

# Mercury Rising? Cool Roofs Help Beat the Heat

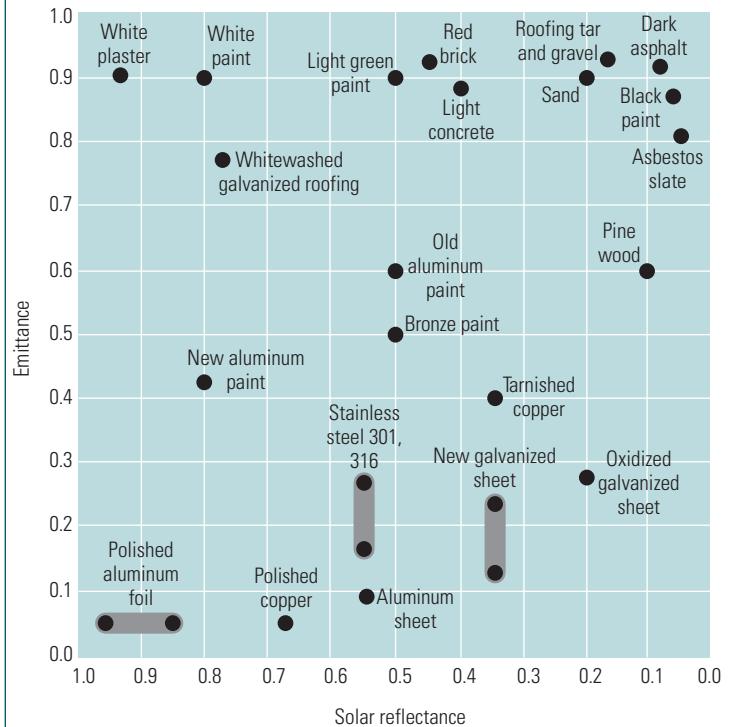
Cool roofs—created with light-colored roofing materials that stay cool even on hot days—can lower air-conditioning loads by up to 40 percent in some buildings. Typical energy savings run around 20 percent, with simple payback periods of a few years. But cool roofs should also last longer than conventional roofs, because they don't overheat. And, in some cases, the reduced cooling load can make it possible to downsize the cooling system, offsetting some or all of the marginal first cost of the cool roof.

## What Is a Cool Roof?

The cool roof is a fairly simple solution to a straightforward problem. Over the years, many buildings have been built with poorly insulated dark roofs. Baking in the sun, these roofs can get very hot—up to about 190 degrees Fahrenheit (F)—and radiate that heat into the space below, increasing air-conditioning loads and potentially making the building occupants miserable. In addition, the cumulative effect of thousands of dark roofs, dark roads, and dark parking lots contributes to a phenomenon known as the urban heat island, raising the ambient temperature of urban areas by as much as 6° to 8°F relative to the surrounding countryside. This in turn exacerbates smog levels and increases the need for air conditioning, which pushes summer peak demand higher, at considerable cost to utilities and their customers.

These problems can be mitigated by using roofing and paving materials that reflect solar radiation (exhibiting high albedo or reflectance) and shed heat (exhibiting high emittance). Figure 1 shows the reflectance and emittance of various building materials. Cool roofs are typically 50° to 70°F cooler on a hot, sunny day than their standard coun-

**Figure 1: Reflectance and emittance of building materials**  
 Even though many metals have a high solar reflectance, if emittance is low, the material will not reject heat effectively. For example, polished aluminum foil has a very high solar reflectance, but its emittance is low, so it retains heat. Note its placement in the lower portion of the graph. The best-performing materials for cooling load reduction have both high albedo and high emittance, and are in the upper left-hand section.



Courtesy: Florida Solar Energy Center

terparts. They radiate far less heat into the building below, thereby reducing air-conditioning loads and improving occupant comfort. Because they stay cooler on hot, sunny days, these roofs expand and contract less and should therefore last longer than conventional roofs.

## Roofing Surfaces

There are three different types of cool roof surfaces that can be used for low-slope roofs (surfaces with a slope of 2:12 inches or less are best for keeping roofs clean).

**Single-ply membranes.** Single-ply roofing systems are factory-fabricated sheets (35 to 60 millimeters thick) that are installed in the field as a single layer. Single-ply roofing comes on a roll and is bonded to the roof surface with a heat gun. Single-ply systems offer ease of installation, light weight, and usually low installation cost due to labor savings. Some of the concerns regarding this technology include puncture resistance, ponding water, delamination, and chemical resistance.

**Roof coatings.** Coatings are typically applied in a liquid state to the roof surface. They can be sprayed or rolled over many substances to create a cool roof where one didn't exist before. They can also be used as a maintenance or repair coating, depending on the condition of the underlying roof. Coatings are often used over single-ply roofs. But not all coatings are considered cool roof products. There are two types of coatings: *Elastomeric* coatings, which create good waterproof membranes; and *cementitious* coatings, which provide high reflectance and emittance but have no waterproofing properties.

**Sprayed polyurethane foam.** Foam is created when two components—*isocyanate* and *polyol*—are mixed together and applied to a roof surface with a spray gun. The mixing of the two chemicals causes a reaction that generates heat and the mixture expands to 20 to 30 times its original volume. Cool roof coatings (or some type of gravel) must be applied to protect the foam from ultraviolet light. Foam only qualifies as a cool roof material when it is used with a coating. Under those conditions, it provides good insulation and is a light-weight cool roof solution.

Several other materials, such as roof tiles and metal roof panels, can also qualify as cool roofs, depending on the specifications. When weighing the options, it's important to remember that just because a roofing material is white, that doesn't mean it qualifies as a cool roof material.

## Cool Roof Economics

In the best applications, cool roofs have no incremental cost, delivering nearly instant payback. In the wrong applications, they will never pay for themselves. The key is to know when a cool roof makes sense.

In general, cool roofs are most cost-effective under one or more of the following conditions:

- New construction is planned or a regularly scheduled roof replacement is due for an existing building
- Older, inefficient HVAC equipment is due to be replaced
- The building is a flat-roofed, low-rise, air-conditioned commercial facility
- There is little or no existing roof insulation
- The climate is hot and sunny (at least in summer)

There is also a big difference between the marginal costs for new construction and retrofits. The marginal cost of choosing a "cool" variety of a material for new construction is zero to small. Adding a cementitious coating to an existing capsheet roof costs between \$0.35 and \$0.50 per square foot (ft<sup>2</sup>), whereas adding an elastomeric coating will cost at least \$0.75/ft<sup>2</sup>, but it also enhances the roof's waterproofing properties. (Unless otherwise indicated, all dollar amounts in this publication are in U.S. dollars.)

A California study of six commercial buildings yielded air-conditioning energy savings that ranged between 0.06 and 0.60 kilowatt-hours (kWh) per square foot

per year. Specific energy savings will depend on a building's locale, construction, insulation levels, and HVAC equipment.

In addition to delivering energy benefits, cool roofs can deliver savings on lifetime maintenance costs. A conventional built-up "hot" roof must have a new top layer added every 10 years or so, at a cost of \$1.50/ft<sup>2</sup>. Beyond three layers, the roof becomes too heavy, so all the layers must be torn off and a new single layer applied. (In California, usually only two layers of standard roofing materials are allowed.) In comparison, a cool roof can receive many thin, lightweight re-coatings (with a materials cost of less than \$1.00/ft<sup>2</sup>) over several 10-year intervals without exceeding weight limits and triggering a major roof replacement. Most types of conventional roofs can be coated.

## Corporate Cool Roof Initiatives

Some commercial chains, including Target and Wal-Mart, are starting to make cool roofs a standard feature for new stores and for roof retrofits. Jim Boler, national energy manager at Target, reports that cool roofs have been used at Target stores across the country for 5 to 10 years. A detailed study was commissioned to quantify the energy savings from switching to cool roofs (see sidebar). The results were compelling. Target now has its own roofing installation group. The group provides the majority of the labor, but local contractors may be brought in to help out as needed.

Ray Darby, the former cool roofs program manager at California Energy Commission (CEC) reports that Wal-Mart is evaluating cool roofs as well. "That's fairly significant," Darby says, "because you can imagine Wal-Mart would be looking for the best buy. So if cool roofs were outrageously expensive and not a good idea, Wal-Mart probably wouldn't be putting out the bucks for them. But they've done several under our program already in California and are probably going to be doing a lot more. It's really exciting."

### Case Study: A Target Store in Austin, Texas

A study of energy savings conducted by Lawrence Berkeley National Laboratory concluded that a 100,000 ft<sup>2</sup> Target retail store in Austin would likely save about \$65,000 over the life of its cool roof. Applying a reflective roof membrane reduced the average summertime daily maximum roof-surface temperature from 168° to 126°F. That, in turn, reduced total air-conditioning energy use within the building by 11 percent, and peak air-conditioning demand fell by 14 percent.

According to the building manager, lower labor costs offset higher material costs for installing a white thermoplastic roof instead of a black rubber roof, yielding a negligible cost difference. As a result, the payback for this system was immediate.

Several of the high-tech facilities in Silicon Valley are also installing cool roofs, including Apple, IBM, Unisys, Nissan, and a few military facilities. Dave Roberts, a consultant for the CEC program, also reports, "Most responsible corporate citizens see cool roofs as being a really smart idea. They are a sustainable roof product, and there is almost no disruption to operations when you work with them—you don't have the strong tar smell that you get when installing or retrofitting asphalt roofs."

## Useful Cool Roof Web Sites

Dave Roberts, an independent consultant, maintains two good sites for the California Energy Commission at [www.coolroofs.info](http://www.coolroofs.info) and [www.coolroofers.com](http://www.coolroofers.com).

The Sacramento Municipal Utility District's Cool Roof program has its own comprehensive site at [www.smud.org/coolroof/index.html](http://www.smud.org/coolroof/index.html).

Lawrence Berkeley National Laboratory also maintains a database on cool roofing materials. It can be accessed on the Web at <http://eetd.lbl.gov/coolroof/>.

Information on Energy Star-labeled roofing products can be found at <http://yosemite1.epa.gov/estar/consumers.nsf/content/roofbus.htm>. (Note that the

Energy Star ratings for cool roofs are preliminary and do not consider emittance. This program currently relies on manufacturers' information.)

The Cool Roof Rating Council (CRRC) is developing a label to be placed on roofing products, much like window labels provided by the National Fenestration

Rating Council. The label will include information on solar reflectance and emittance, based on independent third-party testing. The council includes representatives from all industry interests. For more information about CRRC, visit [www.coolroofs.org](http://www.coolroofs.org).