Art does double duty at Genzyme’s Cambridge, Massachusetts, headquarters. Light-reflecting mobiles (at left in photo) and textured ceiling florets in the 12-story atrium reflect and disperse natural light.
The term “green building” hasn’t reached Webster’s dictionary, but it’s certainly in the news.

The University of North Carolina recently unveiled a sustainably built addition to its school of nursing. Johnson County, Missouri, hopes to complete its first green building—a county office building—by January. Financial services company KeyCorp has just received Leadership in Energy and Environmental Design certification from the U.S. Green Building Council for its 50,000 square-foot campus in Brooklyn, Ohio. And in April, Gov. Christine Gregoire made Washington the first state to require that all schools and other public buildings be built green, using the LEED standards. (So far, the U.S. Green Building Council is the only national organization that rates green buildings—after an extensive application process—designating them as certified, silver, gold, or platinum.)

Hundreds of other municipalities, nonprofits, corporations, homeowners, architects, and developers have also chosen to go green, using standards from LEED, the National Institute of Building Science’s Whole Building Design Guidelines, and local green building programs.

What is green building? In a nutshell, it is designing and constructing buildings in a way that minimizes their negative impacts on the environment. More specifically, it concerns a building’s efficient use of energy, resources, and water; sustainable site planning; and indoor environmental quality.

No single technology can make a building green. Since a building is not merely the sum of its parts, but a collection of interdependent components and systems, building green requires a holistic, systems-based approach. Understanding how certain systems affect others is essential to successful sustainable design and construction. For example, a tighter building envelope allows for the installation of a smaller HVAC system, but also diminishes the building’s capacity to expel excess moisture.

Still, there are some exciting technologies that help make green building easier, cheaper, better looking, and, well, greener. Further, innovation will only increase as green building moves into the mainstream. Here are just a few innovations that experts say we should be keeping an eye on.

Saving energy
Energy efficiency is what springs to mind when most people think of green buildings, especially if they happen to be paying their heating bill or filling their gas tank at the time. Considering the U.S. Department of Energy’s finding that commercial and residential buildings together represent more than a third of primary energy use and more than two-thirds of electricity consumption, energy efficiency is a big deal.

Mike Hatten, principal engineer with Solarc Architecture and Engineering in Eugene, Oregon, says that two factors contribute to energy efficiency in buildings: load-reducing technology and the systems that supply a building’s energy needs. Those systems, particularly HVAC equipment, are becoming more efficient. Variable speed motors in fans and pumps, for instance, allow equipment to run only when needed, rather than constantly or on a fixed schedule, making it more efficient and reducing cycling, which shortens the life of the equipment.

The American Society of Heating, Refrigeration and Air-Conditioning Engineers, which
LEEDing at the Neighborhood Level

Since the first version was released by the U.S. Green Building Council in the late 1990s, the Leadership in Energy and Environmental Design program has been refined and expanded to include several building types. Currently, LEED-certified buildings can be classified as certified, silver, gold, or platinum within five categories: new construction, existing building operations, commercial interiors, core and shell products, and homes.

Now, USGBC has joined the Congress for the New Urbanism and the National Resources Defense Council to create LEED for Neighborhood Development. LEED-ND combines green building with smart growth principles, including density, proximity to transit, mixed use, mixed housing types, and pedestrian- and bicycle-friendly design.

According to the USGBC website, LEED-ND is intended to encourage sustainable development in the same way that other LEED programs have helped green buildings to flourish. "LEED-ND can have a similarly positive effect on development trends to revitalize existing urban areas, decrease land consumption, decrease vehicle miles traveled, improve air quality, decrease polluted stormwater runoff," and create mixed-income, walkable communities.

Architect Doug Farr, chair of the LEED-ND committee, refers to it as "green urbanism—a mix of New Urbanism and sustainable building." He says that LEED-ND will address location, linkage to other communities, and infrastructure issues that other LEED programs haven't touched on.

The LEED for Neighborhood Design standard is still in development, but USGBC hopes to launch pilot programs by next year.

Resources

For a report on green zoning ordinances in the U.S., see "Building Green: Onus or Bonus?" in the April issue of Zoning Practice, published by the APA.


creates industry standards and guidelines, last year released GreenGuide, a primer on non-
standard methods and technologies for HVAC
practitioners. Those technologies are changing
so fast that ASHRAE started on a second
edition only months after releasing the guide
in early 2004.

Hatten says that centralized controls make
heating and cooling systems more efficient.
“What’s really exciting is integrated paths that
can control a whole host of components,” he says. Unfortunately, they’re about
15 years behind other networking technolo-
gies, he adds. “Right now, they don’t talk to
each other. The HVAC, the fire alarm, light-
ing, security” all operate independently.

The most important load-reducing devices
in commercial buildings are high-performance,
energy-efficient glazing systems, Hatten notes.
“Low-emissivity,” or “low-e,” coatings and spec-
trally selective coatings help to reduce radiant
heat transfer through windows, keeping heat
out in the summer and keeping warm air
inside in the winter.

“There is constant, ongoing innovation,” in
insulated glass options, glazing, and even
glass with integrated photovoltaic mechanisms,
says Hatten. “You practically need to check in
every couple of weeks.”

Several promising possibilities involve the
use of chromogenic technology, in which film
on the glass alters the level of energy transmis-
sion in response to light (photochromic), tem-
perature (thermochromic), or electrical stimulus
(electrochromic). The Lawrence Berkeley Na-
tional Laboratory, which is managed by the
University of California at Berkeley, consid-
ers electrochromic technology the most prom-
ising of the three because it allows users to
manually control the level of transparency at
the flip of a switch.

For systems to work efficiently, building
orientation must be taken into account,
says Alex Wilson, president of BuildingGreen
and executive editor of Environmental Build-
ing News, based in Brattleboro, Vermont. He
warns that specifying improper glazing can be
disastrous. South-facing windows—
which allow more light and heat transmis-
sion in the summer because the sun is hot-
ter and higher—should be minimized or
mitigated.

In the shade
Roof overhangs, awnings, and other tech-
niques have been used for centuries to block
the sun, but they are rarely seen on modern
commercial and residential buildings. That
is changing.

At Portland State University’s newest dor-
mitory, Epler Hall, architects at the Seattle-
based firm, Mithun, thought of each building
section as a box, and each got a different
shading treatment. “Each box responds to its
own particular microclimate,” says principal
Ron van der Veen. For that reason, large, loft-
like windows grace the building’s north fa-
cade, while the west features both vertical and
horizontal shades.

In renovating the Bethel Commercial
Center in Chicago, architect and planner Doug
Farr of Farr Associates relied heavily on shading.
He also took it one step further: His
design includes a cornice that provides shad-
ing, but also has electricity-producing photo-
voltaic cells on top.

According to Farr, it also defines the “out-
door room” in front of the building, protects
the lintels by keeping water off the facade, and
shelters pedestrians from the rain. Small holes
and spaces in and between the PV panels
allow dappled sunlight to fall on the sidewalk,
he adds.

Solar-generated electricity also comes into
play at the Chicago Center for Green Tech-
nology, the headquarters of a city program to
promote sustainability. There, PV panels
mounted on south-facing awnings, an array of
roof-mounted panels, and a solar-paneled
berm behind the building provide 20 percent
of the building’s electricity, says program co-
ordinator Elise Zelechowski.

While Zelechowski did not specify what
the systems cost (the city spent $5.4 million
on construction and renovation of the build-
ing, which was formerly a debris crushing
facility), she says that Chicago Green Tech
expects to see a payoff within 10 to 12 years.
“We’ll make back our money and then some,”
she says. “We’ll be a power producer, giving
electricity back to the grid. That’s a powerful
place to be.”

Running hot and cold
Twenty-eight 200-foot-deep wells were drilled
on the grounds of Chicago’s green tech center
for its geothermal heat pump system. At that
depth, the earth’s temperature remains con-
stant at 50 to 55 degrees. Conditioned air
(either heated or cooled, depending on the
season) flows through pipes to an auxiliary
boiler and air exchanger. The facility rarely
uses air conditioning.

Elsewhere in Chicago, the Center for Neigh-
borhood Technology, a sustainability think
tank, uses an innovative thermal storage sys-
tem to supplement a standard cooling system.
Its system consists of a buried tank filled with
glycol solution and small, dimpled plastic
balls full of water. CNT pulls energy off the
grid at night to freeze the water balls. The ice
cools the glycol, which then helps to cool the
building. “Basically, we’re saving up cold air
at night, when the prices are lower,” says
CNT research analyst Lisa McNally.

The center participates in the Energy-Smart
Pricing Plan, offered by the Community En-
ergy Cooperative and the local electric com-
pany, Commonwealth Edison. The program
charges customers market price for energy,
which varies depending on demand. Energy is
more expensive at noon on a summer day, for
example, than it is 10 hours later, when less
cooling is needed. A goal of the program,
which is also available to residential custom-
ers, is to encourage users to examine and alter
their energy consumption patterns.

To be energy-efficient, a building must be
well insulated. Each of the 280-square-foot
studio dorm rooms at Portland State’s Epler
Hall has its own mechanical heating system, but
many students don’t turn the heat on.
Efficient framing and insulation—fiberglass
batt with an R-value of 21—means they don’t
have to, says Ron van der Veen. They stay
toasty from the heat expended by their TVs
and computers.

Exhaust heat at Epler is run through a heat
exchanger to preheat air for the building’s
corridors. In the summer months, the build-
ing is cooled using natural ventilation.

Although numerous insulation options ex-
ist, Alex Wilson says there are no dramatic
innovations. “The innovation is in building
science—understanding the flow of moisture
through buildings,” he says. Wilson and oth-
ers—particularly Joseph Lstiburek, of the con-
sulting firm Building Science Corporation—
point to excess moisture in buildings as a
serious concern. It causes mold and mildew
to grow, and that can affect structural integrity
and indoor air quality.

Lighten up
Lighting may not be something we think
about often. You flip a switch and it’s there.
But the experts say that lighting heavily im-
pacts energy efficiency, thermal comfort, and
even productivity.

“Often, lighting should be the number one
green design issue in commercial buildings,”
says Wilson. The most ideal source of lighting
is free and widely available: the sun. But the
usual office set-up relies on banks of fluores-
cent lights that illuminate every square inch
of the interior. Further, the typical office’s
interior design consists of an outer ring of
private offices with windows and an interior core of cubicle workstations. In many green buildings, that paradigm is shifting.  

"Now we better understand the impact good daylighting can have on worker productivity, healing in hospitals, learning in schools, and even sales in retail stores," Wilson says. A series of studies sponsored by the California Energy Commission in 2003 confirms that claim (it did not study hospitals), but notes that glare and too little daylight can have negative effects.  

Windows, atriums, and skylights—including some high-tech tubular skylights that use moving mirrors to follow the sun—bring light into a building. Interior details such as low cubicle walls, transoms, and glass walls help spaces that aren't near windows share sunlight.

It’s natural  
The California Environmental Protection Agency uses many of those techniques in its Joe Serna Jr. CalEPA Headquarters Building. Access to natural light for all 3,000 employees was a design priority for the building, which was completed in January 2001. At one million square feet, it is the largest high rise in Sacramento.  

"We did two things: tried to keep private offices off windows, and chose low-walled cubes to maximize daylight," says Theresa Parsley, assistant secretary for facility programs. "In all the cubicles there are energy-efficient task lights, but many people don’t turn the lights on," she says. Employees have more options than “on” or “off.” The fixtures have multiple dimming levels.  

Less frequently used areas, such as break and conference rooms, are equipped with motion sensors that measure the activity in the room and light it accordingly. Throughout the building, light sensors can automatically turn off banks of lights when light from the outside suffices. Manual controls can override sensor-controlled lighting.  

Lighting technologies are constantly evolving toward greater energy efficiency, says Mike Hatten. Some of that efficiency comes from having greater control over the systems.  

CalEPA uses Globalight, a patented power regulator and voltage stabilizer system that evens out the lighting power supply. "It takes out the peaks and valleys and improves harmonics," says Craig Sheehy, director of property management for Thomas Properties Group, which manages the facility’s operations. That improves performance, increases the life of the lamps and ballasts, and most important, reduces energy consumption and cost. "You use less voltage, but you don't lose any light quality. We've saved 24 percent on lighting costs," compared to other downtown Sacramento office buildings, he says.

Sheehy notes that the regulator technology is more expensive, but the payback is just 2.1 years, according to his firm’s projections following a 16-month study. "We don’t do anything on the capital side until we know the rate of return," he adds.  

The CalEPA lighting system is tied into an energy management system that also controls and monitors the HVAC system, energy use, security, and other components. It spends just $1 per square foot on electricity, far less than the $1.59 paid by other office buildings in downtown Sacramento, Sheehy says. A 25-year cost-benefit analysis calculated that CalEPA would save $6.9 million in energy alone (not to mention $608,000 from reduced water use and as much as $66 million in worker productivity and health benefits.)  

Across the country, the Genzyme Corporation, a biotechnology company in Cambridge, Massachusetts, sought to build a new headquarters that combined innovative design and cutting-edge technology to create a healthy workplace for 900 employees. The firm worked with the German architectural firm Behnisch, Behnisch and Partner.  

Bo Pielka, a spokesperson for the company, says that all employees have access to outdoor views, and 75 percent rely on natural light most of the time. Plenty of windows, a light-filled, 12-story atrium with louvered skylights
and reflective chandeliers help to spread the light throughout the building.

"The building was designed from the inside out," explains Pichl. "We wanted to create an environment where people could feel comfortable and be productive. The abundance of natural light in the building creates a very pleasant environment for people and connects them with the outdoors. Obviously, it also helps reduce our energy use."

In other buildings, light shelves also help to bounce light deeper into the interior. These light-colored, highly reflective horizontal shelves can be placed either inside or outside. They are angled slightly to catch sunlight and direct it indoors toward the ceiling, which helps disperse light throughout the room. When coupled with skylights in areas far from windows, light shelves can dramatically reduce the need for artificial lighting, says Chicago architect Doug Farr.

"To be useful to perform tasks, the interior brightness must be two percent of outdoor light, or the brightness of 10,000 foot-candles," he adds.

Designing to enhance daylight can be much more complex than it sounds because daylight—and, sometimes, the solar heat gain that comes with it—affects heating, cooling, and lighting loads. It also affects window sizing, placement, and glazing; building orientation; and interior design.

Breathing in the clean stuff

As with natural light, studies have shown that good air quality can enhance worker health and productivity. But in commercial buildings, indoor air is two to five times dirtier, and can be as much as 100 times dirtier, than outside air, according to the American Lung Association.

In offices, as in homes, the best methods for improving indoor air quality are ventilation and removing (or reducing) contaminants such as dust, pesticides, cleaners, carbon monoxide, mold and other allergens, and volatile organic compounds that release harmful gases into the air. Paints with few or no VOCs, as well as comparable carpet, furniture, wood products, sealants, and other materials, are used widely in green buildings.

Some traditional ventilation techniques include operable windows—to encourage cross-ventilation—plus convective chimneys, operable clerestory windows, and high vents. In most cases, however, natural ventilation supplements mechanical systems.

Most mechanical ventilation systems are centralised, but at Cal EPA, a unit on each floor of the building manages air quality more effectively. Locating units in the corners of the floor "took a lot of prime real estate," says Teresa Parsley. "But we really wanted the indoor air to be healthy."

Many green buildings have sophisticated equipment such as carbon dioxide monitors and air filtration systems. Alex Wilson offers a primer on the subject in an October 2003 Environmental Building News article. In the final analysis, though, he expresses misgivings about the use of filtration systems, except where they are truly needed, as in hospitals. "Clearly there are benefits, but they come at a significant cost—both financial and environmental," he writes.

"Achieving clean air in buildings should be an integrated process that is not limited to air filtration," Wilson continues. That process should address what we put in our buildings, and it should address moisture control, maintenance, cleaning practices, and building design, he says. "This may mean, for example, keeping parking lots and driveways further from building facades so that windows can be opened," he says.

Go with the outflow

Managing water onsite to reduce, filter, or slow its flow into municipal treatment systems is an increasingly important goal of many green buildings. One technique that has received a lot of attention is covering the roof with vegetation. (See "Green Is Coming Out on Top" in this issue.) Other technologies are also getting a lot of play.

Portland State's Epler Hall has an intricate rainwater capture and filtration system. When it rains—which happens often, given Portland's 40 inches of annual precipitation—downspouts direct the water to splash boxes lined with river rocks on the building's public plaza. The water then travels through channels that crisscross the plaza, flowing between pavers and into several planter boxes. The plants function as bioswales, filtering the water before it passes into a large underground chamber. From there, it is pumped into the building, passing through ultraviolet light to be cleaned and reused to flush public toilets and for irrigation.

Water coursing through the downsputs and the plaza's pavers sounds like a fountain and buffers noise from an adjacent freeway ramp, says Ron van der Veen. Epler's system collects and reuses about 111,000 gallons of rainwater annually, including water from the roof of a nearby campus apartment building.

If the space is available, many sustainable properties direct the water to onsite bioswales—frequently a series of them—that allow it to percolate back into the ground, cleaning it as it goes. Reducing impermeable surfaces and replacing them with gravel, porous pavers, or other materials helps to prevent oils and residues from getting washed into sewer systems. Sloping parking lots towards bioswales helps, too.

The Center for Neighborhood Technology occupies a building that was once a textile factory. Its small site in a dense Chicago neighborhood prevented it from using extensive bioswales (although it does have a rain garden and rain barrels.) But its parking lot includes a water filtration system. An infiltration trench was created at the lowest point and is filled with layers of gravel that allow water to percolate back into the earth.

CNT's stormwater system returns 62 percent of the annual rainwater to the ground, thus recharging the groundwater supply. The system removes 80 percent of post-development pollutants, McNally says.

The big picture

There is no shortage of green building information in print, on websites, and at numerous conferences. Green building practitioners are often evangelistic and quite willing to share information and experiences.

LEED certification, which many of the projects covered here have received, has had perhaps the biggest impact. "It's had a tremendous effect," says Alex Wilson, who is a board member of the U.S. Green Building Council. "In a very short period of time—within just a few years—I LEED has become part of a dialogue about new buildings. Three to four percent of buildings are going through the LEED process, and the system has influenced many more projects that have used the LEED template for discussing issues."

Whatever the reason, green building is now definitely part of the building conversation. It's time to add the term to your own lexicon.

Meghan Stromberg is Planning's senior editor.
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