Throwing Energy Worries Out the Window
by Loren M. Snyder

Windows and other building-envelope components pay big dividends to managers seeking energy savings.

It's relatively simple and achievable to boost energy efficiency by upgrading lighting or HVAC systems. But achieving energy efficiency isn't solely about air conditioning and lighting. When a building's envelope does not perform as a thermal sheath, facility and maintenance managers are throwing energy right out the window.

Regrettably, there is no single answer for constructing a highly efficient envelope. Envelope efficiency gains depend upon a host of variables, including climate, region, humidity, sunny days, building orientation and age, and envelope integrity. Maintenance managers can achieve substantial energy-efficiency returns, however, when they pay specific attention to four aspects of the building envelope — windows, roofing, insulation and envelope integrity.

Windows that perform
Windows frequently represent the area of greatest envelope efficiency loss — or gain. In fact, poorly performing windows can account for up to one-half of the energy use attributable to the building exterior, according to the American Society of Heating, Refrigeration and Air-conditioning Engineers.

Warren Schmidt, director of facilities for the West Bend (Wis.) School District, recognizes the value of efficient windows.

"For the last four years, I've been exclusively putting in one type of window with a thermal pane, internal shades and an interior pane," he says. "I've put in 38 just this year."

Schmidt says the windows have a high initial cost, but he adds that the gains they generate are worth it. In addition to the thermal pane of the windows, the internal shades also can be drawn to prevent solar heat gain. Schmidt says he also likes internal shades because they require less maintenance and dusting than do exposed shades.

Administrators in the Montpelier (Vt.) School District even realized that benefits could be gained by adding windows to the local high school.

"Four years ago, we replaced windows in our high school," says Don Lorinovich, the district's director of facilities and grounds. "The high school has a lot of windows and, in 1984, some were taken out and the spaces covered. When we replaced windows recently, we added more windows where some had been removed in '84. It's not a solar building, but we did get more light and good solar gain."

Because glass is a poor insulator, windows ultimately lose energy two ways: air infiltration and thermal energy that passes directly through the glass.

To address concerns about air infiltration, managers can ensure that all window hardware is in place and working correctly. But infiltration also can occur through poorly constructed frames or mullions. Storm windows or other devices that sandwich a layer of air between two panes help mitigate air infiltration problems.

But even well-constructed windows and frames let radiant heat pass through glass panes. Managers might also want to avoid aluminum window frames in cold climates for the same reason. The metal's high heat conductivity can be a source of heat loss — unless the frame has thermal breaks to prevent energy transmission.

Remember reflective roofing

Like windows, roofing also can suffer from heat gain, particularly low-slope roofs that use black roofing materials. A consequence of this net heat gain is that a building's air-conditioning system must work harder to compensate for the added load, especially if HVAC ducts run through the plenum. Recent developments in roofing indicate the best way to combat these potential inefficiencies is via a light-colored roof that reflects the sun's infrared heat.

The Florida Solar Energy Center (FSEC), which has conducted research on cool roofing for the last decade, reports that air conditioning is the largest single energy user in buildings, generally consuming 30-45 percent of total electricity in nonresidential buildings.

Traditionally, facilities in the Sun Belt — where cooling costs are often a significant annual expense — stand to benefit the most from cool roofs.

Cool roofing tests indicate peak-cooling demand can be reduced by an average of 30 percent, says Danny Parker, a research scientist with the FSEC. Parker and his associates conducted research on reflective roofing at a Cocoa, Fla., strip mall. Throughout the two-year study, the FSEC collected baseline space-cooling performance data, including energy use, roof surface temperatures, plenum temperatures and meteorological information.

After application of a reflective coating, Parker found that the roof surface temperature dropped by nearly 90 degrees, and every store in the mall registered a significant drop in the temperature of the building's plenum. One shop showed a 48.1 percent drop in cooling energy costs.

Although buildings in cooler climates also can benefit from the installation of light-colored roof materials, maintenance and engineering managers in those regions should first concern themselves with the effectiveness of rooftop insulation.

Insulation considered

Ideally, insulation should be efficient yet strong, lightweight, and resistant to fire and water. Cost and environmental considerations also might be important factors that affect insulation choice. But whatever a facility's needs, old or wet insulation performs poorly and should be replaced.

During the mid-80s, John Venovic, director of facility management at the Rockford Health System in Rockford, Ill., learned of the havoc that water wreaks. Venovic noticed some displaced bricks in a section of wall in one of his structures. Upon investigating the source of the problem, Venovic discovered water behind the wall in that part of the building. The weep holes that should have been installed when the building was constructed in 1974 were not drilled. Moreover, the flashing that would direct water to the weep holes was never installed.

"The insulation in that part of the wall was worthless," Venovic says. "Without the necessary flashing and weep holes, water had soaked the insulation, ruining it."

Another way to improve energy efficiency in the envelope is to combine insulation materials. In snowy northern New Hampshire, for example, Bruce Brown knows the importance of pairing thermal boards with fiberglass insulation.

Brown, the director of facility management for Littleton (N.H.) Regional Hospital, recently helped move the hospital into a new structure.

“[Our] new hospital is mostly single story,” he says. “It has 2 by 6 [inch] walls with steel studs, exterior sheathing, 6-inch fiberglass insulation in the walls, plus insulation board, and a brick veneer at varying heights around the building. So, the walls are dense, pretty efficient.”

The effectiveness of insulation is measured by its R-value: the thermal resistance per square inch of material. The higher the R-value, the more efficient the insulation.

When specifying insulation, managers should remember that some insulation types are stable — the insulation’s R-value does not degrade significantly over time — while other insulation’s R-values change over time in a process known as “drift.” For this reason, managers should seek the aged R-value of insulation.

Envelope integrity

Brown knows the Littleton Regional Hospital will grow. Because of this, he invested extra funds to ensure the adjoining office building meets the same envelope codes as the hospital.

“That way, when we need to expand the hospital, we can just go right into the office building without worrying about upgrading,” Brown says. Brown also paired New England’s sense of aesthetics with thermal efficiency.

“The new hospital is in a rural area, outside of town on an old farm site, and we wanted the hospital to fit in with the surroundings,” Brown says. “The brick and clapboard siding helps it fit in but also helps with the thermal massing.” As important as the “big picture” envelope considerations are the minutiae. The components that help keep thermal efficiency intact are tremendously important. In other words, appropriate caulking, flashing, ventilation and drainage all are essential to maintaining envelope integrity.

One of the buildings in the West Bend School District was put up in the 1960s, a time when builders and administrators weren’t necessarily concerned with energy efficiency, Schmidt says.

“There’s no vapor barrier in the building, no insulation in the attic,” he says.

“We’ve added storm windows, 4-inch insulation in the soffits and replaced the roof, but there’s still more that we could do,” Schmidt says. To find efficiency culprits, he plans to conduct an infrared scan of the building this autumn.

Managers can learn from such diligence in finding the sources of thermal loss. Managers concerned with envelope efficiency should consider a facility’s windows, roofing, insulation and envelope integrity; ultimately, they also should ask the question that plagues Schmidt as he prepares to scan one of his district’s buildings: “What I really need to know is what’s the key energy waster?”