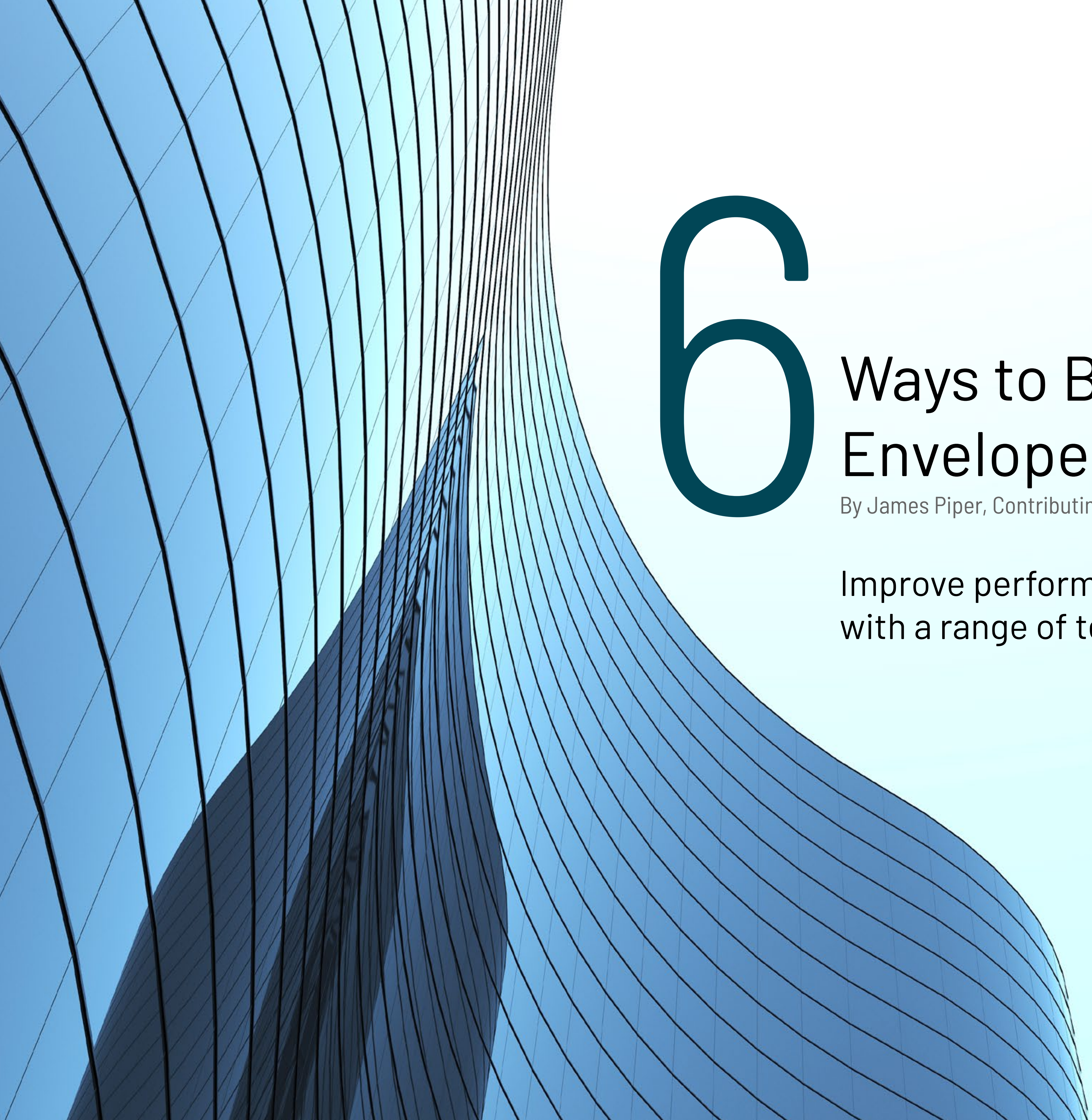

6 Ways to Boost Building Envelope Performance

By James Piper, Contributing Editor, *Building Operating Management*

Improve performance and reduce costs with a range of technologies.

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Advances in building technology, construction techniques, and operating strategies are helping building owners to achieve efficiencies in energy and water use that were out of reach even in the recent past. Some of these advances are entirely new, while others are improvements on existing technologies. The benefit of these advances does not stop with improved operating efficiencies. Owners are finding that their use is resulting in improved occupant comfort and productivity.

These advances — which form the foundation for today's high-performance buildings — touch almost every element in building operations, including the building envelope. High-performance building envelopes, like their conventional design counterparts, protect the building and its occupants from the elements. But they can do more. They can respond to changes in interior and exterior conditions. They can provide levels of fresh air to building occupants based on occupancy levels. They can harvest solar energy. They can harvest and put to use rainwater. And they can perform all of these activities through a combination of active and passive strategies.

High-performance building strategies will allow building owners to improve occupant comfort while minimizing energy and water use. Here are six envelope technologies to consider.

1.

Low-e Glazing

Low-emissivity, or low-e-, glazings have been in use since the 1970s. But a desire to improve building energy efficiency along with more advanced coatings has increased the use of these glazings in both the new construction and the retrofit markets.

Low-e glazings use a thin, nearly transparent coating to improve energy efficiency of buildings in several ways. The coating limits the amount of ultraviolet and infrared light while allowing visible light to pass through. During the cooling season, the coating reduces the heating load on the building's air conditioning system. During the heating season, the reverse is true. The coating reflects the long-wave infrared radiation from inside the building back inside, reducing heat losses. Buildings that are equipped with the low-e glazings are estimated on average to reduce annual energy use by five to 15 percent over buildings with conventional glazings.

Early generations of low-e coatings were effective in reducing building cooling loads by blocking infrared radiation from the sun. But those glazings also blocked that same radiation during the heating season and could unintentionally increase heating loads. Today's generation of coatings has been more finely tuned to allow some of the sun's shortwave infrared radiation to pass through, making them better suited for use in colder climates.

2.

Vegetative Roofs

Vegetative roofs have gained widespread acceptance in commercial and institutional facilities. Among the benefits: By absorbing rainwater, a vegetative roof controls the rate of run-off, reducing the surge on the stormwater system.

PHOTO: ANTONIO GRAVANTE / SHUTTERSTOCK.COM

Vegetative roofs are one element of a high-performance building envelope that have gained widespread acceptance. A vegetative roof may be partially or fully covered with vegetation. The vegetation is planted in a growing medium installed over a waterproof membrane. Depending on the climate, the system may include an irrigation system for periods of drought, and a drainage system to remove excess water from the roof.

Vegetative roofs offer several advantages over conventional roofs. They provide a buffer between the temperature gradient across the roofing materials, decreasing heat loss or gain through the roof and reducing thermal stresses on the roof membrane. Because the membrane is covered by the vegetation and growing medium, it is protected from the harmful effects of the sun's UV light. By absorbing rainwater and then slowly releasing it through evaporation or drainage, a vegetative roof controls the rate of run-off, reducing the surge on the stormwater system.

Vegetative roofs cost more to install than conventional roofs, up to twice as much. Keeping the vegetation healthy requires additional maintenance, including weeding, watering during periods of drought, and replacement. When leaks occur, finding the source of the leak can be difficult, requiring removal and replacement of sections of the vegetation and the growing medium. And when it comes time to replace the roof, there are additional expenses due to the need to remove and replace the vegetation and the growing medium.

3.

Electrochromic Glazing

Building owners have long dreamed of glazings that can change automatically from transparent to opaque. Such glazings could be used to block the sun's infrared light during the cooling season while allowing some or all of it to pass through during the heating season. Such glazings could also be used as needed for security or privacy purposes.

Enter electrochromic glazings. These glazings have been around for more than 25 years but have only recently come into more widespread use due to performance and pricing improvements. The glazing includes a thin coating of multiple layers of ceramics. When a low voltage is applied to the coating, it causes lithium ions to move within the ceramic layers, changing the glazing from opaque to transparent. The voltage need only be applied to change the state of the ions. Once the desired level of transparency is reached, the voltage is removed and the window stays at that level. And it is not an all or nothing proposition.

Some electrochromic glazing can tint different regions of the window to different degrees. This can better address glare while preserving the view.

PHOTO: ADRIEN BARKAKAT, COURTESY OF SAGEGLASS

Glazings can be tuned to let in as much light and infrared energy as desired based on what is needed inside the building. When fully darkened, approximately 98 percent of the light falling on the window can be blocked. When the voltage is applied, most elecrochromic windows take several minutes to transition from one extreme to the other.

At least one electrochromic glazing product can change automatically, in response to outside conditions and occupant preferences, or be controlled by a mobile device.

Electrochromic coatings offer building owners the advantages of automatic darkening, enhanced privacy, and energy efficiency. Through the use of the glazing, building owners can typically reduce the building's cooling load by 8 percent without having to sacrifice the benefits of the sun's infrared energy during the heating season.

One consideration with electrochromic glazing is its cost. Windows today that use the coatings can cost anywhere from five to ten times as much as conventional glazings. Additionally, questions have been raised concerning the service life of the glazings. Where a conventional glazing can last 40 or 50 years, electrochromic glazings may have a service life that is much shorter, perhaps something in the range of 20 years.

Electrochromic glazing allows extensive use of glass to maximize access to daylight without the corresponding heat gain.

PHOTO COURTESY OF VIEW INC.

4.

Rainwater Harvesting

Unlike the systems that many homeowners have installed, commercial building rainwater harvesting systems do more than just direct collected rainwater into a storage tank.

Rainwater has always posed a problem for owners of buildings with large roof areas. It must be trapped and directed away from the building, generally ending up in the area's stormwater system. Rainwater harvesting offers an effective way to reduce a facility's demand for potable water while cutting the facility's runoff. By harvesting rainwater and using it for irrigation, flushing of toilets, vehicle washing, and other activities where potable water is not required, some facilities can reduce total water use as much as 50 percent.

Unlike the systems that many homeowners have installed, commercial building rainwater harvesting systems do more than just direct collected rainwater into a storage tank. Collection points on roofs include a coarse filter to prevent leaves and other debris from entering the system piping. A variety of different filtration systems — including sand filters, horizontal roughing filters, charcoal water filters, and slow sand filters — are used to remove the finer debris from the water. In larger systems, a collection tank may be installed prior to the filtration system to prevent the system from being overloaded during periods of heavy rain. After filtration, water is typically stored in underground concrete, plastic, or concrete tanks. A pump and distribution system then moves the water to where it is needed.

These 10,000-gallon holding tanks are the home for salvaged rainwater from the roof of the Leon County Sustainable Demonstration Center.

PHOTO: LEON COUNTY, FLA.

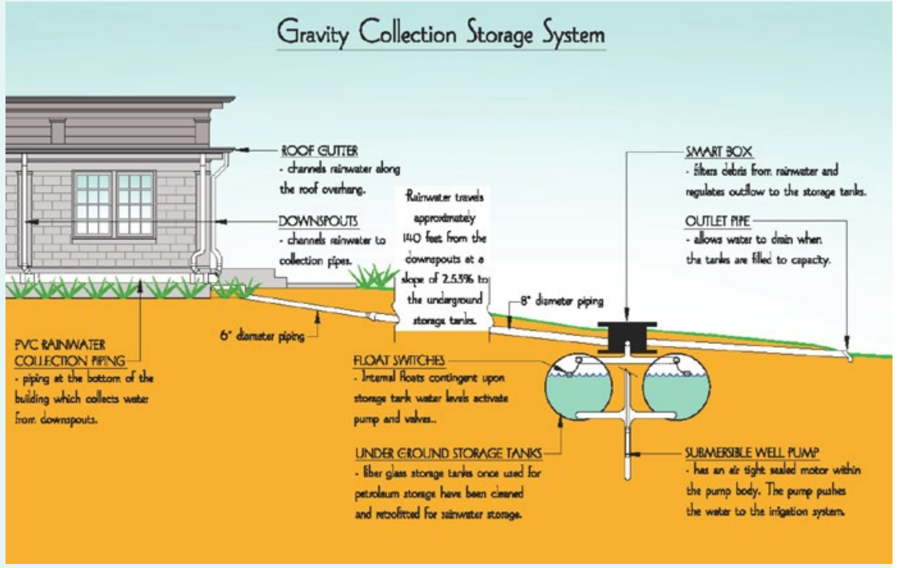
CASE STUDY:

Innovative System Recovers Rooftop Rainwater Runoff

The Leon County, Fla., Sustainable Demonstration Center converted its rooftop into a rainwater collection system to reduce the need for potable water and the amount of storm water discharge into the sewer system.

A water audit showed that the Center had been using about 570,000 gallons of water a year from the municipal water system for its extensive botanical garden and demonstration food crop garden.

Gutters and downspouts channel rooftop runoff into four salvaged 10,000-gallon holding tanks buried on the site, rather than discharging water onto the landscape or impervious parking lots. A submersible well pump with an air-tight sealed motor pushes water from the tanks to the irrigation system. The single-wall fiberglass underground tanks, which were previously used for petroleum storage, were cleaned and retrofitted for their new purpose. Electronic valves enable the Center to use potable municipal water in dry periods if the storage tanks cannot meet the need for mist and drip irrigation.



View larger diagram »

PHOTO: LEON COUNTY, FLA.

One unique feature of the system is the use of HDPE "smart boxes" that filter debris from the rainwater and regulate outflow to the storage tanks, maintaining consistent water levels in the tanks and directing hydraulic overflows to roadside stormwater installations. Those smart boxes, developed by Leon County's staff, helped the rainwater recovery system earn a patent. Other innovative elements of the rainwater recovery system include microcontouring of the existing roof.

*— **Tom Brantley,** chief of building engineering, Leon County, Fla., helped design the rainwater runoff system. **Will Sheftall** works in Leon County as a University of Florida extension agent for natural resource management.*

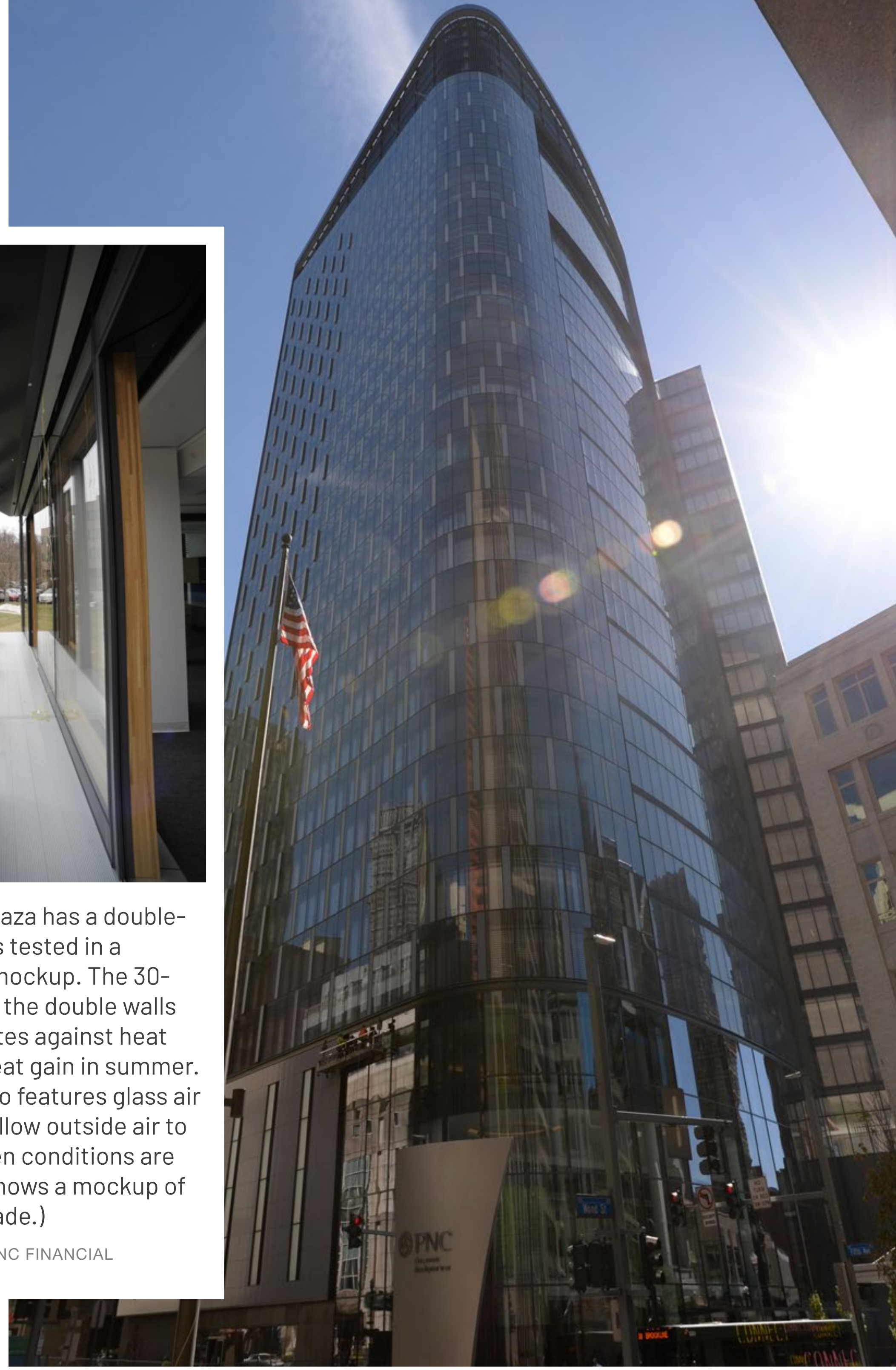
5.

Double-skin Façade

One of the design strategies drawing interest today is the double-skin façade. In double-skin façade construction, the building has two separate skins, both typically glass, separated by an air chamber. The inner layer of glass is typically insulating glass. The cavity between the skins increases the insulating value of the skin and reduces sound transmission to the building.

To improve the building's energy efficiency, the cavity between the glazings is ventilated naturally or mechanically. During the heating season, air from the cavity can be used to help heat the facility. During the cooling season, heated air in the cavity is vented to the exterior, reducing the building's cooling load.

In addition to improving energy efficiency, double-skin façades offer the advantage of improved occupant comfort. Operable windows allow occupants to make use of the natural ventilation between the glazings. There are issues to be solved yet, including how to deal with condensation and dirt on the cavity side of the glazings. And the additional skin results in a significant increase in construction costs.



The Tower at PNC Plaza has a double-skin façade that was tested in a 1,200-square-foot-mockup. The 30-inch cavity between the double walls of the façade insulates against heat loss in winter and heat gain in summer. The exterior wall also features glass air gates that open to allow outside air to enter the cavity when conditions are right. (Inset photo shows a mockup of the double-skin façade.)

PHOTOS COURTESY OF PNC FINANCIAL SERVICES GROUP

6.

Thin-film Photovoltaics

Another long dreamed of glazing is one that serves a dual purpose of allowing light to enter the building while generating electricity. While coatings can reduce energy use by limiting solar transmission into the building, this type of glazing would also allow buildings to harvest solar energy. What is making this possible is the development of thin-film photovoltaics. Applied directly to glass, the thin-films are almost invisible, looking just like a regular window but also serving as a system to harvest solar energy.

Early generations of the cells proved to be fairly efficient but required the use of toxic materials in their manufacture. Recent advances in cell construction have increased the efficiency of the solar cells. Changes in manufacturing techniques are expected to make the process more environmentally friendly and lower their cost. It is not quite ready for prime time, but advances are taking place rapidly. Once that happens, the architectural appeal of buildings with large areas of glass may be seconded by their energy efficiency appeal. ■