What Is A Cool Roof, And How Do I Get One?

Cool roofing is a hot trend in green building.

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Replacing St. John's Regional Medical Center's existing built-up roof involved a tear-off and installation of a watertight, reflective-vinyl roof and a cellular lightweight concrete (CLWC) system that provided superior insulation.

The Tiger Woods Learning Center, Anaheim, CA, boasts a reflective-vinyl roof.

Lowered air-conditioning demand. Reduced urban heat-island effect. Cool roofing can deliver both of these features to the environmentally conscious specifier or owner.

Reflective, or cool, roofing delivers high solar reflectance and thermal emittance values. Solar reflectance, also known as albedo, is a measure of a material's ability to reflect the visible, infrared, and ultraviolet wavelengths of sunlight. Thermal emittance is a measure of a material's ability to release absorbed, or non-reflected, heat. Both properties are measured on a scale of 0 to 1; the coolest roofs have the highest values. A third measure, solar reflectance index (SRI), may be used, and represents solar reflectance and emittance in a single value.

As one of the fastest-growing building and construction trends today, owners of large commercial buildings have more reasons than ever to incorporate cool roofs into their building design. It is a sure-fire way to reduce heat gain in interior spaces and curb the roofing surface's contribution to the urban heat-island effect. That effect consists of the measurable increase in ambient urban air temperature that comes when natural vegetation in the environment is replaced with heat-absorbing roofs, roads, and parking surfaces.

What is a cool roof?

At present, there is no industry-wide definition of cool roofs, but many sustainable-construction guidance documents and standards recommend them. Reflective roofing technologies are increasingly called for in federal, state, and local energy codes, most notably California's building energy code, Title 24. The code prescribes a cool roof for many low-slope, non-residential applications, and specifiers are turning to the Cool Roof Rating Council's (CRRC, Oakland, CA) product-rating database to help make purchasing decisions.

CRRC measures the solar reflectance and thermal emittance of roofing products, and reports information using an online directory (www.coolroofs.org). Each year, CRRC conducts random testing to ensure the credibility of the directory. The program allows manufacturers and sellers to label their roofing products according to the specific properties CRRC measures. Roofs qualifying for Title 24 in California must be tested by a CRRC-approved lab and receive a CRRC label. CRRC does not specify minimum requirements for solar reflectance or thermal emittance, however.

A product rating system that does specify minimum requirements is Energy Star, the joint

program of the U.S. Environmental Protection Agency, Washington, and the U.S. Dept. of Energy, Washington, designed to help businesses and consumers make energy-efficient product choices.

For low-slope roof applications, a roof product qualifying for the Energy Star label under its Roof Products Program must have an initial solar reflectivity of at least 0.65, and weathered reflectance of at least 0.50. Emittance is not a current criterion for this program, although that may change. Title 24's requirements, in comparison, call for initial thermal emittance of 0.75 or better, and initial solar reflectance of 0.70 or better. Beginning in August 2009, aged reflectance—0.55—will be used for products that are CRRC-registered.

How cool makes a difference

How can you get a quantitative analysis of the potential energy savings for a building without performing a detailed building-energy simulation? Simple web-based tools developed by federal agencies can help assign an estimated value on the annual energy savings that can accrue during the life of a typical white reflective roof vs. a non-reflective black roof. EPA's Roofing Comparison Calculator calculates the net cooling savings from installing an Energy Star-labeled roof product on an air-conditioned building, and considers any resulting differences in heating costs. The U.S. Dept. of Energy also has a calculator tool. These calculators can be accessed at www.vinylroofs.org in the Cool Roofing section.

In 2001, the Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA, measured and calculated the reduction in peak energy demand associated with the surface reflectivity of a white-vinyl roof that replaced a black-rubber roof on a major retail store in Austin, TX. Vinyl, or PVC, roofs achieve some of the highest reflectance and emittance measurements for roofing materials. It is not uncommon for such a roof system to reflect 80% or more of the sun's rays and emit at least 70% of the solar radiation that a building absorbs.

A black-asphalt built-up roof, by contrast, reflects 6% to 26% of solar radiation, resulting in greater heat transfer to the building interior and greater demand for air conditioning. In full sun, a black roof typically undergoes a temperature rise of as much as 50 to 90 deg, reaching midday temperatures of 150 to 190 F in summer. A white-vinyl roof on the same building typically increases only 10 to 25 deg. above ambient temperature.

The LBNL findings were consistent with this, recording an average daily summer temperature for the black roof surface of 168 F. Once retrofitted with a white reflective surface (with the same insulation and HVAC systems in place), it measured 125 F, a 43-deg. reduction.

LBNL also found that the retrofitted vinyl membrane delivered an 11% decrease in aggregate air-conditioning energy consumption, and a corresponding 14% drop in peak hour demand, compared with the original black roof. Without considering any tax benefits or other utility charges, annual energy expenditures were reduced by $7,200 or $0.07/sq. ft.

While logic would seem to dictate that vinyl roofs are best specified in southern climate zones only, net annual energy savings are typical even in northern climates. Although there are fewer cooling-degree days, cool roofs can have more impact on energy cost than energy use, cutting consumption during peak power demand when rates are the highest and offsetting any minimal wintertime increases in heating costs.

Whether in northern climates or southern, cool roofs reduce the urban heat-island effect by lowering the surrounding air temperature which, in turn, reduces demand for building cooling and minimizes a building's carbon footprint.

Another direct effect of urban heat islands is an increase in harmful ground-level ozone, the primary constituent of smog. Ozone at ground level forms through a chemical reaction between oxides of nitrogen (NOx) and volatile organic compounds (VOCs), from motor vehicle and other emissions, in the presence of sunlight.

In urban heat islands, the combination of asphalt parking lots and road pavement, sparse vegetation, and expanses of black roofs can raise air temperatures as much as 10 deg. higher than the temperature of the surrounding countryside. In some densely populated areas, a quarter of the land cover may be roof surface alone. Relative to remedying the other sources of the problem, replacing dark roofing requires the least amount of investment for the most immediate return.

Building green with cool roofs

Curbing the urban heat-island effect, along with reducing energy consumption, are significant objectives of the green building programs Green Globes and LEED. Reflective roofing can help meet the criteria of both sustainable construction programs.

Green Globes, an online tool, uses performance benchmark criteria to evaluate a

Navigating The Incentives

The Obama Administration has promised a significantly heightened emphasis on green-building technologies, increasing the likelihood of further interest in cool roofing. Any initiatives will build on the economic stimulus initiatives of the 110th Congress which, using the Emergency Economic Stabilization Act of 2008, extended until 2014 the federal tax deduction for energy-efficient commercial buildings with qualifying systems, including roofs. The amount deductible is as much as $1.80/sq. ft. of building floor area for buildings achieving a 50% energy-savings target.

Other incentives can be found in:

- The Database of State Incentives for Renewable Energy: a state-by-state compilation of energy-efficiency policies and incentives administered by federal and state agencies, utilities, and local organizations.
- The U.S. Dept. of Energy's State Energy Program (SEP): allocates funds for states to design and implement their own energy-efficiency programs.

Links to these resources can be found at www.vinylroofs.org/cool

building's probable energy consumption, comparing the building design against data generated by the EPA's Target Finder, which reflects real-building performance. Building information is verified by a Green Globes-approved and trained, licensed engineer or architect.

As many as 10 points may be awarded for 1% to 100% roof coverage with highly reflective materials, vegetation, or both. To qualify for a rating, roofing materials must have a solar reflectance of at least 0.65 and thermal emittance of at least 0.90.

As of this writing, 18 states recognize Green Globes in public laws. The Green Building Initiative, which owns the rights to Green Globes for New Construction and Green Globes for Continual Improvement of Existing Buildings in the U.S., is in the end stages of work with the American National Standards Institute (ANSI), Gaithersburg, MD, to establish Green Globes for New Construction as the first ANSI standard for commercial green-building design. This process should be completed in 2009.

LEED, the U.S. Green Building Council's (Washington) Leadership in Energy and Environmental Design certification, provides product performance standards in designing buildings, but does not certify products. As of December 2008, LEED initiatives, including legislation, executive orders, resolutions, ordinances, policies, and incentives, exist in 44 states, including 172 localities (112 cities, 32 counties, and 28 towns), 31 state governments, 12 federal agencies or departments, 15 public school jurisdictions, and 39 institutions of higher education across the U.S.

For a roof to receive LEED Sustainable Sites Credit 7.2, at least 75% of the roof surface must use materials having a solar reflective index (SRI) of at least 78. This criterion may also be met by installing a vegetated roof for at least 50% of the roof area, or installing a high albedo and vegetated roof that, in combination, meets this formula: (area of SRI roof/0.75) + (area of vegetated roof/0.5) ≥ total roof area.

The latest version of LEED will allow a lower SRI if the weighted rooftop SRI average meets the following criterion: (area SRI roof/total roof area) * (SRI of installed roof/required SRI) ≥ 75%.

In this vein, a separate but related area of cool roofing pertains to constructing a roof that many think of as the ultimate in cool—the planted roof. Vinyl roof membranes are often used in concealed applications such as the waterproofing layer in planted roofs and plaza decks. The permanent, hot-air welded seams do not deteriorate in the perpetually moist environment of a vegetated roof, and those same seams provide the highest resistance to root penetration of any waterproofing membrane.

The other variation on cool roofs is solar applications, which is gaining considerable momentum in the commercial building sector. Building integrated photovoltaic (BIPV) systems are compatible with a vinyl roof. In fact, some solar companies will only use vinyl membranes for their systems because the material's proven long life-cycle, high reflectivity, superior fire ratings, and hot-air welded seams assure that the roofing substrate will be functioning as long as the PV modules themselves. cbp

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For more information about cool roofing, circle 3 or visit www.cbpmagazine.com