the most leading edge green building certification tool which we could use to inform the sustainability performance goals, and ultimately, the goal of designing a net zero energy building, says Kathy Wardle, LEED AP BD+C, associate principal, director of research, Perkins+Will.

The collective design team has had an ongoing working relationship with the City's operations staff. The post-occupancy relationship is an equally important component of realizing this level of performance.



THE ARCHITECT BRINGS THE TRADES TOGETHER TO CREATE A CURATED PROJECT. BUT THE WORK DOES NOT STAND ALONE; IT MUST BE INTEGRATED INTO THE ARCHITECTURE.

◀ 22 Deciding whether to put thermal control—insulation—above the roof or below the roof impacted structural framing, lighting reflectance, PV connection, solar tube details, etc. "No one could assume that the change was 'minor' until asking every other discipline," says Messick.



Another net zero project, Vancouver's VanDusen Botanical Gardens Center in British Columbia, was so unique—it was one of the first Living Building Certified buildings—that it could not succeed without major collaboration. The project uses on-site, renewable sources—over 50 geexchange boreholes, a solar photovoltaic array, solar hot water tubes—in conjunction with passive design strategies to achieve net-zero energy on an annual basis. "Collaboration was critical on this project as the Living Building Challenge was a new experience to both owner and consultant team. All embraced the concept, but it was a learning experience," says John Ross, project manager, Vancouver Board of Parks & Recreation. The selection of a contractor, continues Ross, was also critical and in this case we were able to engage a contractor who was ready and willing to embrace the concept.

Work Source

At the same time, many contractors know where their bread is buttered, and the ability to land more work is essential to prosperity. A successful outcome on a project, says Dave Yates, owner, F.W. Behler, York, Pa., leads to other leads for other projects. "You need to be a diplomat when it comes to offering changes, and absolutely must be prepared to provide logical sound reasons to support your proposed alteration."

Part of the formula for success for a contractor entails keeping its people busy, says Yates, which involves significant time dedicated to sourcing and bidding work. Having established, positive, relationships with architects ensures the latter will want said contractor to be a participant on their projects. While that doesn't necessarily get you a free pass on bidding, says Yates, it can give you an edge. "Nothing pleases me more than hearing 'Your guys are the easiest, most professional—plumbers, installers, HVAC techs, etc.—we've ever worked with,'" says Yates.

A CONCERTED EFFORT FOR PASSIVE VENTILATION

A key to meeting such an aggressive energy performance goal at VanDusen was early buy in from the entire design team. Incorporating passive ventilation, the project uses heat recovery and operable windows linked to DDC controls.





Voice of the Contractor

And as projects and systems become more exotic and complex, the knowledge and experience of MEP contractors should not be underestimated. "I'm cursed by keeping current with the emerging and constantly changing technology," says Yates. "Where an architect might place an old-style lower-efficiency chimney-vented boiler, I see modulating condensing boilers. Where they dictate heat emitters utilizing and sized for 160/180°F water, I see low-temperature enhanced-comfort heat emitters—alterations that not only slash energy usage, but can greatly enhance comfort."

26 ▶



GEO-TO-RADIANT

This multi-residence home in Wisconsin features a geo- and radiant-floor system, which developer Jason Ridgeway worked together with the architect and general contractor.

GREEN CERTIFIED ▶
The complex, designed by HGA Architects and Engineers (HGA), has received LEED Platinum.

SUSTAINABLE ▶
Opened in 2013, the 73,767-sq.-ft. facility houses the physical science and life science departments.

CASE STUDY

LOS ANGELES HARBOR COLLEGE SCIENCE COMPLEX
Los Angeles

The building integrates numerous sustainable strategies to achieve net zero energy, including building-integrated photovoltaic panels (BIPV) connected to the campus PV systems, occupancy-sensor lighting, natural ventilation, abundant daylight, integrated building systems that respond to weather conditions. Also featured are systems that recover waste energy in exhaust air and recycle that energy and exterior corridors and outdoors classrooms that lessen energy loads.

"The building is designed to be net zero energy and its renewable energy plan was accepted as part of the LEED Platinum certification. For a high energy using building such as a science laboratory this is a major accomplishment," says Patrick Thibaudeau, vice president – Sustainability with HGA.

"WE ALL RECOGNIZE THAT WE HAVE A RESPONSIBILITY TO DELIVER A FINISHED PRODUCT TO THE CLIENT."

SOUND ATTENUATION

In addition to finding passive ventilation alternatives, working with acoustical engineers proved beneficial.

DPR CONSTRUCTION REGIONAL OFFICE
San Francisco

Acoustics were a huge concern at DPR's San Francisco office, especially with locating the work space over the top of their training and conference rooms. The existing wood-framed mezzanine was an acoustic nightmare for this layout.

DPR engaged an acoustic engineer and reviewed numerous options and decided upon adding an additional layer of plywood throughout the mezzanine and an acoustical rubber underlayment on top of the plywood, prior to carpet being installed.

Then the ceiling systems in the training and conference rooms consisted of double layers of sheetrock, insulation and vibration isolators. It turned out to be quite an involved and expensive, but well worth it, as the acoustics in these rooms has never been an issue.



Photo Credit: Drew Kelly

◀ 25

To the keeping workers busy point, Ridgeway points out that designers must have their ducks in a row, as frequent delays in plans create issues, not only with costs of labor and materials, but also expectations that the job be finished shortly after such changes without allowing the construction team to absorb said changes. Furthermore, sometimes architects are very demanding, which can be a challenge, says Foley, stressing it is hard work when, on some projects because of not clearly communicated instructions or plans, sometimes things must be done two or three times to get it right and sometimes it's because the architect does not like what he or she sees. It's not that hard work is abhorrent, it just needs to make sense in context of what everyone has agreed upon.

"The hard work and frayed nerves pays off when we deliver a one-of-a-kind mechanical system that is quiet, efficient, comfortable, silent and invisible," says Foley. In the end, "we all recognize that we have a responsibility to deliver a finished product to the client." [2]

CASE STUDY



YORK CITY HALL
York, Pa.

The city of York is one of F.W. Behler's largest clients. They moved from a smaller building to one that has over 100,000 sq. ft. The old city hall police station expanded to take over that building. They bid the PHVAC and were awarded the HVAC contract. The lead architect from Murphy & Dittenhafer Architects led weekly and sometimes daily meetings. Throughout the project, each of the trades were asked for



input and changes were accepted that vastly improved the quality of the finished product. The York City Police Station was a project on which Yates passed on the bidding process; he later "cleaned" up some mechanical glitches.

▲ **BID OPT-OUT**

Yates passed on the York City Police Station project. He later "cleaned" up some mechanical room glitches.

HARD WORK PAYS OFF WHEN WE DELIVER A MECHANICAL SYSTEM THAT IS QUIET, EFFICIENT, COMFORTABLE AND INVISIBLE.

FLEXIBLE

The design flexibility of the LG VRF solution allowed for the appropriate mix of indoor units to be used.



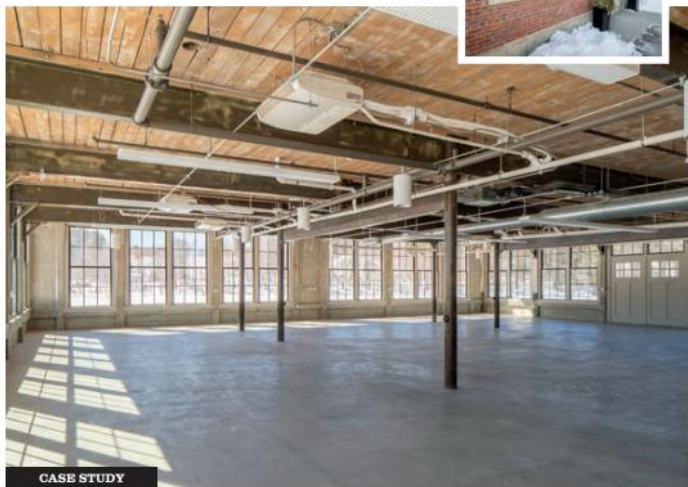
PRACTICAL

LG Multi V Water IV tied into the geothermal wells to deliver an energy-efficient HVAC solution.



COMFORTABLE

This mix of units met the comfort and aesthetic requirements of each interior space.



CASE STUDY

THE MILL AT DOVER-FOXCROFT

Dover-Foxcroft, Maine

Located on the picturesque Piscataquis River in Maine, The Mill at Dover-Foxcroft is 60,000 sq.-ft. complex comprised of nine structures built between 1841 and 1944. After sitting vacant for nearly a decade, Arnold Development Group embarked on a full renovation of the complex to develop a mixed-use building complete with residences, office space, a cafe and a boutique inn.

Located 100 miles from the Canadian border where during the winter months the temperature can frequently sustain below freezing temperatures, the new HVAC system needed to provide year-round comfort. On top of functioning in the extreme conditions, in order to achieve the desired net-zero impact, the HVAC system needed to be energy efficient while still delivering on the specific comfort requirements of the varying businesses operating throughout the complex. All of this had to be achieved with minimal modification to the structure for historic preservation.

After evaluating the needs of the project, Ranor Mechanical, recommended LG's Water Source VRF system to The Mill at Dover-Foxcroft. The robust solution featured 180 tons of LG Multi V Water IV Heat Recovery Units that tied into the geothermal well system and included a variety of indoor units, such as ceiling cassettes, wall mounts, high static ducted and floor standing indoor units. By implementing a predominantly duct-free solution, the small refrigerant piping was minimally invasive to the building's envelope.

| NZB: ENVELOPE |

Right From the Beginning

Early design charrettes can kick off a snowball effect of good decisions that will culminate in a truly efficient and balanced building. While often seen as frustrating and unrealistic, there are those who have embraced charrettes and have seen noticeable improvements in their projects.

Alan Weis, a contributing writer for *Architectural Products*, covers thermal management issues, including building envelope and HVAC systems.

Charrettes are great! Everyone's doing them... right? OK, perhaps not. The concept of getting as many design and construction teams together at the same time in the same place early on to brainstorm ideas that can set the course for the entire project schedule, while attractive to some, can strike others as inconvenient, frustrating and just plain unrealistic. But those who have learned to embrace them have seen noticeable improvements in their projects.

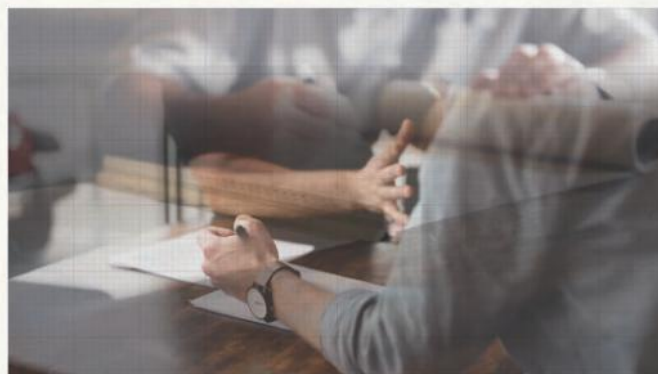
There are those who go all in on charrettes, such as Perkins+Will. According to its sustainable healthcare leader, Breeze Glazer, the firm holds sustainability and/or energy charrettes on nearly every project—and finds them to be quite effective. The meetings typically involve goal setting in collaboration with the owner and consultant team, while exploring related design strategies that may support those goals, such as envelope or roof ideas. However, the decisions on those items typically occur later during design after various options have been explored.

It's important to note that the charrette isn't where the decision-making process ends but rather where it begins. "The value of the charrette is to set the parameters that will guide the subsequent decision making, says Glazer. "For example, if the owner has mandated a LEED certification goal minimum like Silver, the discussion could include the potential impact of a green roof on that goal. If that becomes a supporting strategy to achieve that goal, the project then has a minimum square footage of green roof to work towards within the design process." The charrette often includes setting a minimum energy reduction goal and/or EUI target, which will also then guide the design and decision-making process that follows during design, Glazer explains.

For example, energy modeling typically starts at the same time and provides rapid feedback on relative envelope and roof design parameters, which lead to decisions on glazing selection.

As for achieving net zero, that's a decision that comes even before a charrette, says Glazer, and often involves a client/owner that sets such a goal in advance of hiring the architect, which is becoming more common today. "It is rare for an owner not to have that goal from the start, but instead be convinced to do so by the team they've hired," he notes. "That said, charrettes do greatly increase the low-energy/high-performance/sustainability goal of a building. Any project has the opportunity, regardless of the owner's initial intent, to achieve a higher level of energy performance if the team works toward that goal."

30 ▶



▲ Successful charrettes can lead to noticeable improvements on projects. Accepting and embracing charrettes as a viable part in the design process is an added ingredient to the success of a building.

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CASE STUDY

SAVIO HALL AT DON BOSCO PREPARATORY HIGH SCHOOL

Ramsey, NJ

The mill-finished aluminum roof of Savio Hall at Don Bosco Preparatory High School, Ramsey, N.J., makes for a light, reflective surface, meaning higher albedo (reflection of solar radiation) and reduction of the heat island effect, heat absorption by the building and reduced cooling loads. Additionally, mill finished aluminum does not require chemical finish, reducing the overall environmental impact. Moreover, aluminum roofs have a long lifespan, and the material is easily recyclable, meaning lower overall lifecycle impact.

The building envelope is a traditional brick on block veneer construction with double height curtainwall on the north-facing façade of the building, allowing for ample daylighting of the building's central space (cafeteria), while allowing for minimal solar heat gain. The frame of the curtainwall is detailed as thermally broken to mitigate heat transfer through the building envelope. The head and sill details of the system are thermally broken as well, resulting in additional efficiencies.

In the masonry and block cavity walls (west, east and south façades), a 2-in.-thick layer of high-density rigid insulation provides excellent R-value, while an air gap allows for the movement of heat energy that is transferred through the exterior brick face.



DAYLIGHT IN ►
The envelope allows for ample daylight in the building's central space, while allowing minimal solar heat gain.



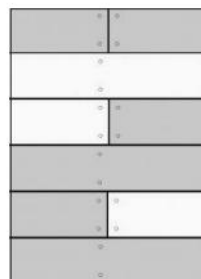
◀ THERMAL BREAKS
Windows in these façades are detailed with thermal breaks and are operable in the classrooms and other occupied spaces, allowing occupants to adjust for thermal comfort.

▼ BRICK ON BLOCK
The building envelope is a traditional brick on block veneer construction on the north façade. The curtainwall is adjacent to a deep loggia, which provides shading opportunities.

◀ 28 Early meetings can serve as a form of "clash detection" as well—e.g., potential battles for the roof in terms of elements like photovoltaics vs. skylights vs. vegetation. That said, while such situations do occur, Glazer assures that they are rare, noting that most of the time other parameters are at play that have reduced the potential options. But if the goal is to include all of these roof features, then it becomes a "where there's a will, there's a way" scenario. "For most projects, there doesn't have to be a choice," he notes. "If the goal is to have all three, there's a way to integrate them all. I'm working on a project now that includes a large green roof that integrate skylights, while elsewhere on the building is a PV array."

As important it is in setting the tone for a project, it's important not to overthink things in a charrette. Brett Bridgeland, project manager with Seventhwave, warns that engineers and energy modelers often get trapped in over-complicated compliance-type modeling that doesn't reflect actual building performance. "Charettes and the early phases of design should be quantitative, with an appropriate level of granularity and precision," he says. "This can be accomplished by new, streamlined tools coming on the market."

At Seventhwave, the organization has been working to scale the idea of performance-based procurement, which involves setting an EUI target as early as the RFP, and emphasizing that EUI at every charrette and design phase. Setting a contractually obligated EUI, says Bridgeland, focuses the design team on the energy goal and prioritizes the decisions that matter. "When you start putting EUI numbers behind envelope decisions in the upper Midwest, for example, you may see that exterior shading has minimal impact; south glazing design has modest impact; but westglazing design has a major impact. EUI-based design is inherently the only path to net zero, setting an energy budget and designing quantitatively within that constraint."



SELF-SEALER
The prefabricated PlankPanels rainscreen cladding system incorporates a double-hardened acrylic finish that can be easily installed on any building type with up to four different layout styles.

PlankPanels
www.plankpanels.com
CIRCLE 307

WINDOW-TO-WALL

Establish WWR

One key element to consider early in the design process is the window-to-wall ratio (WWR). If you start with a lower WWR and optimize the location of glazing, you can use those energy efficiency measures to drive down energy usage into the realm of net zero feasibility for low-rise buildings, notes Brett Bridgeland, project manager with Seventhwave. Very high-performing envelopes (triple-paned glazing, Passive House levels of insulation/infiltration) may allow significantly downsizing HVAC systems. In other words, he explains, controlling envelope loads allows you to jump to the next curve of performance.

That said, Bridgeland feels that there is an epidemic of designers defaulting to highly glazed buildings, partly because it can actually be cheaper on a first-cost basis to glaze an envelope than install an opaque alternative. Over-glazing has also become familiar and is perceived as a safe design, mistaking quantity of glass for quality of space, he notes. A space designed from inside-out, on the other hand, manages glare, privacy and comfort, while designing for daylight, views and experience.

"Designing the exterior for place and style involves consideration of materiality and tectonic, both of which go beyond simple glass," he says. "When it comes to glass, sometimes less is more. A successful net zero charrette marries form and function, including performance. It's not just a performance and cost exercise. The charrette should also result in an inspiring space."

"Without these voices, you risk losing the necessary buy in when it comes time for defining the sustainable priorities," he says. "At some point, hard choices must be made and a transparent process as possible is usually the most successful. The idea is to talk about big design ideas at the same time that sustainable ideas are being formulated.

The question of how early envelope decisions impacts HVAC systems is a critical one to consider, he continues, noting that working with the mechanical engineer as early as possible helps avoid having to "engineer" your way out of a problem scenario. This also means looking at a balance between passive design solutions—envelope tightness, access to natural light and ventilation, high insulation values—and active design solutions, such as building system controls, efficient HVAC, solar panels and energy recovery systems.

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AS IMPORTANT IT IS IN SETTING THE TONE FOR A PROJECT, IT'S JUST AS IMPORTANT NOT TO OVERTHINK THINGS DURING A CHARRETTE.

BOUNDARIES STRETCHED

The new academic building on the Cornell Tech campus sets a new standard for building development in New York City.

While it is well understood now that a successful charrette happens early in the design process and requires all key players at the table—ownership, tenant/leasing, architect, engineers, estimator, GC, subs and operations and maintenance—Bridgeland suggests adding two additional parties if the overall goal is to make net zero mainstream beyond institutional projects and or in mild climates: 1) finance partners who can help overcome barriers such as owner/tenant split incentives and capital hurdles and 2) utility partners who can offer services and incentives and identify additional value of energy efficiency and distributed energy resources in a much larger context.

It's also important to cast a wide net, says Stephen Katz with Gensler, noting that his firm favors an inclusive sustainable design vetting process in the form of charrettes or informal design sessions with stakeholders representing as many groups as possible. This typically includes owners, architects, engineers, contractors, government officials and community groups.

CASE STUDY

THE EMMA AND GEORGINA BLOOMBERG CENTER
Roosevelt Island, NYC

The Emma and Georgina Bloomberg Center, which opened in September, is the academic hub of the new Cornell Tech campus on New York City's Roosevelt Island and was built to "push the boundaries of current energy efficiency practices and set a new standard for building development in New York City," according to Thom Mayne, founder and design director of Morphosis, which designed the building.

The four-story, 160,000-sq.-ft. academic building is set beneath a photovoltaic canopy, with a low and narrow profile, and features a façade that's optimized to balance transparency—maximizing daylighting and exterior views and opacity. Designed as a rainscreen system, the outermost layer of the façade is composed of aluminum panels surfaced with an iridescent, PPG polymer coating.

The all-electric building features a low-maintenance green roof that houses native plant species along the southeast outdoor terrace to help cool the roof surface and manage stormwater runoff.



Photo Credits: Matthew Carboni for Morphosis

With terrible rainstorms rolling through the build site, DensElement became the best option for waterproofing.



IN THE NEWS



▲ CANADIAN 'SUPER TEAM' HEADS TO SOLAR DECATHLON

McGill University was invited to the 2018 Dezhou, China competition and later teamed up with multiple departments from Concordia University to form TeamMTL. In-kind contributions from one of the team's sponsors, ROXUL, included products from the stone wool insulation and roofing lines. The ROXUL team worked directly with TeamMTL to identify the best possible solutions, optimal product applications and consultations to perform thermal bridging and hygrothermal modeling of the wall and roof assemblies.

CASE STUDY



THE PUGET SOUND ENERGY SERVICE CENTER
Bellingham, Wash.

The Puget Sound Energy Service Center in Bellingham, Wash., has serviced the needs of Whatcom County since the 1970s. After four decades of operation, it needed an expanded facility to serve the growing population more efficiently, and the revitalization plan involved an increase 10,000 sq. ft to 28,000 sq. ft. Zervas Group Architect selected the Georgia Pacific DensElement Barrier System as the sheathing solution for the project—not realizing that general contractor, Tiger Construction, had already specified DensGlass with a separate water-resistant board.



◀ 31 "Balancing solutions means targeting the sustainable investments to have the greatest impact on the overall energy use of the project," he says. "There are numerous sub-strategies to focus on, such as reducing water usage or access to natural light but lowering the overall energy use (EUI) over the lifespan of the building is highly desirable goal. And, of course, incorporating very efficient HVAC systems and controls can help make that happen."

Like anything else, charrettes shouldn't take a one-size-fits-all approach. "Because the design charrette process is project-specific, participants can focus on the issues that will affect that particular building, its occupants and the surrounding area," explains Alex Drescher, roof garden project manager with Carlisle. "Gathering a diverse group of stakeholders to identify and define project goals helps to ensure that sustainability concerns such as energy use and storm-water management will be addressed, which often results in the selection of more sustainable roofing systems."

LIKE ANYTHING ELSE IN DESIGN, CHARRETTES SHOULDN'T TAKE A ONE-SIZE-FITS-ALL APPROACH.

Lastly, it's important to simply be realistic. "To set the right direction, it is important that early energy models reflect realistic envelope performance metrics, such as U-values," says Jeff Vaglio of Enclos. "An envelope's U-value is a reflection of its entire assembly, infill materials as well as framing elements, the latter of which can have negative impacts on overall system performance values. If preliminary assumptions rely on, say, a center of glass U-value in the energy model, the true system performance validated by a façade contractor down the road has a good chance of missing model expectations. Coordinating true assembly performance metrics early on helps mitigate a disconnect realized too late in a project." [2]



SELF-SEALER

Enverge Air and Vapor Barrier (AVB) is an asphalt-based, self-sealing wall barrier that provides energy savings and contributes to better air quality for building occupants. Its reduced maintenance costs are attributable to its moisture and thermal control, and self-adhered installation is available in 40-mil or 25-mil thickness.

Firestone
www.firestonebpc.com
CIRCLE 306



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| NZB: WATER |

Spec'ing High Efficiency

Social and financial benefits are two attractive factors when specifying high efficiency plumbing fixtures. But owners and designers alike take note: today's buildings—whether new construction or retrofits—demand closer attention to detail when considering high efficiency plumbing fixtures.

John Mesenbrink has been covering the building and construction industry for more than 15 years, focusing his efforts on the plumbing and HVAC industries—including the launch of his website, which focuses on the installation side of mechanical systems.

Every building is unique, and so is every building drain. Every time there is a reduction in the amount of water that goes into a building drain, there is a risk that problems can result. "The bigger the reduction, the bigger the risk," says Pete DeMarco, executive vice president of Advocacy and Research, The IAPMO Group. Thus, the highest risks, continues DeMarco, are in older buildings, which currently use older water guzzling toilets, for example, that flush at consumption levels of 3.5 gpf or more, and are being replaced with high efficiency models. In such cases, a careful evaluation of drainline carry is critical, stresses DeMarco.

For new construction, the drainline will be free from such defects as slope inconsistencies, root intrusions and other problems associated with aging of the drainline pipe. **The critical variables to keep in mind are the length and slope of the building drain and the consumption level of the toilets being installed.** The risk that blockages will occur increase as the length of the building drain increases and the slope, which can vary per the plumbing codes between 2% and 1%, decreases. The Plumbing Efficiency Research Council (PERC) research—which DeMarco spearheads—found that even in very long drains, today's most common high efficiency fixture consumption levels provide for adequate drainline transport of solid waste where the drainline is free from defects.

If there are extremely long horizontal building drains, consider a solenoid valve and timer at the ends of each to periodically flush the drain and the water supply pipe, suggests Ron George, CPD, president, Plumb-Tech Design & Consulting Services, LLC. "This can often be accomplished with a hub drain and an air gap in a janitor's closet near the toilet rooms," says George.

On retrofit projects, it's also important to investigate the condition of the drainline to determine if repairs are needed prior to installing high efficiency fixtures. PERC research indicates that the problems associated with older building drains result in greatly reduced drainline transport distances, which increase the potential for blockages to occur. Where degradation of the building drain is evident, repairing the drainline and ensuring consistent slope is essential to avoiding problems. For toilets, high-efficiency models have a maximum consumption of 1.28 gallons per flush (gpf). However, manufacturers can design toilets with lower consumption levels. PERC found that the risk for blockages increases dramatically as flush volume drops below 1.28 gpf when installed in non-residential applications with very long building drains, especially on drainline with less than 2% slope thus not recommended in such installations.

36 ▶



Save the Date

April 17-19, 2018 | Pittsburgh, PA

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Rocky Mountain Institute (RMI) and New Buildings Institute (NBI) are once again joining forces to bring you the premier global event dedicated to defining the future of low energy and zero energy buildings.

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NBI is now working with the International Living Future Institute to streamline and strengthen the tracking, verification and certification of ZE buildings. Stay tuned for details.

Sponsorships for the 2018 Getting to Zero National Forum are available. For more information contact: Eric Bruckbauer, eric@newbuildings.org.

WATER



HIGH DEMAND ▶

Airports such as LAX run every day of the year, so maintenance demands important focus.



SOLAR CAPACITY ▶

The faucets also harvest light energy to deliver a complete sustainable solution.



CASE STUDY



STEALTH MODE

The Stealth Phantom is synonymous with sophistication; making it the most upscale ultra-high-efficiency toilet on the market. This toilet touts patented Stealth Technology with a whisper quiet and powerful flush. Eco-minded luxury in a lean silhouette, the narrow tank and smooth, skirted bowl add a sleek touch to any modern bathroom. The Phantom makes it effortless to forget your old toilet by easily covering the existing footprint with its large, extended footprint design.

Niagara Conservation
www.niagaracorp.com
CIRCLE 305



LOS ANGELES INTERNATIONAL AIRPORT (LAX)

Los Angeles,

Thanks to the \$14 billion LAX Modernization Project, building owners have added new and updated concourses, restrooms and other spaces with the goal of maximizing sustainability and efficiency. Architects had to specify commercial restroom products they knew could handle the high volume of users. A variety of Sloan products were selected for restrooms throughout the facility, where contractors benefit from easier, more cost-effective maintenance, while the design aligns with the architects' vision for a restroom of the future. Sloan Optima Automatic Sink Faucets are CalGreen certified, meeting the building owner's need for water sustainability. Standard High Efficiency Urinals (HEU), are also WaterSense listed and feature Royal automatic sensor flushometers, provide LAX maintenance personnel convenient cleaning and reduced maintenance costs.

◀34 In addition, you should be asking, "are there existing oversized drains"? Oversized drains reduce the hydraulic depth of flow. "For example, with shallow water in a channel, boats will drag the bottom of the channel. Boats that drag on the bottom of a stream do not travel very far down the stream or channel. Only increased flows will raise the hydraulic depth of the stream or channel—drain pipe, in this case—allowing the boats to continue downstream," says George. However, PERC research found that drainline diameter was a non-significant variable in determining drainline transport distances, as long as the drainlines are sized per code.

Financial & Social

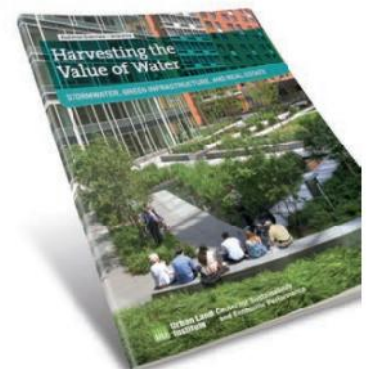
Nonetheless, there are economic and social benefits to installing high-efficiency fixtures. From a building ownership perspective, the biggest driver for installing high-efficiency plumbing fixtures is cost avoidance. "Water rates and wastewater treatment costs are increasing around the country at a higher pace than energy costs and many other operational cost considerations. This trend is expected to continue and accelerate especially in areas of water scarcity," says DeMarco. The savings from installing water-efficient products and systems in and around buildings—paying special attention to installing water efficient landscape irrigation systems—will increasingly pay back dividends over time.

REPORT

Report Explores Creative Use of Green Infrastructure, Enhancing Property Values

The growing involvement of the real estate industry in helping municipalities manage stormwater runoff with systems using natural resources is explored in a new Urban Land Institute (ULI) publication, *Harvesting the Value of Water: Stormwater, Green Infrastructure, and Real Estate*.

The report looks at how water management mechanisms using green infrastructure can create value for real estate projects by improving operational efficiency as well as serving as an attractive amenity. Green infrastructure, explains the report, includes pipes-and-pumps alternatives such as rain gardens, bioswales and green roofs, which are often accompanied by water storage and recycling tools such as cisterns. These types of sustainable stormwater management practices can provide benefits for building users as well as the environment.



CASE STUDY

THE EDITH GREEN-WENDELL WYATT FEDERAL BUILDING
Portland, Ore.

The federal building, an 18-story, 512,474-sq.-ft. office tower in downtown Portland, achieved 65% water savings through a dual strategy of incorporating water conserving plumbing fixtures together with a rainwater collection system. Over the course of a year, an impressive 626,544 gal. of rainwater has been collected and reused, the equivalent of seven competition-size high school swimming pools. During winter months, rainwater accounts for up to 85% of total building water use.



Photo Credit: SERA

▲ DUAL STRATEGY

The dual strategy of using water conserving fixtures and rainwater harvesting proved beneficial to the building.

The social benefits are also important to realize. In 1992, the Energy Policy Act (EPAct) added plumbing fixtures to the list of federally regulated products. Utilities across the country have since seen dramatic reductions in water use. In cities like Los Angeles and Seattle, water use has stayed flat despite high population growth. This means that less energy is used to extract water from surface or groundwater sources, less water needs to be treated to drinking water standards and pumped to homes and buildings, and less wastewater needs to be treated. This helps extend the useful life of existing water infrastructure, which are already under stress and in a state of disrepair in most areas of the country.

Although, low-flow fixtures were only mandated in new construction, existing higher-volume fixtures could remain in existing buildings. "As those older fixtures are being replaced, we are seeing a noticeable increase in drainline blockages. The increase in drainline blockages started to appear shortly after these requirements went into effect and further water conservation efforts have reduce the flows and as new products like flushable toilet seat covers and flushable wipes have appeared we are approaching or may have past the point of sustainable water flow reduction," says George.

WATER EFFICIENCY

Low-flow Specs

Specifying high-efficiency fixtures takes careful consideration. Ideal for low flow are:

- ▷ Buildings of three stories or more
- ▷ Buildings with a high density of frequently used plumbing fixtures
- ▷ Buildings with high populations
- ▷ Buildings with in-house wastewater treatment and re-use

Not suitable:

- ▷ Buildings with long water service pipes (More than 200 ft.)
- ▷ Buildings with long building sewers (More than 200 ft.)
- ▷ Buildings with oversized existing building sewers
- ▷ Buildings that are flat or two-story buildings
- ▷ Buildings with long horizontal runs of water and sewer pipes
- ▷ Buildings with seasonal use
- ▷ Buildings with graywater recycling systems
- ▷ Buildings with water reclaim systems
- ▷ Do not use low-flow showerheads on older style two-handle shower valves.

Install new shower valves with balanced pressure or thermostatic controls conforming to code.

Source: Plumb-Tech Design & Consulting Services, LLC



▲ **SIZABLE COLLECTION**
Oldcastle Precast provided the 800,000-gallon cistern for rainwater collection.

▲ **WATER SAVINGS**
The system is expected to save 1.2 to 1.6 million gallons of water per year.

LIGHT RAIL HARVESTING

When the City of Santa Monica began planning a nearly 80,000-sq.-ft., state-of-the-art Operations and Light Rail Vehicle Maintenance Facility for the L.A. Metro, they needed to reduce stormwater runoff on the property by California ordinance.

Wahas provided a system designed to treat harvested water to California Title 22 standards so that it could be safely used to irrigate the landscaping and to provide water to wash the train cars. The system uses OptiRTC technology to monitor weather events and manage cistern levels so that detention capacity is available. The harvested water helps reduce potable water use by 40% at the facility, and provides 50% of the municipal water needed for landscape irrigation.

◀ 37

Public sewer systems are increasingly having to deal with giant clogs or balls of grease and flushable wipes that congeal together where the flushable wipes act like reinforcing concrete, such as England's "Fatbergs," named by the London Sewer Dept. Another thing to consider when evaluating a building while specifying high efficiency fixtures is whether there are other graywater, water re-use or water reclaim systems in the building that will take away graywater drainage flows that would normally be used to assist with sanitary drain line transport of solid waste. "If so, and you have a large flat building with plumbing fixtures that are long distances from each other, try not to reduce water flows beyond the code required maximums," says George.

RESEARCH

COST AVOIDANCE

For more on the cost avoidance benefits of water efficiency, the Alliance for Water Efficiency has conducted research that details how water conservation has helped keep water rates lower in three U.S. communities.

The reports can be downloaded at:
www.allianceforwaterefficiency.org

Going Green: Doing the Right Thing

In the last 20 years or so, environmental conservation and green building programs seem to have brainwashed some people into thinking they must reduce water flows to gain points for green building programs, says George. "Be careful not to fall into the trap of doing things to gain points especially when there are other recycling or re-use water systems. It is very difficult for a drainage system to perform well—removing solid waste—when there is little to no flow of water going down the drain."

"Points for an energy and environmental design certificate to hang on the wall can be very expensive," says George. The energy and environmental or water conservation programs use simple math to show water flow reductions and savings. Most of the calculations do not take into consideration the life cycle cost of water consumption savings.

"There are certification costs for the design team, the building owner, the building, and the life-cycle cost of water consumption savings vs. the additional costs associated with the several drain cleaning services required each year for many buildings that comply with ultra-low flow requirements," says George.

▼ FACILITY UPGRADES

Some of the facility upgrades include replacing existing aged pump and fan motors with premium efficiency motors and installing variable frequency drives.



▲ IMPROVING EFFICIENCY AND CONTROL

Facility upgrades will not only reduce energy consumption, but will impact patient comfort by way of better efficiency and control of heating and air conditioning equipment.



CASE STUDY

VA Efficiency

According to a recent U.S. Dept. of Veterans Affairs (VA) Scorecard on Sustainability/Efficiency, only 15% of VA facilities are considered sustainable, and 23% of facilities are not on track to meet their energy intensity reduction goals. The partnership with Schneider Electric will provide new resources to help the VA close these sustainability and efficiency gaps while also addressing the tight budget constraints that many VA facilities face.

Schneider Electric will implement more than \$7 million in infrastructure upgrades at the VA Medical Center in San Juan, Puerto Rico, part of the Sunshine Healthcare Network (VISN 8). The project will include comprehensive facility improvements and upgrades that will enhance patient care, all delivered with no up-front capital investment through a guaranteed energy savings performance contract (ESPC).

Schneider Electric will guarantee more than \$1 million in annual energy savings to the VA to fund the improvements over the life of the project. A significant portion of the work focuses on water conservation efforts to alleviate high water bills brought on by recent drought conditions and a remote water island environment, which drive up the price of fresh water. By installing efficient fixtures, the VA will be able to significantly reduce water consumption, which translates to utility savings.

EVERY BUILDING IS UNIQUE; PLUMBING SYSTEMS ARE ALL DYNAMIC, AND ALL WATER SUPPLY AND DRAINAGE ISSUES MUST BE CONSIDERED FOR THE SYSTEM TO BE SUSTAINABLE AND FUNCTION AS INTENDED.

Further, he adds, in the case of a sewage overflow problem, you'll need to factor the cost of clean up; the disinfection and treatment of water distribution systems fouled with Legionella bacteria and other organic pathogens—which, because of stagnant water, chlorine or water treatment chemicals used to control bacteria growth are not able to do so. Also, George says, one must add the cost of loss of business during the times the sewers are backed up, or when the water supply is shut down because of bacteria in the water supply.

As a result, the engineer would like to see no further drain-flow reductions until there is data to support further drainage flow reductions. "Currently, every time someone with good intentions proposes further water-flow reductions, the code committees have voted for them with no scientific data to support it—who could be against saving water? But as these drain-flow reductions are being enforced, we are seeing increasing numbers of drain blockage problems. More research is needed," says George.

Lesson learned: plumbing systems are dynamic, and all water supply and drainage issues must be considered for the system to be sustainable and function as intended. ☑

| NZB: ONSITE POWER |

Microgrids Gaining Macro Attention

Microgrids can support both net-zero and resiliency goals by pairing renewables with additional, less-intermittent resources to enable full off-grid operation. Two projects illustrate the range of possibilities—both behind the meter and at utility scale—for supporting a greener and stronger grid.

Chuck Ross is a freelance writer covering building design and technology topics. He has been writing about building efficiency issues, including onsite energy and demand-side management topics, for more than 20 years.

When the net zero movement began, emphasis was primarily on designing individual buildings that were essentially electrically self-supporting, with the latter using onsite renewable resources, on a net, annual basis. Greenhouse gas reduction was the primary driver, rather than resilient self-sufficiency. For a number of reasons—including an appreciation for economies of scale and increased demand for resilience in the face of recent severe-weather events, this building-by-building approach to meeting a facility's energy needs is evolving. Microgrid technology is one approach to meeting both environmental and resiliency goals that's getting increased attention today. By allowing developers to tie multiple buildings to either multiple or centralized generation resources, a microgrid can lead to lower per-building installation and connection costs. And, with sufficient generation diversity, microgrids can disconnect from local utility grids during outages to keep the buildings they support up and running. Increasingly, these systems also are being used to reduce utility-billed demand charges and provide new income streams as suppliers of both added grid capacity and grid support services.

Up until recently, college campuses and military bases have been the primary consumers of new microgrid systems, but demand is growing quickly in other markets. Commercial and industrial (C&I) applications are on the verge of rapid growth, according to Navigant Research. Global annual C&I capacity growth is expected to top 5,300 megawatts (MW) by 2026, from this year's anticipated 448 MW. While the Asia Pacific region will lead this expansion, North America will be the second largest market, growing to 870.8MW annually by 2026. This rapid uptick over the next decade also will see C&I applications becoming

a bigger contributor to the overall microgrid market. C&I projects currently represent almost 20% of the market, with a 2017 value of \$1.9 billion. By the end of this report's forecast period, the C&I sector's market-spending share is expected to climb to more than 35%, to \$18.3 billion annually.

Two recent installations show the broad range in scale in which today's microgrid developers are operating. Supporting just a single building, a Minneapolis project is helping a data center operator more affordably maintain the constant cooling such operations require, while also ensuring a secure, uninterrupted power supply. And, at a much larger scale, a major Midwest utility recently powered up its own microgrid to support an entire utility distribution circuit. Almost 200 commercial and residential customers, along with the utility's own technology center, are being supported by this ambitious installation.

42 ▶



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IN THE NEWS

PV's Future Bright Even Post Eclipse

August's solar eclipse proved California's ability to manage large shifts of solar power on and off the grid, as 3,400 megawatts of PV-supplied electricity was smoothly replaced with generation from hydropower and gas plants through the event's short duration. Things went just as well for other systems falling under the eclipse's trajectory, with many grid operators losing less solar generation than had been predicted.

INTEGRATED ▶
The electric-drive absorption chiller at the heart of OATI's cooling system is fully supported by the microturbine system, which provides both electrical power and waste heat.



SYNERGISTIC ▶
OATI's natural gas microturbine generates both electricity to power building operations and heat, which feeds an absorption chiller to keep both occupants and server rooms cool and comfortable.



LITHIUM-ION BATTERIES RESPOND QUICKLY TO BALANCE FLUCTUATIONS. FLOW BATTERIES HAVE A SLOWER RAMP RATE, BUT CAN RUN FULLY CHARGED TO FULLY DISCHARGED.

◀ 40 **Hard-working Showcase**

When software company **Open Access Technology International (OATI)** was planning its new data center and office space in the Minneapolis suburb of Bloomington, Minn., a microgrid became part of the design early in the design process. OATI specializes in cloud-based software applications that help utilities, independent system operators and energy traders manage power distribution. It made sense to develop their own miniature distribution system to showcase how its GridMind software can optimize multiple generation resources to meet multiple demand requirements.

Most significantly, as one of the company's data operations hubs, the building—dubbed the OATI Microgrid Technology Center—had some pretty specific performance targets, specifically a need for constant, 24/7 cooling. According to David Heim, the company's chief strategy officer, this made a combined heat and power system a natural, as the centerpiece for both power generation and cooling. The 600-kW natural gas Capstone microturbine supports both on-site electricity demand and supplies waste heat for the absorption chiller that keeps the company's servers running smoothly.

"Cogeneration, in general, with heat capture used for cooling, is a great application where you have a constant cooling load," Heim says. "Anywhere you're looking at a constant, 24x7 cooling or heating need, or both."

Additional on-site generation resources include a 150-kW rooftop solar array, a 24-kW array of roof-mounted vertical-axis wind turbines, a 1500-kW diesel backup generator and an energy storage system combining both flow and lithium-ion batteries. While it's unusual to see multiple battery types in the same installation, this pairing made sense for OATI's operations.

"We did an analysis of different technologies and ended with the Ensync flow system and lithium-ion," Heim says, noting how each added to resiliency and power-quality goals. Lithium-ion is especially good at responding quickly to help balance instantaneous power fluctuations. Flow batteries have a slower ramp period, but they're designed to reliably be run fully charged to fully discharged constantly.



FUEL CELLS IMPROVE

In Japan, fuel cell systems producing both onsite electricity and waste heat for hot water have become popular, and now are being introduced in Europe. Kyocera, in fact, has introduced a solid oxide option in the 3–5kW range, suitable for institutional use. The unit, delivers 52% generation efficiency, and an overall efficiency of 90% when exhaust-heat recovery is optimized.

Kyocera
www.kyocera.com
CIRCLE 304

“PART OF OUR OBJECTIVES WAS TO BE ABLE TO USE IT AS A SHOWCASE OF HOW A MICROGRID CAN INTERACT WITH, AND SUPPORT, THE LOCAL UTILITY.”

This hybrid system, designed by engineers with the Minneapolis-based engineering firm Dunham, combines renewables, storage and traditional diesel generation; it has the capacity to carry the entire building load—and does so most of the time, according to Heim. Coming up with the right mix of generation resources to support the data center, OATI's own staff needs, and the demand of tenants now leasing the building's top two floors, required significant modeling. Also built into these calculations, says Heim, was a recognition that both building demand and on-site resources could increase in time. OATI's operations are anticipated to grow into the currently leased space, over time, and plans are already on the boards to install additional solar panels over an on-site stormwater detention pond to support charging equipment for electric vehicles, which could become an added resource in a sort of vehicle-to-grid arrangement.

Despite adequate on-site generation, though, Heim says the building was never intended to operate entirely independent of the local grid for an indefinite period. There are times when the control software turns to imported power from the local utility, Xcel Energy, just as there are times when the building becomes a net exporter. Adding utility pricing and other data into GridMind calculations, and resulting system operations, was another goal of the project.

“Part of our objectives was to be able to use it as a showcase of how a microgrid can interact with, and support, the local utility, as well,” says Heim—an especially timely capability, given the results of this year's active storm season. “I expect this conversation topic to take off like crazy, after all the hurricanes we've had lately.”

44 ▶

**LARGER BACKUP OPTION**

Diesel generators remain a go-to option for on-site backup and prime-power applications, but their efficiency can depend on how well output is matched to facility demand. Kohler Power addresses this issue with its new KD Series of industrial generators, featuring company-designed G-Drive engines. The generators can be specified at any of six stand-by power ratings, between 800 kWe and 4000 kWe, providing more efficient fuel consumption at a broad range of outputs.

Kohler Power

www.kdseries.com
CIRCLE 303

BRINGING NEW SMARTS

Tigo's new TS4-R retrofit system pairs a universal mounting bracket that snaps onto standard PV panels with a choice of three electronic covers, each featuring upgraded capabilities for monitoring, safety and system optimization. The three Duo covers all work with any inverter and any PV panel that falls within stated electrical specifications.

Tigo

www.tigoenergy.com
CIRCLE 302

**IN THE NEWS****Real Power, with Virtual Delivery, Funding More Wind Development**

Kimberly-Clark and Anheuser-Busch are among the latest corporations to fund utility-scale wind farms to virtually offset electricity used at manufacturing facilities across the U.S. and around the globe. The companies both recently signed large “virtual” power purchase agreements (VPPAs) that will add hundreds of megawatts of wind-generated electricity to the grid, though it won't be supplying either company's operations directly.

Kimberly-Clark has signed up to purchase the output from two new wind farms, Santa Rita Energy Center in Texas and Rock Falls Wind in Oklahoma (shown here), for a total of 245 MW, which the company says will equal about a third of its North American manufacturing demand.

Anheuser-Busch's deal, for 152.5 MW from Oklahoma's new Thunder Ranch project, represents about half that facility's total output. While these VPPAs will bring both companies closer toward their respective sustainability goals, the contracts also could represent a new income stream.

Under a VPPA, a company agrees to buy a wind farm's output at a contracted rate from the project developer. The developer sells that electricity into regional power markets at the market price—if that price is higher than the contracted rate, the corporate buyer gains a windfall. As a potential downside, when market prices fall below the contract rate, the corporate buyer is responsible for the difference.

**▲ ENERGY PRODUCTION AT ROCK FALLS WIND**

Renewable energy produced will provide Kimberly-Clark with power equal to a significant portion of the electricity needs of its North American manufacturing operations.

◀ THE ECONOMICS

The project has created more than 150 jobs since start of construction in July 2017 along with millions of dollars injected into the local economy.

IN THE NEWS



When a Microgrid is the Only Grid

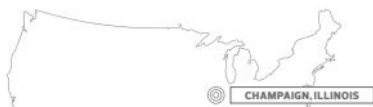
Though only 14 mi. off the coast of one of the nation's most congested electricity markets, the Massachusetts island of Cattyhunk has always stood alone when it comes to its power supply. A new microgrid has made electricity both more reliable and less expensive for the island, by tying new solar panels and storage to existing diesel generators. Output from the 1020 new PV panels now takes precedence over that from the generator, thanks to a Princeton Power Systems microgrid controller. The 1.25MWh Samsung lithium-ion battery system then steps in, with the generators picking up the slack as storage depletes. During the first summer, PV covered half the island's demand, and that figure is expected to rise to 80% in off-season months. Annual diesel consumption, however, is expected to drop by 30,000 gallons.

MULTI-SOURCING ▶

Ameren's multi-sourced microgrid incorporates a 100kW wind turbine, along with a 125kW solar array and two 500kW generators. The equipment is co-located with the utility's Technology Applications Center, adjacent to University of Illinois Champaign-Urbana.

◀ 43 Utility-Scale Aspirations

While the OATI project covers a single building, another ambitious effort considers microgrids at a significantly more macro level. The Illinois utility Ameren recently flipped the switch on a system designed to support an entire distribution circuit. It's installed at Ameren's Technology Applications Center adjacent to the campus of the University of Illinois in Champaign. In addition to supporting that facility's operation, the distribution circuit also serves a mix of residential and commercial customers, along with a cell tower, for a total of 192 customer meters.



"They were looking for a way to support the grid of the future," says Chris Evanich, microgrids director for S&C Electric, the Chicago-based electrical manufacturer that designed the system and supplied switchgear, controllers, energy storage equipment and management software. "They could have done something at a service center just for utility assets, but they have real customers out there." Included in the the microgrid's generating assets are a 125kW solar array, a 100kW onsite wind turbine and two 500kW natural gas generators. Additionally, a 250kW/500 kilowatt-hour lithium-ion battery system allows operators to smoothly switch between the local resources and grid-supplied power. Combined, the system totals 1.4 megawatts of production capacity.



ENERGY MANAGEMENT

The PureWave SMS 25 Storage Management System provides the controls critical to smoothly transition Ameren's microgrid from utility-supplied power to onsite resources. This capability is critical to ensuring reliable service to the 190 connected customer meters.



▲ BACKUP GENERATION

Ameren's two 500kW natural gas generators provide full backup for the 1MW distribution circuit served by the microgrid, complementing the onsite solar array and wind turbine.



GOING LARGE-SCALE

While more likely to be used in utility-scale wind farms than in distributed applications, GE's new 4.8-158 onshore wind turbine could make wind a more appealing resource in low-to-medium wind speed regions. The 4.8 MW turbine features a 518-ft. rotor diameter, which is the largest in its class.

Its towers are tall enough to result in blade tips reaching up to 787 ft. above the ground. At such heights, the turbines can better access higher wind speeds to produce more electricity and reduce resulting energy costs.

GE
www.ge.com
CIRCLE 301



▲ PERFORMANCE AND RELIABILITY

The wind turbine will set standards for annual energy production and electricity generation costs, and feature wind technology focused on performance and reliability.



▲ LOSS REDUCTION

The entire DFIG—doubly-fed induction generator—electrical system is integrated in the machine head of the onshore turbine to enable the reduction of line losses.

Evanich says the storage, with its accompanying control software, is a critical ingredient, especially when dealing with a system at this scale, and with this many customers depending on reliable electricity supplies. "All of the major capabilities come from the energy storage system," he says, noting this equipment's importance to smooth switching between power sources, both within the microgrid and with the larger distribution grid. "It's done seamlessly. The voltage and frequency is all stabilized by the energy storage system—it's really the backbone of the system."

Evanich makes clear that, although the microgrid will be a test subject for Ameren's technology center, the utility sees significant commercial potential in the installation that far outweighs its value as a research tool. The company has identified 15 different use cases for similar projects elsewhere in its system. "Let's take a look at our most important customers, let's take a look at where we have system constraints," Evanich says, ticking off multiple examples of distribution grid locations where adding generation resources and redundancy could improve operations. "They were capable of demonstrating so many different benefits."

ALTHOUGH THE MICROGRID WILL BE A TEST SUBJECT FOR AMEREN, THE UTILITY SEES SIGNIFICANT COMMERCIAL POTENTIAL THAT FAR OUTWEIGHS ITS VALUE AS A RESEARCH TOOL.

Though it's been operational for less than a year, the project already is attracting attention from other U.S. and Canadian utilities. North Bay Hydro, the utility serving the city of North Bay in northern Ontario, has signed a deal for a similar microgrid to power a community aquatic center and ice rink, which will also enable those facilities to operate as a community refuge if the utility grid goes down. And Ameren is continuing to explore additional opportunities throughout its service territory.

"They're still at the stage where they're trying to pick out other sites," Evanich says. "What you'll hear them say is they're extremely happy with the microgrid—the phrase they use is, they're trying to transform tomorrow with innovation." 

IN THE NEWS

Reliability for Rent

Buying and maintaining on-site backup generation can be an expensive, but essential proposition for small- to mid-size commercial operations that need to keep doors open and refrigeration equipment running at night. Now some entrepreneurs are borrowing a page from solar-lease pioneers and offering generator-based reliability as a monthly service, while aggregating the output from their distributed generators to participate in local electricity markets. One pioneer in this plan, Houston-based Enchanted Rock Energy, now has its natural gas generators installed at more than 60 H-E-B supermarkets across Texas. During Hurricane Harvey, 18 of those stores were able to keep running during and after flooding struck the region late this summer thanks to those generators, along with controls allowing the stores to island their operations from the local distribution system.



OPERATIONAL

The grocers' fleet of stores were able to stay operational post-Hurricane Harvey, thanks to its unusual power agreement.

| NZB: LIGHTING |

Lighting Decision Making

Thanks to terrific Internet tools like SurveyMonkey and WordPress, there's no reason not to democratize lighting design to include a project's future occupants directly into the design process. This way real feedback supersedes assumption of what people want or need.

Kevin Willmorth is a lighting professional who has emphasized lighting conservation for more than 30 years. He helped create *Architectural SSL* magazine and remains its editor. He is also the owner of Lumenique, a consultancy focused on deploying SSL products.

The explosion of available information is changing the face of design, and lighting is no different. Conventional lighting design decision-making has relied heavily on the preferences of design teams, tempered by regulatory requirements and customer influence. Prior to the Internet, free data access, and open networking, information used in decision making came from seasoned subject experts, be they architects, daylighting specialists, lighting designers or electrical engineers, who brought their knowledge to the table in charette-style discussions. End users, historically, have been represented by proxy of subject experts, as are financial management interests. Scientists, specifically those focused on the effect light has on human well-being, unfortunately, are represented only through variable interpretations, composited opinion and marketing influencers. Because of this, the pace of movement from new understanding to legitimate adoption is slow and frequently distorted by special interest cherry picking data to sell product. **The use of objective information to gain new insight, however, creates a deeper bench of participants, transforming professionals from proxy representatives to process experts.** The future of design decision making changes from what a team knows, to how teams use process to capture information to know more than they did before starting any design project.

More information is now available to do so; white papers are an excellent source, and now widely available, as are presentations and conference proceedings, which can be parsed for use to support design approaches with objective data. Research that is presented and published for peer review is always sounder than data points presented by marketers. Further, when properly vetted—usually by seeking corollary work with

similar conclusions—the level of knowledge throughout the design team and end customer is elevated.

But there's a way to go even further: collect user information through open survey portals, such as SurveyMonkey, as an opportunity to include occupants into the process. How? Publish a brief of a design concept with alternative renderings to choose from on a closed blog using a service such as WordPress. Within it, embed links to survey questions to elicit input which puts those who will live in the end-result inside the process. Alternatively, present concepts for input via online meetings—or simply use Dropbox to download a presentation users can view at their convenience. These tools allow designers to move from assuming what a group might think to receiving real-time feedback.


48 ▶




A surplus of information is available to end users, and it's changing the face of design.

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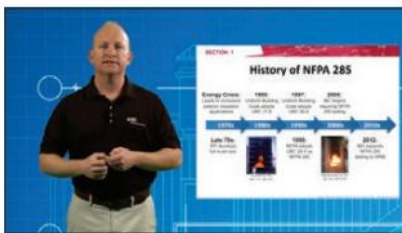
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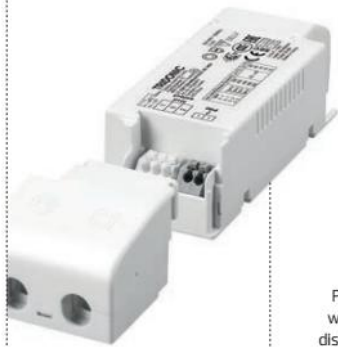
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Presenting information is often a challenge in communicating to shareholders. In this regard, graphics are more effective than numeric tables or text. Most importantly, representing data accurately requires understanding of what information is significant, and which is not. Sample sizes can skew the results, making such charts not helpful in making decisions. In general, comparing subjective information with objective targets produces the most meaningful insight. Balancing subjective preference with costs involved is on the minds of designers and project owners alike. A familiar 4 square presentation can reveal a great deal about preferences and costs, which can be used for further discussion, as well as decision making. A similar approach could be taken in the evaluation of daylight treatments, and human factors issues.



SPOT DRIVER

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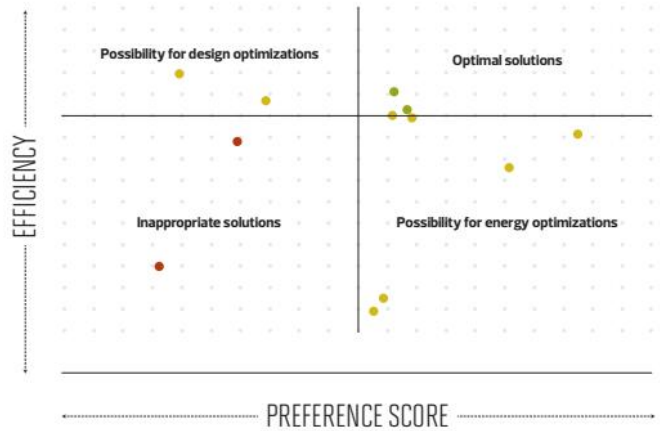
Tridonic
www.tridonic.us
 CIRCLE 300

GLARE FREE ▶
 Parscan spotlights with oval flood light distribution are used for steady, glare-free illumination of desk surfaces.

DISCREET ▶
 ERCO track lighting was integrated into the ceiling structure so that it appears as a supplementary element.



DATAPOINT



Preference vs. Efficiency

Placing the target of 0.4 W/sq. ft. and preference of 5/10 at the center reveals samples that fell into the upper left quad produced higher efficiency, but lower preference, leaving room for improvement. Samples in the lower right were preferred, but were more inefficient.



CASE STUDY

CANDALEPAS ASSOCS.
 Sydney, Australia

One of the lighting design challenges of this architect's office was addressing the distinctively different amounts of daylight in individual areas, which required a balance of natural and artificial light. Following the directive that lighting should be installed only where it was needed, ERCO developed a concept, which was essentially implemented with three luminaire families: in the basement 8W Starpoint downlights with wide flood lenses provide a bright, friendly atmosphere; in the entrance area and offices, dimmable spotlights from the Parscan and Pantrac luminaire families were placed with a variety of wattages and light distributions. In meeting areas are 24W Parscan wallwashers.

RIDGEDALE MALL

Minnetonka, Minn.

At forefront of the Dark Sky discussion, the city has taken a disciplined approach to outdoor lighting. When General Growth Properties set out to redevelop the façades at the mall, it stipulated new lighting would feature a high BUG rating (backlight/up-light/glare) and address

Dark Sky. Kick fixtures from Architecture Area Lighting provided the performance and aesthetics necessary; at 103 lumens per watt, General Growth Properties also receives the sustainable energy-saving benefits associated with LED technology.

DARK SKY COMPLIANT ▶

AAL's Kick was the first full cutoff optic fixture to feature an upward angle with zero uplight.



◀ The use of renderings is not limited to providing a window into a design result; they offer an excellent opportunity to solicit feedback or start discussions. Lighting software produces photorealistic output that is easily manipulated to show several lighting approaches for direct comparison.



Bringing end users into a design process through use of renderings with numerous lighting and daylighting conditions can be used to gather preference information. Rather than this being completed in a typical blind "survey," inclusion of two or more individuals to view the examples together may open discussion that leads to fresh discovery. The renderings above are a simple example of the power of rendering in presenting lighting concepts that can easily be used to solicit input or make decisions.

Collection of information, whether from authorities, research papers or end-user and customer interaction, is an expanding area of design expertise. Every project is a unique, complex, custom conglomeration of ideas, products, capital resources, time and individual human participants. Over the time a design is developed, it is inevitable changes will occur that cause reconsideration of previous decisions. Reviewing the process and conclusions of prior decisions is the first step in defining what changes need to be made. In many cases, proposed changes are the product of a "miss"-information, that when reviewed against information used, eliminates the need for further action, reducing wasted time and effort. ☑

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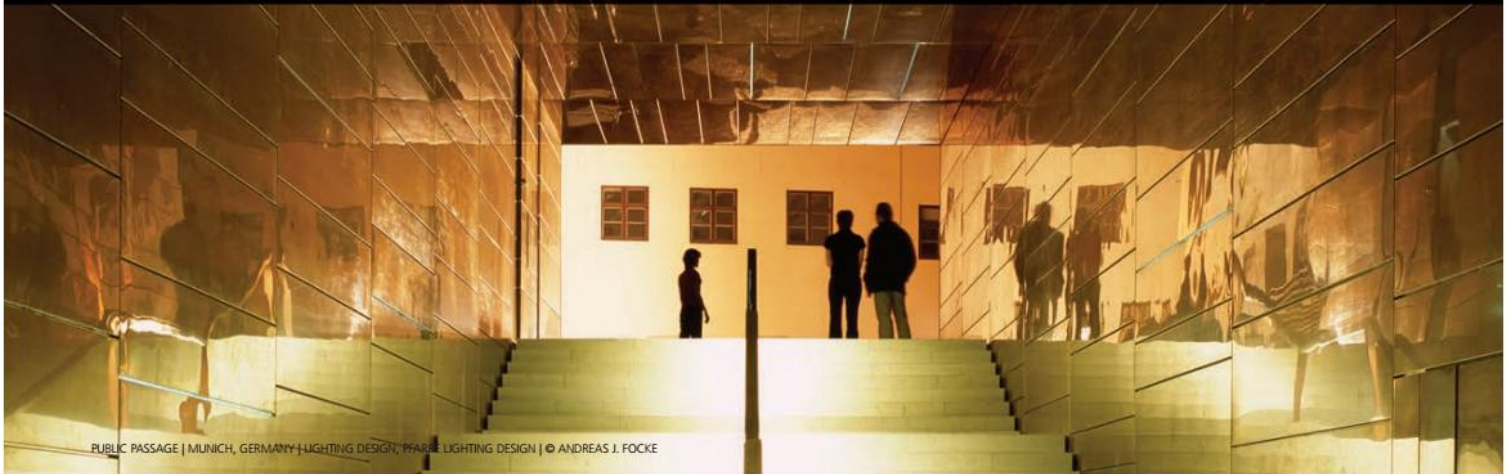
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The Wind Farm Debate Continues

Wind power in Illinois provides approximately 6% of the state's electrical power. Yet, it seems all of these benefits are not enough to console local landowners that have to live near these towers.

Following in the footsteps of Frederick Law Olmstead, I try, every day, to immerse myself into green spaces. Considered the "father" of American landscape architecture, and known for his critical thinking in urban planning and design, Olmstead—of Central Park fame—encouraged the full utilization of the naturally occurring features of a given space. To Olmstead, a park is a necessity of everyday urban life, and subjecting oneself to it—once a day, at the very least, he believed—is essential to a healthier life.

My commute, about an hour west of Chicago, provides ample opportunity to experience green space in abundance. Lately, however, my view has been somewhat marred by a growing number of "No Wind Turbine" signs spattered across the countryside.

To me, it seems to be a case of trading one farm for another, but others, especially those who have moved from the city to a more peaceful, rural setting, don't want their pastoral visions marred either; the construction of wind towers might potentially interfere with this dream of a "quieter" life. Beyond aesthetics and noise, there is much concern regarding depreciating home values from residents situated near wind towers.

However, a recent study released by the Lawrence Berkeley National Laboratory found little evidence that wind farms depress home values. "Neither the view of the wind facilities nor the distance of the home to those facilities is found to have any consistent, measurable and statistically significant effect on home sales prices," the study concludes. Further, the productivity numbers can't be denied.

A study, "Economic Impact—Illinois Wind Energy Development," conducted by the Center for Renewable Energy at Illinois State University, states that as of April 2016, the Land of Lincoln ranked 5th in the U.S. in overall installed wind capacity, and 14th in potential capacity. Illinois currently has 46 wind projects online, which will account for 3,842.15 MW of wind generating capacity. In fact, the 25 largest wind farms in Illinois:

- ▷ Create approximately 20,173 full-time equivalent jobs during construction periods
- ▷ Support approximately 869 permanent jobs in rural Illinois
- ▷ Support local economies by generating \$30.4 million in annual property taxes
- ▷ Generate \$13.86 million annually in extra income for Illinois landowners who lease their land to the wind farm developer
- ▷ Will generate a total economic benefit of \$6.4 billion over the life of the projects.



Illinois is pushing for more renewable power. The Future Energy Jobs Act has essentially removed wind energy requirements, and the legislation could generate \$2.2 billion from new wind construction. The Future Energy Jobs Act will strengthen and expand the Renewable Portfolio Standard to ensure predictable funding for renewable development, providing \$180 million per year—growing to \$220 million per year.

These numbers are true. If only Olmstead could weigh in on the need to balance green space with the need for green power. ☑

WIND CAPACITY

Illinois ranks 5th in the U.S. in overall wind capacity, and 14th in installed capacity. Nationally, if wind energy continues to grow to be 35% by 2050, says the ISU report, we can expect that there will be a 2% savings in electric rates for consumers, and a 3% savings in power systems costs. Pollution and water use will continue to fall, and 600,000 jobs will be supported across the nation.

John Mesenbrink
Contributing Editor
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