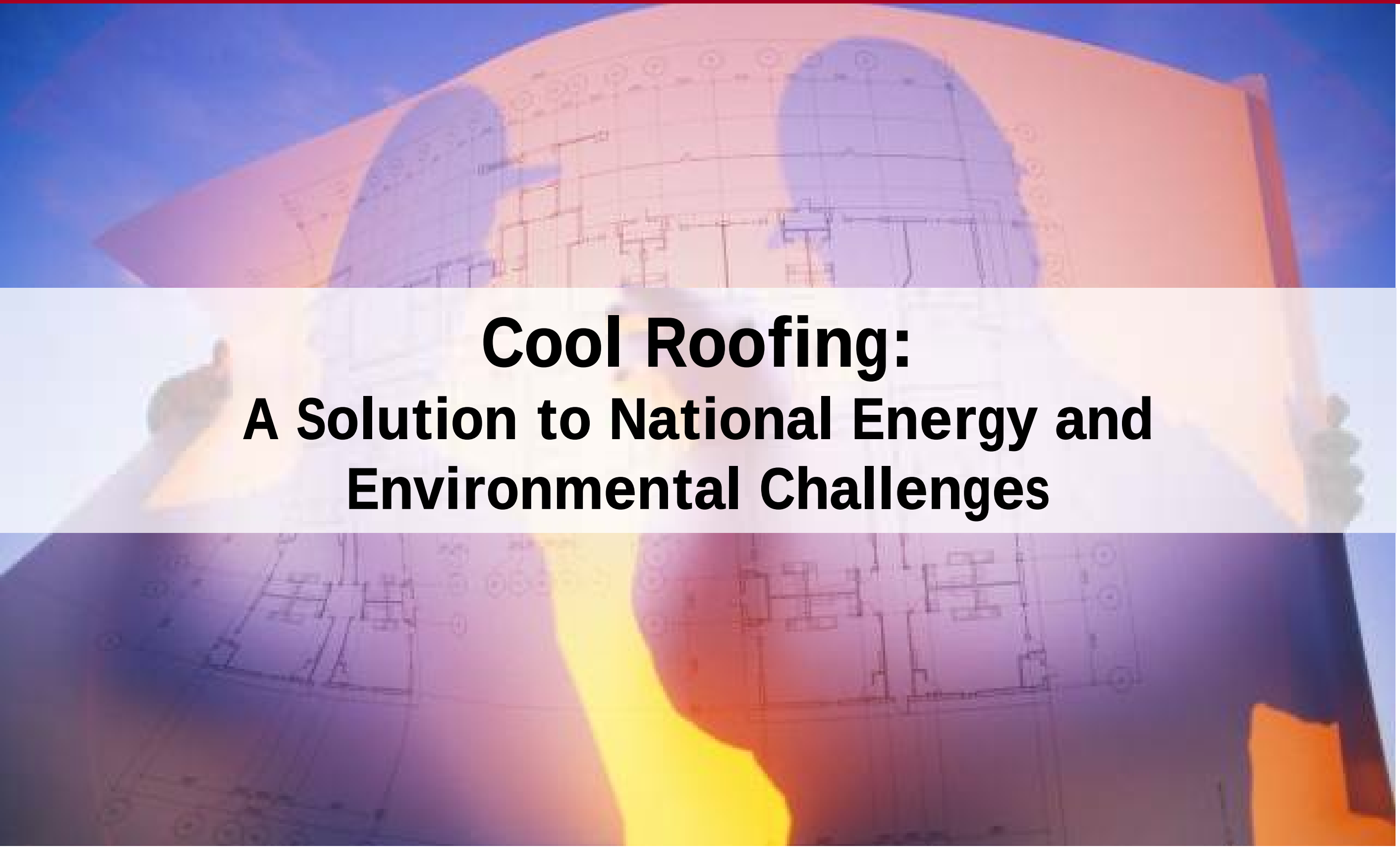

# Cool Roofing:

## A Solution to National Energy and Environmental Challenges

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# Cool Roofing: A Solution to National Energy and Environmental Challenges

Presented By: Chemical Fabrics and Film Association Inc.
1300 Sumner Ave.
Cleveland, OH 44115

Description: Provides an overview of the performance characteristics and benefits of cool roofing systems using reflective white vinyl roofing. Green roofing, energy saving programs, environmental challenges and solutions are also reviewed.

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## Learning Objectives

Upon completing this course, you will be able to:

- Recall at least 2 approaches of cool roofs in curbing the urban heat island effect and how it contributes to improved air quality
- Use white reflective vinyl roofing to meet Energy Star®, Title 24, LEED®, and Green Globes™ criteria for successful installation of environmentally sound cool roofing systems
- Calculate how building energy costs and peak energy demand can be reduced through the use of white reflective vinyl roofing membranes and green or planted roofs
- Recall incentive programs for use of cool roofs and apply these to an ongoing project

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# Cool Roofing

# “Cooler” Roofing

In full sun, the surface of a black low slope roof may experience a temperature rise of as much as 50 to 90 degrees Fahrenheit, reaching midday temperatures of 150 to 190 degrees Fahrenheit on a summer day.

A white reflective roof on the same building typically increases only 10 to 25 degrees Fahrenheit above ambient temperature under the same conditions.

A differential of this significance begs the question: what makes one roofing material “cooler” than another?

# What is Cool Roofing?

When a roof system can deliver a high **solar reflectance** (the reflecting of sunlight from the roof's surface), and a high **thermal emittance** (the radiating away of most of the solar energy absorbed), it is regarded as a cool roof.

Cool roofs reflect the sun's rays well across the entire solar spectrum, especially in the infrared and visible wavelengths. The less solar radiation a material absorbs, the cooler it is. The coolest materials also radiate away what little heat they do absorb.

# Benefits of Cool Roofing

Cool roofs provide environmental and economic benefits – typically without an installed cost premium – without sacrificing any other roofing performance attribute. Cool roofs reduce both building cooling loads and the urban “heat island” effect. And cool roofs may enhance the life expectancy of both the membrane and the building cooling equipment.

In some jurisdictions, local codes allow a reduction in insulation when cool roofing is employed. That’s because in cooling-dominated climates, less insulation is needed as the building cooling load is reduced. A further benefit: improved thermal efficiency of whatever roof insulation is required. As the temperature increases the thermal conductivity of the insulation increases.

More than just a sensible “green” building design approach, cool roofing is a significant solution to critical national energy and environmental challenges.

# Measuring Cool Roofing

Also known as albedo, solar reflectance is a measure of a material's ability to reflect sunlight (including the visible, infrared and ultraviolet wavelengths), expressed either as a decimal fraction or a percentage. A value of 0 indicates that the surface absorbs all solar radiation, and a value of 1 represents total reflectivity.

Thermal emittance is the ability of a material to release a material's absorbed (non-reflected) heat, expressed either as a decimal fraction between 0 and 1, or a percentage.

## Measuring Cool Roofing

A third measure, the solar reflectance index (SRI), is now used by some in the construction industry to evaluate a roofing material's coolness. SRI incorporates both solar reflectance and emittance in a single value to represent a material's temperature in the sun.

SRI quantifies how hot a surface would get relative to standard black and standard white surfaces. It is defined such that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100. Some highly reflective materials have a SRI greater than 100.

# Measuring Cool Roofing

There are several ways to attain the benefits of a cool roofing system. They range from short-term solutions such as paints and coatings that can temporarily turn dark roofs white to long-term waterproofing solutions such as highly reflective white or light-colored single-ply vinyl membranes. Green, or planted, roof systems also fall into this category.

Single-ply vinyl, or PVC, membranes achieve some of the highest reflectance and emittance measures of which roofing materials are capable.

White vinyl roofs can reflect three-quarters of the sun’s rays – usually far more – and emit 70 or more percent of the solar radiation absorbed. Black asphalt built-up roofs, by comparison, reflect between 6 percent and 26 percent of solar radiation.

# Characteristics of Common Roofing Systems

| | Solar Reflectance | Emittance | Solar Reflectance Index |
|---|---|---|---|
| **Black EPDM** | 0.06 | 0.86 | -1 |
| **Smooth Bitumen** | 0.06 | 0.86 | -1 |
| **White Granular Surface Bitumen** | 0.26 | 0.92 | 28 |
| **Dark Gravel on BUR** | 0.12 | 0.9 | 9 |
| **Light Gravel on BUR** | 0.34 | 0.9 | 37 |
| **White Thermoplastic (Vinyl)** | 0.83 | 0.92 | 104 |

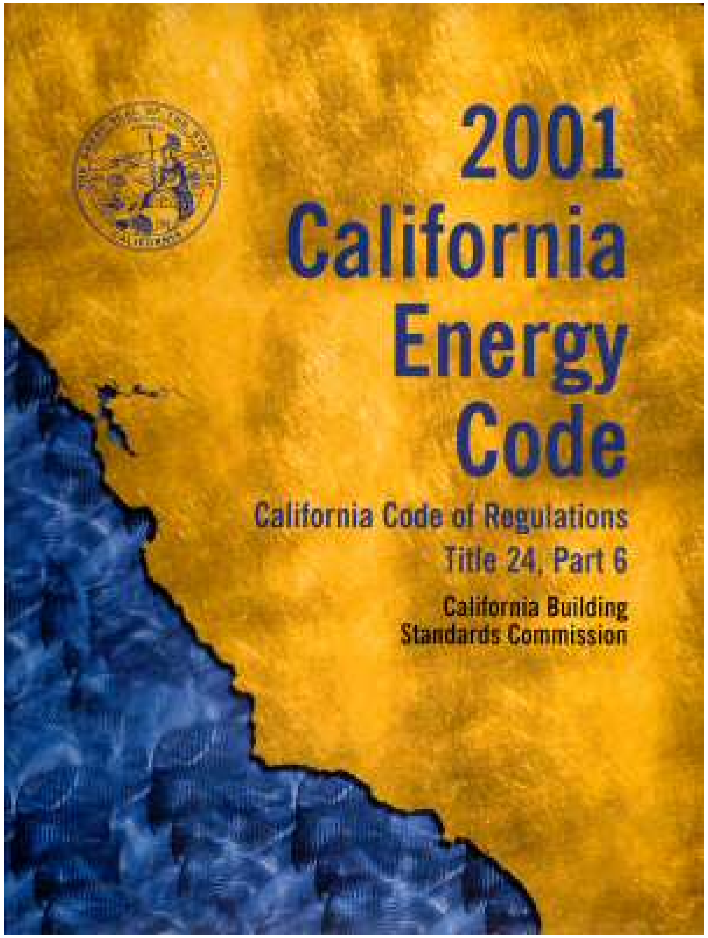
Source: Lawrence Berkeley National Laboratory Cool Roofing Materials Database

# Energy Saving Programs

# Title 24

Reflective roofing technologies are increasingly included in federal, state and local energy codes.

California's building energy code, known as Title 24, is viewed as the model in this area, prescribing a cool roof for most low slope, non-residential applications. Title 24 incorporates both solar reflectance and thermal emittance measures into its cool roofing standard. Under this program, a roofing material's initial thermal emittance must be .75 or greater and initial solar reflectance must be .70 or greater to be in compliance with the legislation. Aged values for solar reflectance are used for products registered with Cool Roof Rating Council. Enforcement occurs according to climate zones, and a solar reflective index (SRI) of 78 is an alternative to meeting separate solar reflectance and emittance requirements.



# Methods for Complying with Title 24

Cool roofs are required on low-slope buildings when the owner or developer is using the prescriptive envelope component method for meeting Title 24 requirements. It is the simplest, most cost effective way to comply with the standard in commercial re-roofing projects. The following quick reference chart summarizes three different methods for complying with Title 24:

| | **Envelope Component Approach** | **Overall Envelope TDV Energy Approach** | **Whole Building Performance Approach** |
|---|---|---|---|
| **Complexity** | Simplest | More complex | Most complex |
| **Flexibility** | Least flexible | Somewhat flexible | Most flexible |
| **Tradeoffs** | Does not allow tradeoffs - each building component must meet or exceed the requirement for that climate zone | Allows tradeoffs - if one building component does not meet the requirement but another exceeds it, it may offset the component that does not meet the requirement | Allows tradeoffs - if one building component does not meet the requirement but another exceeds it, it may offset the component that does not meet the requirement |
| **Calculations** | Fewest calculations | Requires more calculations | Requires computer simulations |
| **Cool roof requirement** | Cool roof is required for low-sloped and steep sloped buildings | Cool roof is not necessarily required | Cool roof is not necessarily required |

# CRRC

Qualifying roofs must be tested by a Cool Roof Rating Council (CRRC) approved laboratory and receive a CRRC label.

CRRC is the sponsor of a third-party testing and rating program that provides credible reflectance and emissivity data on roof surfaces for building code bodies, energy service providers, architects and specifiers, property owners and community planners.

# Energy Star®

CRRC also maintains a database providing roofing manufacturers the opportunity to label roof products with radiative property values rated under a strict CRRC-administered program. Specifiers are increasingly consulting this database to help make purchasing decisions.

However, product rating for energy efficiency is nothing new; for many years the joint U.S. Environmental Protection Agency/U.S. Department of Energy program, ENERGY STAR® has helped businesses and consumers save money making energy-efficient product choices.

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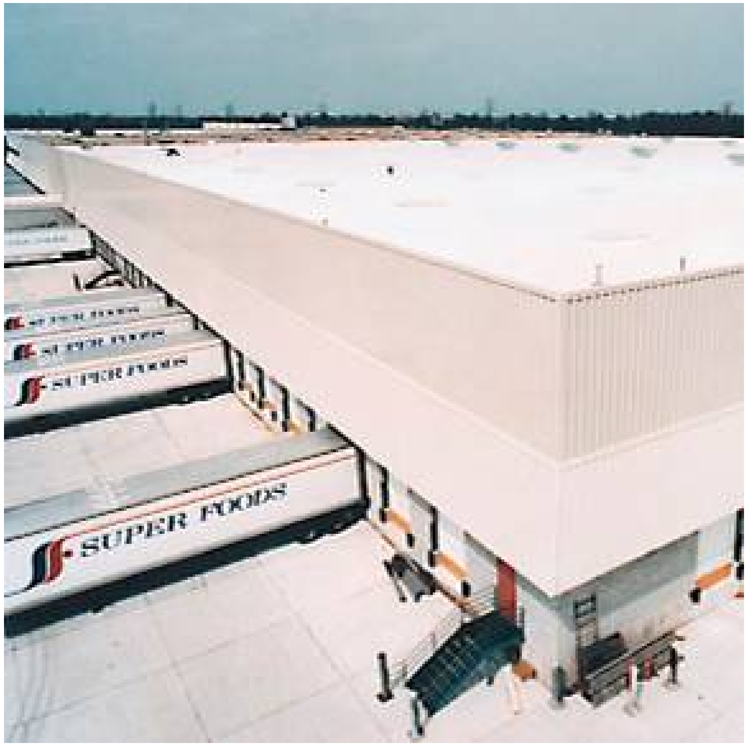
# Energy Star®

In the low slope commercial roofing category, a roof product qualifying for the ENERGY STAR® label must have an initial solar reflectivity of at least 0.65, and a three-year weathered reflectance of at least 0.50, in accordance with EPA testing procedures.

Weathered reflectance is the solar reflectance value of roofing after it has been installed and subjected to actual weather conditions for at least three years.



# Energy Star®

Warranties for reflective roof products that are ENERGY STAR®-labeled must be equal in all material respects to warranties offered for comparable non-reflective roof products, either by a given company or relative to industry standards.

The Roof Program's product list includes vinyl roof membranes with weathered reflectance from 77 percent to as high as 86 percent.

# LEED (Leadership in Energy and Environmental Design)

Voluntary green building programs have been promoting the integration of cool roofing technologies into building designs for a number of years.

For example, credits associated with reflective vinyl roofing or planted roofs can help a building achieve certification under the U.S. Green Building Council's (USGBC) LEED Green Building Rating System.

LEED's Rating System is a voluntary, continuously evolving, national standard for developing high performance, sustainable buildings. LEED provides standards for choosing products, but does not certify those products.

# Sustainable Sites Credit 7.2

The criteria for Sustainable Sites Credit 7.2, Heat Island Effect: Roof, can be met by using roofing materials having an SRI of at least 78 for a minimum of 75 percent of the roof surface, **or** installing a planted roof for at least 50 percent of the roof area, **or** installing high albedo and planted roof surfaces that, in combination, meet this formula:

(Area of SRI Roof / 0.75) + (Area of vegetated roof / 0.5) ≥ Total Roof Area

The latest version of LEED will allow for 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%.

# The Utah Olympic Oval

In fact, one of the first LEED rated buildings in the world had as its centerpiece a white reflective vinyl roof, a component of the building envelope that was crucial to the building's performance. The Utah Olympic Oval, the venue for speed skating events at the 2002 Winter Games in Salt Lake City, was designed to have the "fastest ice in the world," which necessitated an environmentally contained system in which athletes could compete in ideal conditions.


Speedy ice in this case called for a white roof to help reduce the energy needed to condition the venue by providing the reflectivity necessary to reduce heat gain inside the building.

# University of California Bren Center

The highest designation LEED bestows, the platinum rating, was given to the Donald Bren School of Environmental Science & Management at the University of California, Santa Barbara, for a building design that incorporates a cool vinyl roof. The building was intended to be a “living laboratory” supporting the school’s teachings on the principles and practices of sustainability.

# Green Globes™

Another voluntary program is the Green Globes™ system. This is an online assessment protocol, rating system and guide for integrating environmentally friendly designs into commercial buildings. It was developed by the Green Building Initiative (GBI), a non-profit network of building industry leaders committed to developing building approaches that are environmentally progressive, as well as practical and affordable to implement.

The system is questionnaire-driven. At each stage of the design process, users are walked through a logical sequence of questions that guide their next steps and provide guidance for integrating important elements of sustainability, such as reducing the urban heat island effect and building energy usage.

GREEN GLOBES

# Green Globes™

Green Globes™ uses performance benchmark criteria to evaluate the probable energy consumption of a building, but instead of comparing a building design to the performance of a hypothetical structure designed to ASHRAE 90.1 standards, Green Globes™ compares against data generated by the EPA's Target Finder, which reflects real building performance.

The GBI is in the end stages of work with the American National Standards Institute (ANSI) to establish Green Globes for New Construction as the first ANSI standard for commercial green building design. This process should be completed in 2009.

To receive a final rating of one, two, three or four globes, the data submitted online must be assessed by a GBI-approved and Green Globes-trained licensed engineer or architect with significant experience in building sciences and sustainability. Third-party assessment is optional but required for external recognition as a Green Globes certified building.

## Green Globes™

Once an assessment is verified by a third party, including a site inspection, properties achieving a score of 35 percent or more receive a Green Globes™ rating based on the percentage of total points (up to 1,000) achieved. As many as 10 points may be awarded for 1-100 percent roof coverage with either vegetation or highly reflective materials or both. To qualify, materials must have a solar reflectance of at least 0.65 and a thermal emittance of at least 0.90. An SRI of 78 may also be used in lieu of separate reflectance and emittance values.

## ANSI Standard for Commercial Green Buildings

In April 2010, The Green Building Initiative (GBI) completed the first American National Standards Institute (ANSI) approved standard for commercial green buildings, ANSI/GBI 01-2010: Green Building Assessment Protocol for Commercial Buildings. ANSI/GBI 01-2010 was derived from the Green Globes environmental design and assessment rating system for New Construction and uses a holistic approach to commercial green building through the use of seven assessment areas: Project Management, Site, Water, Energy, Emissions, Indoor Environment and Resources.

The standard addresses low-slope roofing within its assessment of the building site. To satisfy the standard, 40% or more of the exposed surface of a roof must be either vegetated, and/or be covered with a material having a solar reflective index (SRI) of 78 or greater. A maximum of six points are awarded within this assessment category and distributed as follows:

- 40-55% of the exposed roof surface has SRI of ≥78 = 2 points
- 56-70% of the exposed roof surface has SRI of ≥ 78 = 4 points
- Greater than 71% of the exposed roof surface has SRI of ≥ 78 = 6 points

# ANSI Standard for Commercial Green Buildings

As of May 2010, the GBI was taking the standard through a limited pilot program to use the new protocol to assess and certify an initial list of commercial buildings. This pilot is designed so that practitioners may experience the new standard in a real-world setting. The current version of the Green Globes standard will continue to be available throughout the pilot period.

Those interested in submitting an application for their new construction or major renovation project to join the pilot can obtain complete program information at:

http://www.thegbi.org/green-globes/ansi-gbi-standard.asp

# ASHRAE Standard 189.1, High Performance Green Building Standard

The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) has partnered with the US Green Building Council (USGBC) and Illuminating Engineering Society (IES) to publish the nation's first code-intended high-performance green building standard – Standard 189.1, Standard for the Design of High-Performance Green Buildings, Except Low-Rise Residential Buildings.

The standard provides compliance options for high-performance commercial green buildings and establishes mandatory criteria in all topic areas: site sustainability, water use efficiency, energy efficiency, indoor environmental quality (IEQ) and the building's impact on the atmosphere, materials and resources.

## ASHRAE Standard 189.1, High Performance Green Building Standard

Roofing is addressed in the site sustainability requirements of Standard 189.1. With regard to low-slope roofing, the standard calls for a minimum of 75% of the roof surface to be covered with roofing materials with a solar reflectance index (SRI) of at least 78 and comply with the criteria for the EPA's Energy Star® Program Requirements for Roof Products. Roof penetrations, rooftop decks and walkways, vegetated systems and photovoltaics are not part of the computation.

To date, more than 1,400 authorities having jurisdiction (AHJ), including several states and the federal government, have expressed interest in adopting the code. Two addenda have already gone through public review and will be released 18 months after the initial release of the standard. New versions of the standard will appear on three year cycles. Currently, plans are in place to internationalize the standard to make it more universal.

For more information on Standard 189.1 and for an easily readable version of the standard, visit www.ashrae.org/greenstandard.

# Cool Roofing at a Glance

| | | Solar Reflectance | Emittance | Solar Reflectance Index |
|---|---|---|---|---|
| **ENERGY STAR®** | Low slope[1]<br>Initial<br>Aged[2] | <br>0.65<br>0.50 | | |
| **Green Globes™** | | 0.65 | 0.90 | 78 [3] |
| **California Title 24**[3] | Low slope<br>Initial<br>Aged [2] | <br>0.70<br>0.55 | 0.75 | 64 [4] |
| **USGBC LEED** | Low slope | | | 78 [3]<br>(min 75% of roof) |
| **ANSI/GBI 01-2010** | Low slope | | | 78<br>(min. 40% of roof) |
| **ASHRAE Standard 189.1** | Low slope | | | 78<br>(min. 75% of roof) |

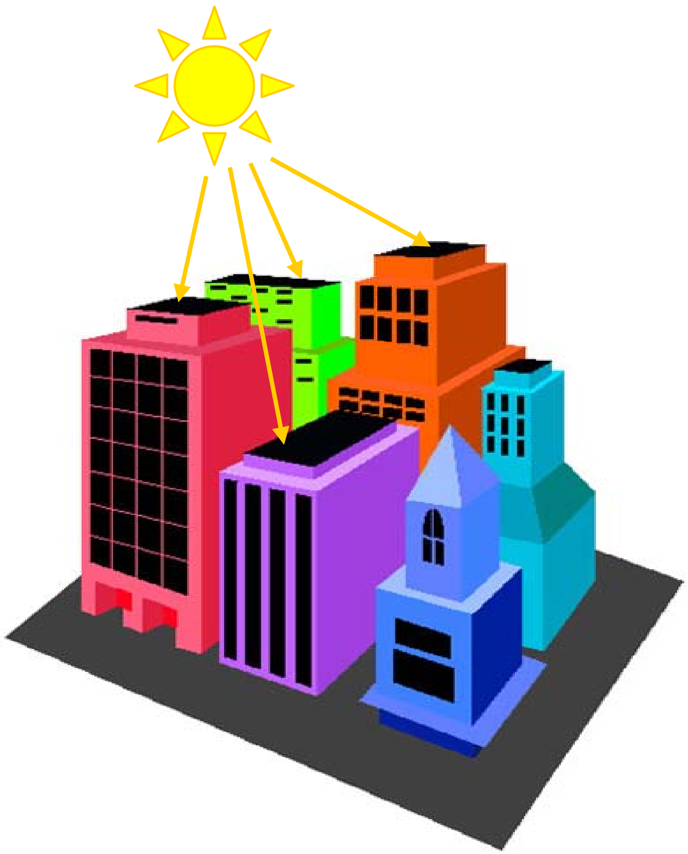
1. A roof surface having a maximum slope of 2 inches rise for 12 inches run.
2. Three years' exposure
3. Roughly equivalent to, for example, 0.65 reflectance and 0.90 thermal emittance, although a number of different combinations of reflectance and emittance can achieve this value.
4. May not apply in every climate zone.

# Environmental and Energy Concerns

# Urban Heat Islands

For millions of Americans living in and around cities, heat islands are of growing concern.

One reason green building programs embrace cool roofing is to mitigate the aggregate impact of buildings in causing the urban heat island effect, and resulting poorer air quality, experienced by most major cities.



# Urban Heat Islands

Urban heat islands are those areas where the combination of asphalt parking lots and road pavement, sparse vegetation, and expanses of black rooftops and other heat-absorbing infrastructure can raise air temperatures as much as 8 to 10 degrees higher than the temperature of the surrounding countryside.

In some densely developed areas, a quarter of the land cover may be roof surface alone. The standard black roof can have a temperature rise of as much as 90 degrees Fahrenheit in full sun, while the corresponding temperature rise for the standard white reflective roof is typically around 15 degrees Fahrenheit under the same conditions.

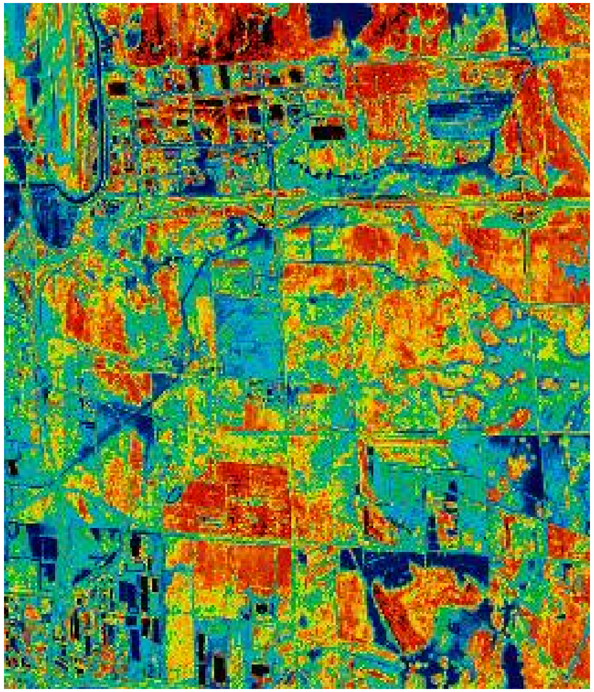
# Urban Heat Islands

A – Aerial view of Salt Lake City, Utah, site of a 865,000 square foot white reflective roof.

B – Thermal infrared image of same area, showing hot (red and yellow) and cool (green and blue) spots. The reflective vinyl roof, not absorbing solar radiation, is shown in blue surrounded by other hot spots.

A

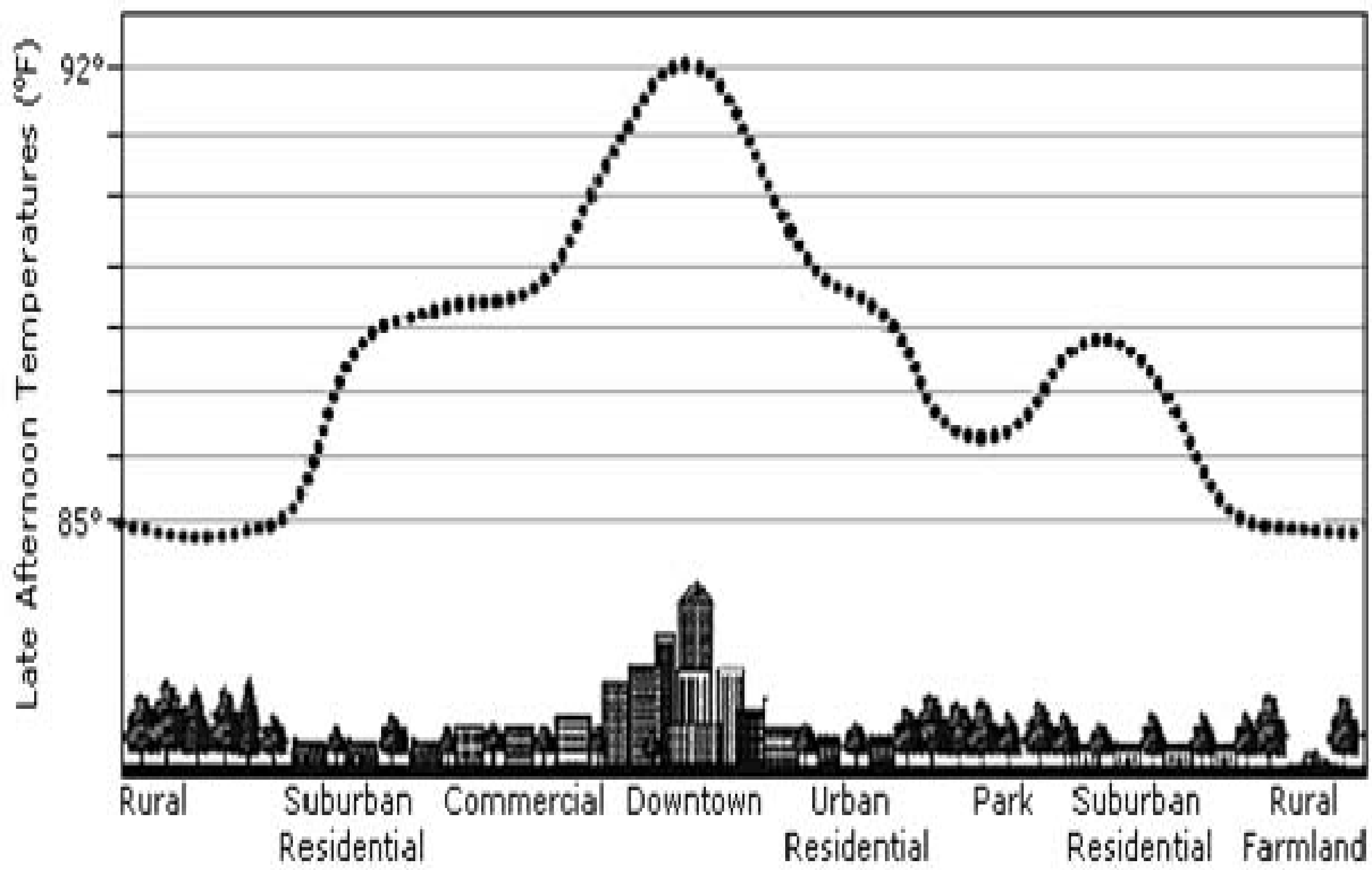
B



Images courtesy of NASA

## Urban Heat Island Profile

Urban heat islands can raise ambient temperatures in cities by as much as 8°F.




Source: Lawrence Berkeley National Laboratory

# Reducing the Urban Heat Island Effect

According to the LBNL, nearly 40 percent of the temperature rise is due to the prevalence of dark roofs, with the balance coming from dark pavement (6 percent) and the declining presence of vegetation (56 percent).

Light-colored roofs minimize the temperature rise and reduce smog formation. Relative to remedying the other sources of the problem, replacing dark roofing requires the least amount of investment for the greatest return.

Planting more trees is also desirable, but is a longer-term solution for which success will be constantly challenged by the demand for more development. Replacing roads and parking lots is a costly alternative that proportionately will have less of an effect on the heat island.

## Case Study

Naturally, buildings with a dark colored roof stand to consume more energy for air conditioning than a cooler building would – a strain on both operating costs and the electric power grid. Cool roofs offer both immediate and long-term savings in building energy costs.

In a 2001 federal study, "Measured Energy Savings and Demand Reduction from a Reflective Roof Membrane on a Large Retail Store in Austin,[1]" the Lawrence Berkeley National Laboratory (LBNL) measured and calculated the reduction in peak energy demand associated with the surface reflectivity of a vinyl roof on a retail building in Austin, Texas.

Instruments measured weather conditions on the roof, temperatures inside the building and throughout the roof layers, and air conditioning and total building power consumption. Measurements were taken with the original black rubber roofing membrane and then after replacement with a white vinyl roof with the same insulation and HVAC systems in place.

[1] Report # LBNL - 47149

## Case Study

LBNL found that the average daily summertime temperature of the black roof surface was 168°F, but once retrofitted with a white reflective surface, it measured 125°F, a decrease of 43°F.

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

# Climate Considerations

Abating the urban heat island effect is just as critical in cooler climates as it is in the southern regions. According to LBNL, if strategies to mitigate this effect, including cool roofs, were widely adopted, the Greater Toronto metropolitan area could save more than $11 million annually on energy costs[2].

Even in northern climates, net annual energy savings are typical and make white vinyl roofs a worthwhile investment. Cool roofs can have more impact on energy cost than energy use, cutting consumption during peak power demand when the rates are the highest. This more than offsets any potential minimal increases in heating costs that a reflective roof might bring.

★ Please remember the **exam password** REFLECTIVE. You will be required to enter it in order to proceed with the online examination.

[2] LBNL-49172, S. Konopacki and H. Akbari, “Energy Impacts of Heat Island Reduction Strategies in the Greater Toronto Area, Canada,” Lawrence Berkeley National Laboratory, Heat Island Group, November 2001.

# Climate Considerations

Per btu, air conditioning costs are typically 2-3 times greater than heating costs for the same space. In recognition of this, some northern utility companies offer rebates and incentives for use of cool roofs to help facilities reduce peak demand load.

If there is any "winter penalty" at all, it is minimal because winter days are shorter and cloudier, what sun there is lies lower on the horizon and is less intense than summer sun, and the roof may be covered in reflective snow for long periods.

# Achieving Energy Savings

# Calculating Savings

A qualitative analysis of potential building energy savings is possible without performing a detailed building energy simulation. Simple web-based tools developed by federal agencies can provide an estimated value of the annual savings that can accrue during the life of a typical white reflective roof vs. a non-reflective black roof.

**U.S. Department of Energy (DOE) Cool Roof Calculator**

www.ornl.gov/sci/roofs+walls/facts/CoolCalcEnergy.htm

This tool developed by DOE's Oak Ridge National Laboratory estimates cooling and heating savings for low slope roof applications with non-black surfaces.

Expected in mid-late 2010, the DOE calculator will be replaced by the Roof Savings Calculator (RSC), a joint project of Oak Ridge National Laboratory and Lawrence Berkeley National Laboratory. The RSC is currently in beta testing at www.roofcalc.com.

# Government Incentives

To reduce electric power generation and associated air emissions, more government entities and utilities are offering incentives and rebates when these systems are installed. A significant and regularly updated resource on these programs can be found at the Database of State Incentives for Renewables & Efficiency, www.dsireusa.org

This site compiles information state by state about energy efficiency policies and incentives administered by federal and state agencies, utilities and local organizations.

## Government Incentives

The federal government recognized the importance of incentives when it enacted the Energy Policy Act of 2005, establishing a tax deduction for energy-efficient commercial buildings with qualifying systems placed in service from January 1, 2006 through December 31, 2008. The Emergency Economic Stabilization Act of 2008 (HR-1424) extends the benefits of the 2005 Act through December 31, 2013.

The deduction is equal to the cost of energy-efficient materials or systems installed during construction, up to $1.80 psf. Eligible for consideration are commercial buildings reducing annual energy consumption by 50 percent compared to minimum requirements set by ASHRAE Standard 90.1-2004.

ASHRAE, established by the U.S. Department of Energy as the commercial building reference standard for state building energy codes, recognizes thermal insulation and reflective roofing as the two roofing technologies pertinent to this requirement.

# Weathered Reflectance

Natural weathering and soiling can affect a roof’s ability to maintain its high reflectance values. Depending on such variables as geographic location and climate; urban, agricultural or industrial setting; the amount and type of discharge from the building and adjacent structures; and roof slope, particles and pollutants of all kinds can accumulate and diminish the roof surface’s inherent reflectivity.

Although there will be some loss of reflectivity from years of exposure, the levels will continue to be significantly higher than that of traditional black materials. Even simple cleaning techniques can restore most if not all of the original reflectivity.

Studies have shown that washing a weathered cool roof membrane can result in a practically complete restoration of solar reflectance. Studies have also found that most reductions in reflectivity occurred during the first year, then leveled off, with further reductions negligible by the sixth year.

# Types of Green Roofing

# Green Roofing

Another roof technology that can reduce both peak energy demand and the urban heat island effect is the green (or planted, garden or vegetated) roof. These benefits are achieved because green roofs are excellent insulators during the warm weather months and the plants cool the surrounding environment. Air quality is improved as the plants absorb and convert carbon dioxide to oxygen.

Green roofs also absorb storm water and curb runoff, generally retaining as much as three-quarters of the volume of rainwater. The result is less rainwater runoff to overstressed sewer systems.

# Types of Green Roofs

Planted roofs typically consist of the following components: an insulation layer, a waterproof membrane; a drainage layer, usually made of lightweight gravel, clay, or plastic; a geotextile or filter mat that allows water to soak through but prevents erosion of fine soil particles; a growing medium; plants; and, sometimes, a wind blanket.

There are two basic types of green roofs: intensive and extensive.

# Intensive Green Roofs

Intensive green roofs consist of a minimum of one foot of soil depth to create a more traditional rooftop garden, with large trees, shrubs and other manicured landscapes. They are multi-layer constructions with elaborate irrigation and drainage systems, used only on low-slope roofs. Often designed expressly for recreational purposes or other foot traffic, intensive green roofs add considerable load to a structure and require significant levels of maintenance and irrigation.

# Extensive Green Roofs

In contrast, extensive green roofs range from as little as 1 to 5 inches in soil depth, adding less load to a building. The plants supported usually have low water requirements and are typically those tolerant of high heat, drought, wind and frost, such as sedums, wildflowers and moss. Extensive green roof systems generally require less maintenance than intensive systems. Some green roof designs incorporate both intensive and extensive elements.

Vinyl is often used for the waterproofing membrane. They are manufactured to remain watertight in extreme conditions including constant dampness, ponding water, high and low alkaline conditions and exposure to plant roots, fungi and bacterial organisms. Some green roofs in Europe have lasted more than 40 years without being replaced.

# Course Summary

# Cool Roofing

When a roof system can deliver a high **solar reflectance** (the reflecting of sunlight from the roof's surface), and a high **thermal emittance** (the radiating away of most of the solar energy absorbed), it is regarded as a cool roof. The less solar radiation a material absorbs, the cooler it is.

Cool roofs provide environmental and economic benefits – typically without an installed cost premium – without sacrificing any other roofing performance attribute. These benefits can be attained from short-term solutions such as paints and coatings to long-term waterproofing solutions such as highly reflective white or light-colored single-ply vinyl membranes. Green, or planted, roof systems also fall into this category.

White vinyl roofs can reflect more of the sun's rays, and emit more absorbed solar radiation than black asphalt built-up roofs.

More than just a sensible "green" building design approach, cool roofing is a significant solution to critical national energy and environmental challenges.

## Energy Saving Programs

California's building energy code, known as Title 24, is viewed as the model in this area. It incorporates both solar reflectance and thermal emittance measures into its cool roofing standard.

In the low slope commercial roofing category, a roof product qualifying for the ENERGY STAR® label must have an initial solar reflectivity of at least 0.65, and a three-year weathered reflectance of at least 0.50, in accordance with EPA testing procedures.

# Energy Saving Programs cont'd...

The LEED criteria for Sustainable Sites Credit 7.2, Heat Island Effect: Roof, can be met by using roofing materials having an SRI of at least 78 for a minimum of 75 percent of the roof surface, **or** installing a planted roof for at least 50 percent of the roof area, **or** installing high albedo and planted roof surfaces that, in combination, meet this formula: (Area of SRI Roof / 0.75) + (Area of vegetated roof / 0.5) >= Total Roof Area. The latest version of LEED will allow for 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%.

Green Globes™ uses performance benchmark criteria to evaluate the probable energy consumption of a building, but instead of comparing a building design to the performance of a hypothetical structure designed to ASHRAE 90.1 standards, Green Globes™ compares against data generated by the EPA's Target Finder, which reflects real building performance.

# Energy Saving Programs cont'd…

ANSI/GBI 01-2010 addresses low-slope roofing within its assessment of the building site. To satisfy the standard, 40% or more of the exposed surface of a roof must be either vegetated, and/or be covered with a material having a solar reflective index (SRI) of 78 or greater. The greater the percentage of coverage with a high SRI material the more points are garnered.

ASHRAE Standard 189.1 calls for a minimum of 75% of the low slope roof surface to be covered with roofing materials with a solar reflectance index (SRI) of at least 78 and comply with the criteria for the EPA's Energy Star® Program Requirements for Roof Products. Roof penetrations, rooftop decks and walkways, vegetated systems and photovoltaics are not part of the computation.

## Environmental and Energy Concerns

According to the LBNL, nearly 40 percent of the temperature rise due to the heat island effect is due to the prevalence of dark roofs, with the balance coming from dark pavement and the declining presence of vegetation.

Light-colored roofs minimize the temperature rise and reduce smog formation. And relative to remedying the other sources of the problem, replacing dark roofing requires the least amount of investment for the greatest return. Planting more trees is desirable, but is a longer-term solution for which success will be constantly challenged by the demand for more development. Replacing roads and parking lots is a costly alternative that proportionately will have less of an effect on the heat island.

Even in northern climates, net annual energy savings are typical and make white vinyl roofs a worthwhile investment. Cool roofs can have more impact on energy cost than energy use, cutting consumption during peak power demand when the rates are the highest. This more than offsets any potential minimal increases in heating costs that a reflective roof might bring.

# Achieving Energy Savings

The federal government recognized the importance of incentives when it enacted the Energy Policy Act of 2005, establishing a tax deduction for energy-efficient commercial buildings with qualifying systems placed in service from January 1, 2006 through December 31, 2008. The Emergency Economic Stabilization Act of 2008 extends the benefits of the 2005 Act through December 31, 2013. Eligible for consideration are commercial buildings reducing annual energy consumption by 50 percent compared to minimum requirements set by ASHRAE Standard 90.1-2004.

Natural weathering and soiling can affect a roof's ability to maintain its high reflectance values. Depending on such variables as geographic location and climate; urban, agricultural or industrial setting; the amount and type of discharge from the building and adjacent structures; and roof slope, particles and pollutants of all kinds can accumulate and diminish the roof surface's inherent reflectivity.

Although there will be some loss of reflectivity from years of exposure, the levels will continue to be significantly higher than that of traditional black materials. Even simple cleaning techniques can restore most if not all of the original reflectivity.

# Green Roofing

Green (or planted, garden or vegetated) roofing technology can also reduce both peak energy demand and the urban heat island effect.

There are two basic types of green roofs: intensive and extensive.

Intensive green roofs create a more traditional rooftop garden, with large trees, shrubs and other manicured landscapes. They are multi-layer constructions used only on low-slope roofs and are often designed for recreational purposes or other foot traffic. They add considerable load to a structure and require significant levels of maintenance and irrigation.

In contrast, extensive green roofs add less load to a building. The plants supported usually have low water requirements and are typically those tolerant of high heat, drought, wind and frost, such as sedums, wildflowers and moss. Extensive green roof systems generally require less maintenance than intensive systems. Some green roof designs incorporate both intensive and extensive elements.

Vinyl is often used for the waterproofing membrane. They are manufactured to remain watertight in extreme conditions including constant dampness, ponding water, high and low alkaline conditions and exposure to plant roots, fungi and bacterial organisms.

# Conclusion of This Program

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