

## Glossary

**albedo:** Another word for solar reflectivity or solar reflectance of the surface of a material.

**aluminum roof coating:** A cool roof technology. The material is an asphalt-type resin containing “leafing” aluminum flakes, meaning flakes tend to accumulate at the upper portion of the coating exposed to solar radiation. The aluminum flakes increase the solar reflectance of asphalt from a few percent to above 50 percent.

**anthropogenic heat:** Manmade heat generated by buildings, people, or machinery. Anthropogenic heat is considered a climate change contributor by almost the whole scientific community.

**ASHRAE:** The American Society of Heating, Refrigerating and Air-Conditioning Engineers. ASHRAE produces energy efficiency standards for buildings, which include cool roof requirements or performance criteria, with respect to the overall energy performance of the building envelope.

**asphalt cement concrete:** A construction material, usually called asphalt, used for paving roads but sometimes roofs as well. It is a hardened mixture mainly composed of an asphalt binder (material produced by petroleum refineries that glues loose material together and accounts for less than 8 percent of the total pavement weight) and aggregate (mixture of various sized stones, dust and sand, accounting for not less than 92 percent of the total pavement weight). Cool roof materials and technologies improve the thermal performance of asphalt-made roofs under solar radiation.

**asphalt chip seals:** A cool material technology. Asphalt chip sealing is a paving treatment in which a thin layer of asphalt binder is applied and immediately covered with a layer of light-colored aggregate. Afterwards, the aggregate is pressed into the binder using a heavy roller. Using a light-colored aggregate increases the solar reflectance of the roof's paved surface.

**ASTM:** The American Society for Testing and Materials. The Society provides international

technical standards. See CEN and EN for the European equivalent bodies. The ASTM publishes reference standards for solar and thermal testing of cool roof materials.

**building envelope:** The separation between the interior and the exterior environments of a building. The exterior can be the outdoor environment as well as another built environment. The main components of the building envelope include the ground construction, roof, walls, doors, and windows. The building envelope serves as the outer shell to protect the indoor environment and should ensure comfortable conditions with minimum energy consumption.

**built-up roof:** A product widely used for flat roofs. It is a membrane consisting of layers of asphalt, which serve as a waterproofing component, alternating with felt fabrics. Cool roof materials and technologies improve the thermal performance of built-up roofs under solar radiation.

**canopy (layer):** A “mattress-type” layer of air just above the ground in cities, extending up to the average height of buildings. Above the urban canopy layer lies the urban boundary layer, the thickness of which varies from a few hundred meters up to one kilometer. The urban heat island often refers to both layers, but usually the urban heat island effect refers to the layer below the canopy.

**Clean Energy Ministerial (CEM):** A high-level global forum to promote policies and programs that advance clean energy technology, share lessons learned and best practices, and encourage the transition to a global clean energy economy. Initiatives are based on areas of common interest among participating governments and other stakeholders. The CEM brings together ministers with responsibility for clean energy technologies from the world's major economies and ministers from a select number of smaller countries that are leading in various areas of clean energy.

**climate change:** Sometimes used to refer to all forms of climatic inconsistency, the term is properly used to imply a significant change from one climatic condition (human driven or natural) to another because the Earth's climate is never static.

**climate zone:** Portion of the earth's surface within which the climate is generally homogeneous in some respect. The performance of cool roof materials and technology is related to the climatic characteristics of the site. The hotter the climate is, the greater the benefits will be in terms of energy savings and thermal comfort.

**coatings:** Products that can be applied with a brush, roller or spray equipment, over a roofing system for several purposes (like protection from moisture, water, hail, UV rays, physical damage). Elastomeric coatings have elastic properties (in the summertime heat they expand and then return to their original shape without damage) and are widely used in roof applications.

**concrete:** Construction material often used in roof and road pavements. Concrete is a hardened mixture of Portland cement, sand, and coarse aggregate. Waste materials like fly ash, slag, and plastic fibers can also be used in concrete mixture. Cool roof materials and technologies improve the thermal performance of concrete roofs under solar radiation.

**cool colored roofs:** Roofs made of highly reflective building materials that are not white, but a range of traditional roof colors (e.g., gray and red). Many building materials can be treated with a reflective coating, regardless of the color.

**cool roofs:** Roofs with reflective and emissive properties that help improve the energy efficiency of the building and/or mitigate the urban heat island effect.

**Cool Roof Rating Council (CRRC):** The U.S. supervising entity for standards and testing of roofing products. The CRRC is responsible for administering the certification program relating to reflectivity and emissivity ratings for those roofing products. No similar body exists in Europe.

**degree days:** Cooling and heating degree days (CDD/HDD) are often used to estimate how hot the climate is and how much energy may be needed to keep buildings at a comfortable temperature.

CDD are calculated by subtracting a reference indoor temperature from the mean daily

temperature, and summing only positive values over an entire year.

HDD are calculated by subtracting the mean daily temperature from a reference indoor temperature, and summing up only positive values over an entire year.

The reference temperature is generally the comfort temperature and varies according to regulations or standards. CDD and HDD are climatic indicators, useful for assessing the energy performance of cool roof technology in different climatic zones. CDH or cooling degree hours rely on the same methodology (as does heating degree hours or HDH), with hours not days.

As an example, the HDD in Rome and Brussels are 2092 and 3758, at a reference indoor temperature of 20 degrees Celsius; the CDD in Rome and Brussels are 346 and 23, at a reference indoor temperature of 20 degrees Celsius. (Please note, these are not official figures for Rome and Brussels. They were determined using a typical reference year and are presented simply to demonstrate the concept.)

**energy consumption:** The amount of energy consumed in a process or a system. In buildings it refers to the energy consumed by the energy systems to ensure comfortable indoor conditions. Energy consumption can also refer to a single energy system, for example heating, cooling, ventilation, or artificial lighting. More efficient buildings use less energy ensuring the same comfort conditions. Cool roof technology applications can reduce the cooling and the overall energy consumption of a building and improve its efficiency.

**ENERGY STAR:** A voluntary labeling program designed to identify and promote energy-efficient products, including roofing products, developed by the Environmental Protection Agency of the USA. Several energy efficient products for buildings are labeled, including heating and cooling systems, lighting, windows, and insulation. Including cool roof products in the ENERGY STAR Program recognizes the importance of the technology to achieve significant energy savings. The EU has also launched an ENERGY STAR Program dedicated to energy efficient equipment.

**global warming:** The gradual rise of the Earth's surface temperature. Global warming is believed to be caused by the greenhouse effect and is responsible for changes in global climate patterns and an increase in the near-surface temperature of the Earth.

**greenhouse gas:** Any gas that absorbs infrared radiation in the atmosphere. The most well known greenhouse gases are carbon dioxide, methane, nitrous oxide, halogenated fluorocarbons, ozone, per-fluorinated carbons, and hydro-fluorocarbons; however, water vapor is also included. By reducing energy consumption in buildings, cool roofs reduce greenhouse gas emissions in the atmosphere.

**Global Superior Energy Performance Partnership (GSEP):** A new initiative to accelerate energy efficiency improvements throughout industrial facilities and large buildings. Announced by government and corporate leaders, on July 20, 2010, at the Clean Energy Ministerial (CEM) in Washington, DC, the purpose of the initiative is to significantly cut global energy use by: (1) encouraging industrial facilities and commercial buildings to pursue continuous improvements in energy efficiency, and (2) promoting public-private partnerships for cooperation on specific technologies or in individual energy-intensive sectors. Cool Roofs and Pavements is one of six working groups within GSEP.

**Heat transfer:** The transition of thermal energy from a heated item to a cooler item. Classical transfer of thermal energy occurs only through conduction, convection, radiation, or any combination of these.

**IECC:** The International Energy Conservation Code a model energy building code produced by the International Code Council. It is developed, and revised on a periodic basis, through a public hearing process by national experts under the direction of the International Code Council.

**IgCC:** The International Green Construction Code, which provides model code language to establish baseline regulations for new and existing buildings related to energy conservation, water efficiency, building owner responsibilities,

site impacts, building waste, materials, and other considerations. Like the IECC, IgCC is a model building code produced by the International Code Council.

**ISO:** International Organization for Standardization, an international standard setting body composed of representatives from various national standards organizations. The organization promulgates worldwide proprietary industrial and commercial standards. ISO standards are often implemented in the EU as EN standards.

**Leadership in Energy and Environmental Design (LEED):** A points-based building certification using independent, third-party verification to ensure that a building, home, or community was designed and built using strategies to achieve sustainable site development, water savings, energy efficiency, green materials selection, and indoor environmental quality.

**membranes:** Roof products, fabricated from strong, flexible, and waterproof materials. They can be applied in multiple layers or consist of a single-ply membrane. Membranes usually contain a fabric made from felt, fiberglass, or polyester for strength, which is laminated or impregnated with a flexible polymeric material. Cool roof materials and technologies improve the thermal performance of built-up roofs under solar radiation.

**solar reflectance:** Also known as reflectivity, the fraction of the solar energy that is reflected by a roof's surface back to the sky, expressed with a number between 0 and 1 (or 0 percent and 100 percent). White surfaces have the highest solar reflectivity, while black have the lowest.

**solar spectrum:** The spectral distribution of radiative energy in sunlight. The solar spectrum includes three main types of radiation: Ultraviolet is short wavelength sunlight that cannot be seen. The visible portion is medium wavelength light that can be seen by humans. Near infrared is the longest wavelength light and cannot be seen.

**reflectivity:** Another word for albedo or reflectance.

**roof slope:** Inclination of a roof, which determines the roof's classification and consequently the choice of cool roof technology on a given roof. There are ASTM standards that define the criteria for roof classification.

Flat roofs generally have a small slope so that water will run off to a drain system and not collect.

Low-sloped roofs have a surface with a maximum slope of 5 centimeters rise for 30 centimeters run, corresponding to somewhat less than a 10 degree inclination, as defined in ASTM Standard E 1918-97.

Steep-sloped roofs, or sloped roofs, are surfaces with a minimum slope of 5 centimeters rise for 30 centimeters run, corresponding to more than a 10 degree inclination, as defined in ASTM Standard E 1918-97.

**shingles (asphalt):** Cool roof materials composed of asphalt saturated mats made from organic felts or fiberglass. The asphalt is protected from the sun's ultraviolet light by roofing granules pressed into the shingle during the manufacturing process while it is hot (and soft). The roofing granules are 1 millimeter-sized stones, which are coated with an inorganic silicate material. The coating contains microscopic pigment particles, similar to those used in paint, to provide color and can be used for both roof and road pavements.

**shingles (roof):** Roofing technology consisting of individual overlapping elements. These elements are normally flat rectangular shapes that are laid in rows. Shingles are laid from the bottom edge of the roof up, with the bottom edge of each row overlapping the previous row by about one third its length. Cool roof materials and technologies improve the thermal performance of roof shingles under solar radiation.

**single-ply roof:** Single-ply roofing is a flexible or semi-flexible pre-manufactured membrane typically made of rubber or plastic materials. Single-ply roofing comes in large rolls and must be glued or mechanically fastened to a roof, and sealed at all seams. Cool roof materials and technologies improve the thermal performance of single-ply roofs under solar radiation.

**smog:** A type of air pollution containing ozone and other reactive chemical compounds formed by the reaction of sunlight with hydrocarbons and nitrogen oxides. Derived from the combination of "smoke" and "fog."

**Solar Reflective Index (SRI):** A measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. This indicator was developed by the Heat Island Project within the Lawrence Berkeley National Laboratory's Environmental Energy Technologies Division. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100. SRI combines reflectance and emittance into one number.

**temperature rise:** The maximum rise of the roof surface temperature above the outdoor air temperature. This indicator was developed by the Heat Island Project within the Lawrence Berkeley National Laboratory's Environmental Energy Technologies Division. The maximum roof surface temperature is calculated adding the maximum air temperature to the temperature rise. Cool materials have very small temperature rise, while traditional construction materials reach temperature rises of 20-25°C or even higher.

**thermal comfort:** A condition of mind that expresses satisfaction with the thermal environment. The most commonly used indicator of thermal comfort is air temperature. But air temperature alone is neither a valid nor an accurate indicator of thermal comfort, as it must be considered in relation to other main environmental and personal factors. Cool roofs help maintain thermal comfort conditions in the built environment by lowering the indoor air temperature and radiant temperature (responsible for the radiant thermal exchange between the human body and the temperature of the surface around the built environment).

**thermal emittance:** The ability of material to release absorbed heat, expressed with a number between 0 and 1 (or 0 percent and 100 percent), also known as infrared emittance or emissivity. Metallic surfaces have a low infrared emissivity. Most construction materials have high emittance.

High infrared emissivity helps keep surfaces cool, even if a high solar reflectance is needed as well.

**tiles:** Roofing technology usually consisting of overlapping individual elements made of ceramic (e.g., clay fired at a high temperature) or fabricated from cement concrete or other stone types. Some of the lighter tile types use fibers (e.g., cellulose) added for strength. Cool roof materials and technologies improve the thermal performance of tiles under solar radiation. The light color of a tile may be dispersed throughout, or it may be applied in the form of a coating.

**Title 24:** The Energy Efficiency Standards for Residential and Nonresidential Buildings in California, established in 1978 in response to a legislative mandate to reduce California's energy consumption. The standards are updated periodically to allow consideration and possible incorporation of new energy efficiency technologies and methods. Title 24 is a part of the California Code of Regulations.

**urban fabric:** A generic term used to describe the physical composition of cities including building types, paved areas, tree cover, and open space.

**urban heat island effect:** The increased air temperatures in urban areas in contrast to cooler surrounding rural areas. The main cause of the urban heat island effect is modification of the land surface through urban development, where vegetation is replaced by built surfaces characterized by low solar reflectance, high impermeability, and favorable thermal properties for energy storage and heat release. Many studies show that the urban heat island effect is higher at night. The urban heat island effect depends on several factors, but is typically between 2 and 4 degrees Celsius. Yet intensities up to 12 degrees Celsius have been measured.

**vegetated roofs:** Rooftops planted with vegetation. Intensive vegetated roofs have thick layers of soil that can support a broad variety of plant or tree species. Extensive roofs are simpler vegetated roofs with a soil layer to support turf, grass, or other thin ground cover. Vegetated roofs can be considered as an alternative to cool roofs because they keep the surface cool, reduce the cooling demand of the building and, in addition to cool roofs, provide thermal insulation. Vegetated roofs have higher construction and maintenance costs compared to cool roofs. They are also not reflective, so would not have a significant impact on global temperatures even if they were widely implemented.

**white and tinted roof coatings:** Roof coatings that contain transparent polymeric materials, such as acrylic, and a white pigment, to make them opaque and reflective. These coatings typically reflect 70 to 90 percent of the sun's energy. Despite the white appearance, these coatings absorb the 5 percent or so of the sun's energy that falls in the ultraviolet range (apart from the white cement-based coatings which can reflect up to 60 percent of ultraviolet light). In this way, the pigments help protect the polymer material and the substrate underneath from UV damage. The solar reflectance of colored coatings is in general lower than white coatings, but still can reach reflectance as high as 85 percent, particularly the lightly colored ones. Additionally organic coatings can be produced, using natural products such as milk and vinegar.