

Cool Roofs

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.

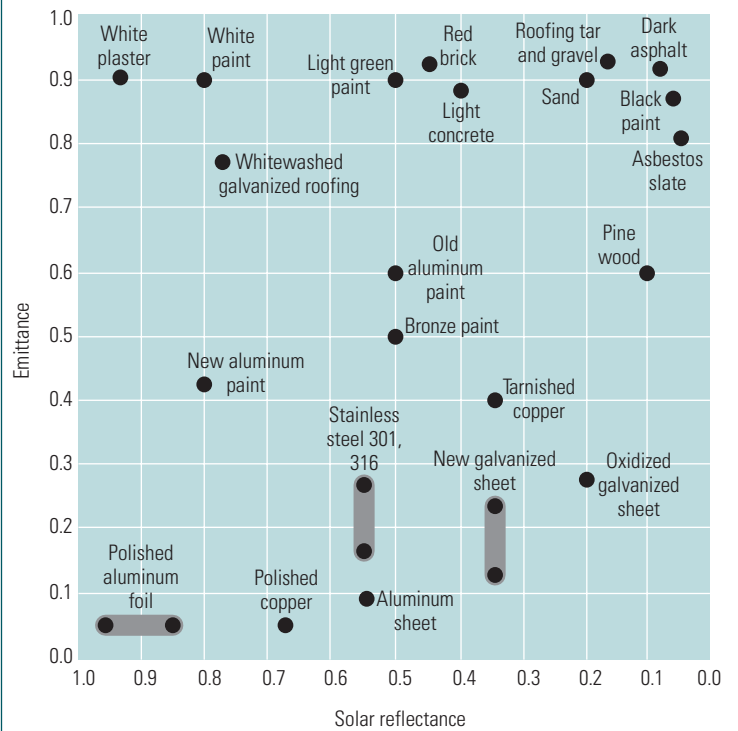
What Is a Cool Roof?

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° 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 higher than temperatures in 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 counterparts. They radiate far less heat into the building below, thereby reducing air-conditioning loads and improving

Figure 1: Reflectance and emittance of building materials

Even though many metals have a high solar reflectance, they will not reject heat effectively if emittance is low. 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 they are in the upper left-hand section of the graph.



Courtesy: Florida Solar Energy Center

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.

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 *polynol*—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 lightweight 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 (ft²), whereas adding an elastomeric coating will cost at least \$0.75/ft², but it also enhances the roof's waterproofing properties.

A California study of six commercial buildings yielded air-conditioning energy savings that ranged between 0.06 and 0.60 kilowatt-hours 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/ft². 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 recoatings (with a materials cost of less than \$1.00/ft²) over several 10-year intervals without exceeding weight limits and triggering a major roof replacement. Most types of conventional roofs can be coated.

Cool Roof Benefits a Small Business Owner

Some small businesses have already reaped cool roof benefits. The California Machining Center is a small business located in Santa Clara, California, that specializes in precision machining operations for the electronics industry. This business operates a number of computer numerically controlled (CNC) machines, lathes, and mills. Company President Michael Pleban owns the 14,000-ft² building that is half-occupied by his business, and he installed a cool roof as part of an overall building upgrade.

Initially, Pleban's main reasons for retrofitting his roof were to help attract new tenants to share space and to reduce maintenance problems. He says that he "didn't want the headache of a leaking roof" and that he sought out a quality installation that would last some 15 to 20 years. However, the installation of a cool roof created additional benefits that reduced energy costs.

The nature of Pleban's business requires stable interior temperatures to guarantee the precision of machining operations. Additionally, when the machines are

running, they produce significant waste heat. Prior to installing the cool roof, he frequently had to run his air-conditioning units to maintain occupant comfort and to prevent temperature fluctuations that could degrade operations. Now, he rarely has to run his air conditioning, although he did upgrade his systems as part of his building retrofit. Pleban notes that there is only a 4° to 6°F variance in his interior temperatures, even if exterior temperatures are high and he is running his machines. Says Pleban, "I love my roof."

Useful Cool Roof Web Sites

Dave Roberts, an independent consultant, maintains two good sites for the **California Energy Commission** at www.coolroofs.info and www.coolroofers.com.

The **Sacramento Municipal Utility District's** Cool Roof Program has its own comprehensive site at www.smud.org/commercial/saving/service/roof.html.

Information on **Energy Star**-labeled roofing products can be found at www.energystar.gov (select the "Products" tab and click on "Roof Products").

The **Cool Roof Rating Council** (CRRC) is developing a label to be placed on roofing products that is much like the 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. For more information about CRRC, visit www.coolroofs.org.