



## Put a "green" top on your building to improve energy efficiency

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Rapidly rising energy costs have put a large spotlight on energy efficiency, especially on the designers, builders and owners of commercial or industrial buildings, which account for 65% of all electricity usage. Roofs have become the focus of efforts to improve energy efficiency because of the major role they play controlling energy consumption.

In an effort to control energy consumption, the International Code Council has developed an energy code design for the International Building Code standard, based on ASHRAE 90.1 and 90.2 standards. ASHRAE, the American Society of Heating, Refrigerating and Air-Conditioning Engineers in Atlanta, Georgia, strives to serve both humanity and the environment by advancing those technologies.

Currently, more than 25 states have implemented energy-efficient regulations within their statewide building codes. Many cities and local municipalities are implementing similar codes to lower the heat-island effect and stabilize energy demands.

"The increased demand for energy-efficient rooftops has been driven more by legislation than product development, but that is starting to change," said Dick Gillenwater, manager of advanced projects at Carlisle SynTec, a single-ply roofing manufacturer headquartered in Carlisle, Penn. "Energy-efficient roofing technology has been around for a long time, but is just now becoming the focus of the industry."

The most recognized options for energy-efficient roofing in the U.S. are reflective or cool roofs, which use light-colored materials to reflect the sun's solar energy. The roof garden (green roof), uses growth medium and moisture transpiration to reduce the roof's surface temperature, and is also gaining popularity.

### Cool Roofs

Over the past 15 years, numerous governmental and private organizations that support the creation of ratings and standards for roofing product reflectivity have developed: Energy Star (run by the U.S. Environmental Protection Agency); the California Energy Commission (CEC); ASHRAE; the independent Cool Roof Rating Council (CRRC.)

To receive an Energy Star rating, low-sloped roof products must have an initial reflectance of 0.65 on a scale of zero to one (zero equaling no reflectivity, one equaling absolute reflectivity.) There is also a three-year age requirement of 0.50 reflectivity. "Energy Star only provides ratings for superior reflective performance," said Steve Ryan, of Energy Star's labeled roof products division.

In contrast, CRRC will rate any product, regardless of its reflectivity value. While Energy Star receives its ratings from product manufacturers, the CRRC certifies ratings testing performed by accredited third-party laboratories.

"Energy Star is a big supporter of CRRC, but they are a consumer program, while our ratings are

designed to support building codes," said Peter Turnbull, supervisor of commercial programs at Pacific Gas and Electric Co. and vice chairman of CRRC.

One such building code is California's Title 24, which in 2001, was entered into the state's building code as an optional program. In October 2005, the California Energy Commission amended Title 24, making cool roofs the prescriptive minimum for virtually all low-sloped, non-residential roof projects, for both new construction and re-roofs.

One product that has gained popularity in California since the adoption of Title 24 is the single-ply-membrane thermoplastic polyolefin (TPO). Under CRRC, white TPO has an initial reflectivity ranging from 0.76 to 0.88, depending on the manufacturer.

Other popular reflective products include PVC and white EPDM. The specification of these reflective materials continues to grow, as building owners begin to recognize the financial benefits.

In 1997, the Lawrence Berkeley National Laboratory (LBNL) researched the effect of cool roofs on air conditioning costs. "Based on 1997 energy prices, building owners can collectively save \$750 million annually in net air conditioning and heating costs because of cool roofs," said Hashem Akbari, leader of the Heat Island Group at LBNL. Other studies, conducted by LBNL and the Florida Solar Energy Center, have found that cool roofs can reduce air conditioning costs by as much as 40%.

Cool roofs can also lessen the heat-island effect, which results from heat retention created by dark-colored building materials, and causes urban areas to be six to eight degrees Fahrenheit warmer than their surroundings. "Roofs receive approximately 20 percent of a dense urban area's solar energy, yet they produce 40 percent of the heat that is attributed to the heat-island effect," said Turnbull.

Reflecting that energy could have a positive effect on the overall temperature of urban areas. "During peak summer conditions, for every 0.01 difference in reflectivity, there is a one degree Fahrenheit change in rooftop temperature," said Akbari.

The most popular energy-efficient technology for steep-slope roofs is that of cool-colored roofing materials, which retain a traditional dark color and have a significantly higher reflectivity than traditional steep-slope materials. This reflectivity is due to special pigments that reflect near-infrared rays.

"Depending on the color of the roof tile, these cool-colored materials have reached 0.40 reflectivity, much higher than their traditional 0.05 to 0.12," said Akbari. Work is also being done at LBNL to create asphalt shingles with the same reflective properties. "Some 70 percent of the U.S. steep-slope roofing market is asphalt-based shingles. We are hoping to implement this technology and greatly improve the quality of these popular asphalt shingles," said Akbari

## Green Roofs

Several organizations that promote the use of green roofs have recently developed. None are more expansive or influential than The United States Green Building Council (USGBC), Washington, and its flagship program, LEED (Leadership in Energy and Environmental Design). LEED is an architectural standard that awards credits to buildings that use efficient, environmentally friendly components.

LEED is classified into two groups: LEED (EB) for renovations to existing buildings and LEED (NC) for new construction. LEED ranks green buildings as certified, silver, gold, or platinum, based on the

amount of points they receive.

According to Bill Retzlaff, professor of biological sciences at Southern Illinois Univ., Edwardsville and coordinator of the university's Green Roof Environmental Evaluation Network (GREEN), the State of Illinois might require all new state buildings to obtain a minimum silver status under LEED rankings.

This requirement would be fitting, as Chicago, along with the rest of the state, is putting LEED and green roofs on the U.S. roofing map. In 2000, Chicago Mayor Richard Daley installed a green roof on City Hall, setting off a citywide green roof movement.

Over the past few years, Chicago has awarded a number of \$5,000 grants to building owners who installed green roofs. The city is now offering five \$100,000 matching grants for larger green roof projects.

Currently, there is little reported research on the specific benefits of green roofs, but there are a growing number of projects underway. Retzlaff is currently working on a large-scale, green-roof project at SIUE, conducting experiments to determine energy, thermal and stormwater retention benefits. "We monitor 40 ground-level gardens and four projects on the roof of the engineering building for water retention and energy saving benefits."

Like reflective roofs, green roofs can reduce the heat-island effect and decrease air-conditioning demands. "If properly maintained, a green roof will qualify as a cool roof," said Akbari. Retzlaff concurred, noting that Chicago could lower its average daily temperature by approximately 10 degrees Fahrenheit if 65% of its rooftops incorporated vegetation.

Green roofs also provide long-term service. "If properly installed, green roofs could double the life of a commercial roof," said Joe Carbine, director of strategic accounts at Carlisle SynTec. "Green roofs provide significant energy and cost savings, but their contribution to stormwater management is their largest asset."

In major metropolitan cities like Chicago, stormwater and sewage share one drainage system. Heavy rainfall produces an overflow of this system, causing pollution in streams and rivers. Chicago uses green roofs to minimize excessive storm drainage.

"Research on green roofs has shown that a half-inch of rain can be fully absorbed by a previously dry, six- to eight-inch green roof," said Retzlaff.

Virtually all green roofs begin with the installation of a waterproofing system on the roof deck. This waterproofing membrane ensures that entrapped water does not leak into the building. The majority of green-roof construction is based on four waterproofing systems—EPDM, TPO, PVC, and hot, rubberized asphalt.

"The waterproofing systems are combined with protection courses, drainage composites, insulation, root barriers, and moisture mats, to construct green roofs," said David Barnes, technical representative for Carlisle Coatings & Waterproofing, a manufacturer of roof garden products, Wylie, Tex.

Currently, green roofs are used primarily on low-slope roofs, but there is a growing movement to use them on sloped roofs. Retzlaff plans to experiment with steeper-sloped green roofs, which would incorporate honeycomb-like structures that would be filled with soil and stabilized with plants.

Roof modules (trays) are also improving roof garden installation and maintenance. The trays can be easily moved for leak repairs, saving plants that would otherwise be uprooted.

Integral to the energy efficiency of both cool roofs and green roofs is insulation. When used in

combination with either a cool or green roof, insulation prevents the transfer of any latent heat, solar gain, and atmospheric temperature into the building.

Recognizing the importance of energy savings in building construction, the federal government now offers tax breaks of up to \$1.80 per s/f of a building that has an energy efficiency 50% better than ASHRAE standards, and \$.60 per s/f of a roof that is 50% more efficient than ASHRAE roof standards.

Along this line, LEED will award up to 10 credit points based on the extent to which a building exceeds ASHRAE standards. Title24 set insulation R-values at or above ASHRAE standards.

Regardless of their preference for cool or green roofs, advocates of energy-efficient roofing share one common goal: to reduce energy usage and create a healthier environment. "I don't think any one [energy-efficient] system is better than the other. There's room for all of them," said Retzlaff. "The most important thing is to match your roof to specific goals."

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