

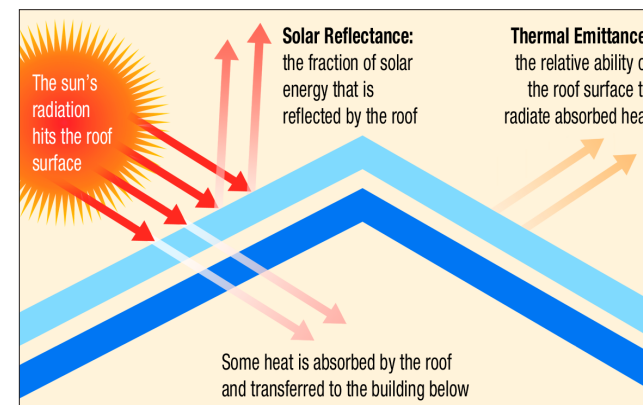


Cool roofs are ready to save energy, cool urban heat islands, and help slow global warming.

Cool roofing is the fastest growing sector of the building industry, as building owners and facility managers realize the immediate and long-term benefits of roofs that stay cool in the sun. Studies exploring the energy efficiency, cost-effectiveness, and sustainability of cool roofs show that in warm or hot climates, substituting a cool roof for a conventional roof can:

- Reduce by up to 15% the annual air-conditioning energy use of a single-story building
• Cool interior spaces in buildings that do not have air conditioning, making occupants more comfortable
• Reduce carbon emissions by lowering the need for fossil-fuel generated electricity to run air conditioners
• Potentially slow global warming by cooling the atmosphere

If you are installing a new roof or reroofing an existing building, a systems approach to providing an energy efficient roof should be taken with a cool roof considered as one of the options available.



A white roof saves energy by strongly reflecting sunlight (high solar reflectance) and efficiently emitting thermal radiation (high thermal emittance).

How Cool Roofs Work

Traditional dark-colored roofing materials strongly absorb sunlight, making them warm in the sun and heating the building. White or special "cool color" roofs absorb less sunlight, staying cooler in the sun and transmitting less heat into the building. This reduces the need for cooling energy if the building is air conditioned, or lowers the inside air temperature if the building is not cooled.

The "coolness" of a roof is determined by two properties and their combined effects on temperature:

- Solar reflectance — the fraction of sunlight that is reflected
• Thermal emittance — the efficiency with which a surface cools itself by emitting thermal radiation

Both properties are measured on a scale of 0 to 1 — the higher the values, the cooler the roof.

about \$1/ft² to the installed cost.

- Installing a white roof on a commercial building yields annual energy savings worth up to \$0.20/ft² and installing a cool color roof on a home yields annual energy savings worth up to \$0.05/ft². Savings vary, and are greatest in hot and warm climates. Use the DOE or EPA calculator referred to later in this document to estimate your savings.
• A cool roof may increase the need for heating energy in winter by reflecting sunlight that would otherwise warm the building. However, winter penalties can be smaller than summer savings even in mixed climates (locations with comparable heating and cooling requirements).

How to Select and Buy Cool Roofing Materials

The energy and cost savings that can be achieved by using cool roofing technologies depend on many factors, such as climate and building characteristics.

Three aspects of cool roofing technologies also affect their cost-effectiveness:

- The aged solar reflectance and thermal emittance of the roof (since many roofs become less reflective over time, energy savings should be based on long-term values of solar reflectance and thermal emittance).
• The incremental initial cost of the cool roof (if any).
• The incremental cost of keeping a cool roof clean and reflective (if any).

Several tools are available to help consumers and professionals choose appropriate cool roofing materials and estimate their benefits.

- DOE's Building Energy Software Tools Directory provides information on 370 building software tools for evaluating energy efficiency, renewable energy, and sustainability in buildings. http://apps1.eere.energy.gov/buildings/tools_directory
• The DOE and the U.S. Environmental Protection Agency (EPA) each offer online calculators that estimate the cooling energy savings and heating energy penalties attained by installing a cool roof. DOE calculator: http://www.ornl.gov/sci/roofs+walls/facts/CoolCalcEnergy.htm EPA calculator: http://roofcalc.com
• The EPA lists thousands of ENERGY STAR approved cool roofing materials. http://www.energystar.gov/index.cfm?c=roof_prods.pr_roof_products
• The Cool Roof Rating Council (CRRC) maintains a program for measuring and reporting the solar reflectances and thermal emittances of roofing materials. Their Rated Products Directory lists over 1000 materials. http://coolroofs.org

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The Emergence of Cool Roofs

Cool roofing is not a new concept. In the mid-1980s, researchers at DOE national laboratories in Tennessee and California were measuring the energy-saving benefits of “solar radiation control coatings” on test roofs. Although energy savings were confirmed in these early studies, they were not sufficient to lead roofing designers and installers to switch away from traditional dark-colored roofing systems.

A parallel effort was launched to determine the influence of light-colored roofing products on summer urban heat islands. This research demonstrated that solar reflective roofs, solar reflective pavements, and vegetation could lower urban air temperatures, saving additional energy and improving air quality.

Rolling blackouts during the summer of 2001 motivated California’s public utilities to expand the scope of their peak load management programs. They found that cool roofing reduces peak demand for electricity, helping to lower costs and avoid power outages.



Cool roofing for residential buildings need not be white; cool colors are available for a number of roofing materials.

Twenty years after DOE initiated its work on cool roofs, these products dominate the commercial roofing marketplace in warm and hot climates, partly because the State of California changed its energy code to prescribe cool roofing for most commercial buildings with low-sloped roofs.

Today

Today both white and “cool color” products are available for low-slope and steep-slope roofs.

- Cool products are generally economical on low-slope roofs for commercial or industrial buildings.
- Cool options are available for most traditional roofing materials.
- White roofs are coolest, but cool colors are a popular alternative for roofs that can be seen by neighbors.
- The U.S. EPA lists about 3,000 ENERGY STAR® compliant cool-roofing materials.
- Federal tax credits are available for some cool materials, including asphalt shingles and metal products.
 - Many state agencies and utility programs offer incentives for installing cool roofs.
 - Cool roof credits are offered in sustainable building programs such as the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED).

Cool Roofs Save Energy and Money in Many Settings

Cool choices now exist for most traditional roofing materials. Cool roofing should be considered whenever construction or an energy retrofit is being planned.

- For low-slope roofs (pitch \leq 2:12), cool thermoplastic membranes, elastomeric coatings, and metal products are available.
- For steep roofs, cool asphalt shingle, clay tile, concrete tile, and metal products are available.

Urban Heat Islands

(Adapted from EPA Urban Heat Island Basics Compendium)

<http://www.epa.gov/heatisland/resources/pdf/BasicsCompendium.pdf>

Air temperatures in many urban and suburban areas are higher than those in their rural surroundings; this regional elevation in air temperature is called an “urban heat island.” Many factors contribute to urban heat islands. In rural areas, trees and other vegetation provide shade and also reduce air temperatures by releasing water to the surrounding air. Vegetative surfaces are also moderately solar reflective. In contrast, urban areas are characterized by dry and impervious surfaces that strongly absorb light, such as conventional roofs, sidewalks, roads, and parking lots. As these urban surfaces are warmed by the sun, they heat both the interiors of buildings and the outside air. Choosing solar-reflective roofing cools the buildings and the outside air. Cool roofs in an urban area can therefore:

- Lower the local air and ground temperatures
- Improve human comfort and health in uncooled buildings and outdoors
- Reduce the need for electricity to cool buildings
- Decrease emissions of nitrogen oxides (NO_x), sulfur dioxide (SO₂), carbon dioxide (CO₂), and/or mercury (Hg) from electrical power plants



Philadelphia, PA reduced temperatures in row houses by installing cool roofs, which improves comfort for occupants and may help reduce deaths from heat waves. Baltimore, MD took similar steps following the success in Philadelphia.