Cool Roof Rating Council
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Determining the Energy Savings of a Cool Roof

Introduction

"Cool" roofs reflect sunlight and efficiently radiate heat to the sky to reduce heat flow into the building. Coolness is measured by two properties, solar reflectance and thermal emittance. Each property is measured from 0 to 1 and the higher the values, the "cooler" the roof.

Cool roofs can cut energy costs in air-conditioned spaces by reducing the need for air-conditioning[1]. Quantifying the energy savings and the associated energy cost savings provided by a cool roof is challenging because each installation is unique. This document provides an overview of some of the primary factors that influence cool-roof energy savings and identifies resources available to learn more.

[1] I. Hernández-Pérez, G. Álvarez, J. Xamán, I. Zavala-Guillén, J. Arce, E. Simá, Thermal performance of reflective materials applied to exterior building components—A review, *Energy Build.* 80 (2014) 81–105. https://doi.org/10.1016/j.enbuild.2014.05.008.

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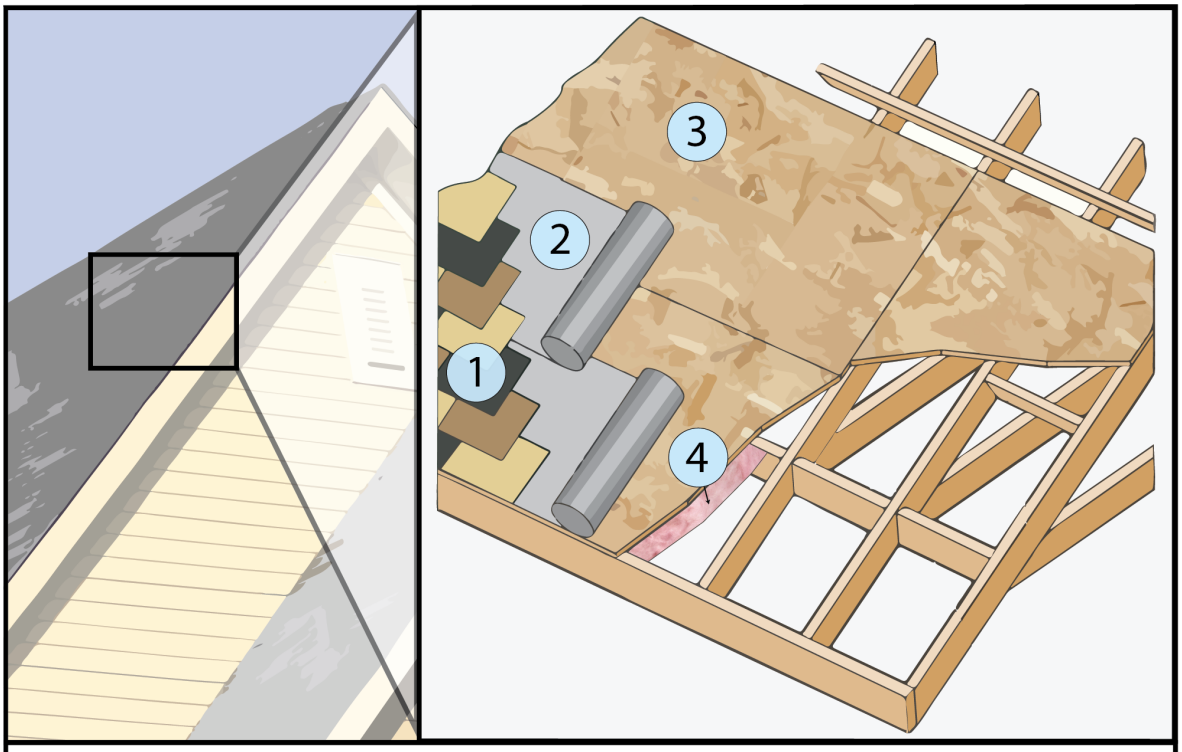
Anatomy of a Roof



1. **Roof covering**: The topmost layer of the roof that is exposed to sunlight (e.g., asphalt shingles, metal panels, clay tiles, or concrete tiles)
2. **Underlayment:** A water-resistant or waterproof barrier
3. **Roof deck (also called sheathing)**: A flat surface attached to the underlying roof structure. Commonly made of plywood, oriented strand board (OSB), or steel
4. **Insulation:** Material used to reduce unwanted heat loss and gain through the roof

Graphic adapted from APA's "Proper Installation of APA Rated Sheathing for Roof Applications". This figure represents one configuration of a residential steep-slope roof. There are many other residential and commercial roof configurations that contain similar components.

In this document, "roof product", "roof product type", and "cool roof" all are used to refer to the **roof covering** as defined in the diagram above.

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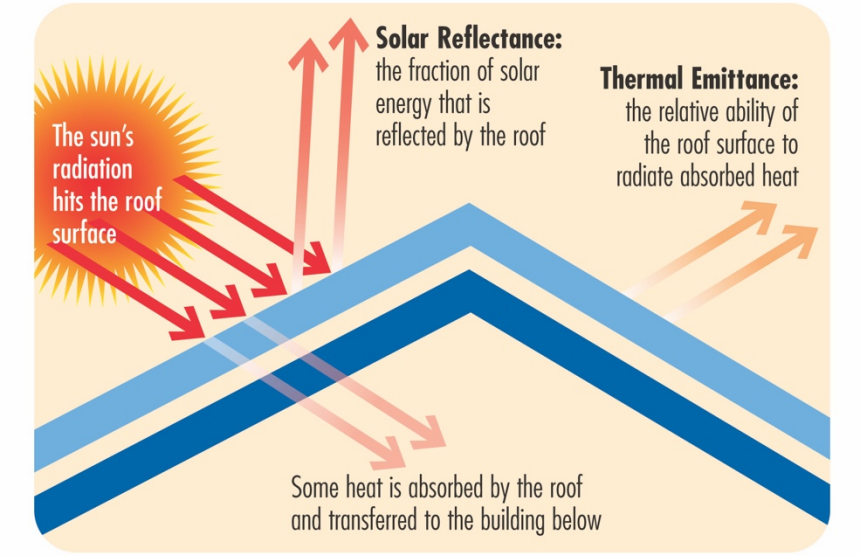
How a Cool Roof Works

Cool roofs reflect solar energy before it can heat the building as shown in the figure below. This saves energy in an air-conditioned building and makes a building without air conditioning more comfortable.



Estimating Energy Savings

Energy modeling is generally required to develop an accurate estimate of the energy savings attained by replacing an existing roof with a more reflective option. The potential energy savings are affected by many variables, some of which are described below.

Roofing Product Details

- **Solar reflectance of the new roof covering and the existing/baseline roof covering.** A larger increase in solar reflectance between the existing roof covering and the new roof covering will generally yield greater energy savings. If the existing roof covering is a darker, low-reflectance color, installing a "cooler" alternative will yield greater cooling energy savings.
- **Type of roof covering.** Thermal mass (capacity to store heat) varies by roof covering type (e.g., asphalt shingle, single-ply membrane) and roof assembly. For example, concrete roof tiles have a high thermal mass, which means they absorb and release heat slowly. This can reduce air-conditioning demand in climates with warm days and cool

nights. The above-sheathing ventilation (airflow between the roof covering and the roof deck) also varies by roof covering type.

Location and Climate

- **Climate.** Characteristics of the climate where a cool roof is installed such as the amount of incoming solar radiation (sunlight) and seasonal temperatures affect the potential energy savings of a cool roof. Cool roofs will yield greater energy savings when replacing a non-reflective roof covering in hot climates than in more temperate climates.
    - In climates where heating is required in colder months, cool roofs can create a "heating penalty", meaning that more energy is needed to heat the home. However, this annual heating penalty is usually small compared to the annual cooling savings because roofs in cold climates tend to receive much less sunlight in winter than in summer. More information about the winter heating penalty can be found in the FAQs of the CRRC website.
- **Local environment.** The local environment in which a cool roof is installed can affect the long-term performance of the roofing product. The solar reflectance of most products decreases with aging, and this problem is often aggravated in areas of high pollution and regions prone to biological growth.

Roof and Ceiling Insulation

- **Amount of insulation.** Cool roof products and insulation work in tandem to prevent the transfer of heat into a building. Like insulation, a cool roof reduces the amount of cooling needed by limiting the heat transferred into the building. However, it works in a very different way. Generally, the same cool roof product will yield greater energy savings in older buildings with little roof insulation than in newer buildings with highly insulated roofs.
    - Note: Energy savings cannot be generated in uncooled spaces. However, the installation of a cool roof on an unconditioned building may increase occupant comfort by keeping the building's interior cooler during hot months.

Other Factors

There are many other factors that impact the energy savings associated with installing a cool roof to a lesser degree than the factors described above, including but not limited to:

- Building vintage (year of construction)
- Building type/function (e.g., office, warehouse, retail)
- Roof orientation and slope

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- Attic ventilation
- Air flow between the roofing product and the roof deck (above-sheathing ventilation)
- Roof deck (sheathing) material (e.g., wood, concrete)
- Shading from trees and neighboring buildings
- Type of heating and cooling equipment used in the building

Energy Cost Savings

Cool roof energy savings contribute to lower energy bills. The cost savings depend on several factors, including but not limited to cooling and heating system efficiencies, energy prices, and peak power demand charges. Some cities and states also offer incentives for installing a cool roof or for reduced energy consumption. See the “Learn More” section for more information.

Resources

There are several resources that can provide an estimate of the energy savings associated with installing a cool roof. Please note that the values provided by any of these tools should be considered an estimate and not a guarantee of actual results.

ORNL Cool Roof Calculator
- Online tool for low-slope (e.g., commercial) roofs
- Intended for or small and medium-sized facilities that purchase electricity without a demand charge based on peak monthly load
- A version of the calculator is available for large facilities that purchase electricity with a demand charge based on peak monthly load here.

DOE Steep Slope Calculator
- Online tool for steep-slope (e.g., residential) roofs

Lawrence Berkeley National Laboratory’s Cool Surface Savings Explorer
- Excel tool that reports energy, energy cost, emission, and peak power demand savings estimates drawn from simulation database
- Limited to certain building categories, locations, and vintages

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Learn More

Individual cities, counties, and states can have varying energy codes, ordinances, and incentive programs, including cool roof requirements. The Database of State Incentives for Renewables & Efficiency offers a searchable database of programs, however, contacting your local jurisdiction directly is important to learn about available programs and ensure compliance.

Learn more about the benefits of cool roofs from the Global Cool Cities Alliance.

Visit the CRRC Rated Products Directory to compare roofing products and learn more about cool roofs, look for code requirements and green building programs, and more. To contact the CRRC, email info@coolroofs.org or call (866) 465-2523.