

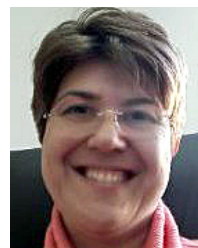
# Cool Roofs in the European context



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The status of cool roofs in the European context is presented. Various definitions of cool roofing materials are analysed and presented. The promotion and rating of cool roofs in Europe is pinpointed. The European legislation as well as the challenges for cool roofs' products in the European context is discussed.

**Keywords:** urban heat island, cool roofs definitions, standards, European policy

Increased urban temperatures have an important impact on the energy consumption of buildings mainly during the summer period. Heat island is the most documented phenomenon of climatic change. Heat island is related to the increase of urban temperatures compared to the suburban areas because of the positive heat balance.

Rejection of solar gains is the aim of passive cooling strategies in any type of building and any climatic region. Cool materials work by reflecting solar radiation and therefore rejecting solar heat gains at the opaque external surfaces of the building [1], [2]. Heat transfer

to the internal space by conduction is therefore reduced while the magnitude of the reduction will be determined mainly by the solar radiation intensity, the temperature difference between inside and outside as well as the constructional characteristics of the roof. The extent of cool materials usefulness is dependent on the severity of external conditions and internal heat gains [3].

The effect of cool materials in hot climatic conditions are studied by various researchers [4]–[7]. In most cases a reduction of the cooling load of almost 20–40% is revealed by the application of cool roofs while a consid-

erable indoor comfort improvement is noticed [8]. Moreover, the energy efficiency attributed to cool roofs ranges between 2.5-10 kWh/m<sup>2</sup> (with average of 6.25 kWh/m<sup>2</sup>) of roof. For houses and offices that are not air conditioned, cool-coloured roofing materials offer comfort, typically at very reasonable costs. Assuming an emission rate of 750 gCO<sub>2</sub>/kWh of electricity savings, the annual CO<sub>2</sub> savings ranges from 1.9 to 7.5 kg/m<sup>2</sup> of roof area with 4.7 kg/m<sup>2</sup> of roof surface as an average [9]. The way cool roofs operate is depicted in **Figure 1**.

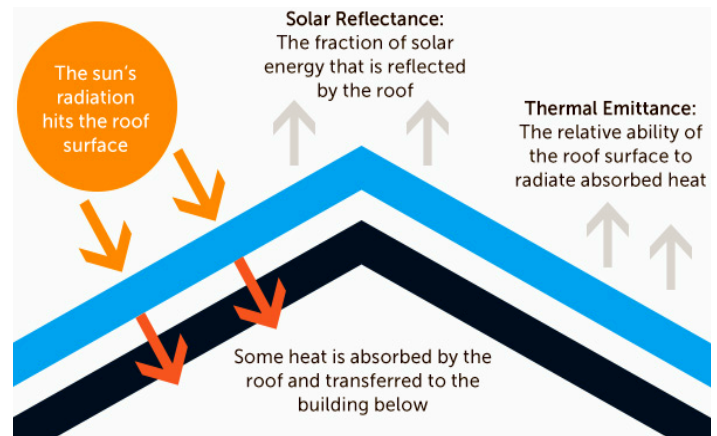
The aim of the present work is to outline the efforts performed in the European context for the promotion of the cool roofs.

### Cool Roof materials definitions worldwide

Cool roofing products are made of highly reflective and emissive materials that can remain substantially (e.g. 30°C) cooler than traditional materials during peak summer weather.

Building owners and roofing contractors have used these types of cool roofing products for more than 20 years to reduce the energy consumption for air conditioning devices.

The main difficulty is that roofing materials are exposed to weather and pollution. Their initial values in the virgin state will vary over time, depending on location, climate and surrounding. Therefore, their ageing characteristics are very important. For that



**Figure 1.** The cool roofs optical properties.

reason, the various organizations such as CRRC (Cool Roof Rating Council) provide or should provide data on the cool roofing products exposition at various climatic conditions and pollution.

The main definitions of cool roofing materials are tabulated in **Table 1**. As we can see different programs have different definitions of a cool roof.

### Cool Roofs' products

The various cool roofs' products that exist in the market are described in this section. Two main categories are described [10], [11], i.e. the prefabricated and the on-site application cool roofs.

**Table 1.** Cool Roofs' definitions worldwide.

		Solar Reflectance	Thermal Emittance	Solar Reflectance Index
ENERGY STAR®	Low slope <sup>(1)</sup> Initial Aged <sup>(2)</sup>	0.65 0.50		
Green Globes™	Initial	0.65	0.90	78 <sup>(3)</sup>
California Title 24	Low slope Aged <sup>(2)</sup>	0.63	0.75	75 <sup>(4)</sup>
USGBC LEED, v2009	Low slope, initial			78 <sup>(3)</sup> (min 75% of roof)
USGBC LEED, v4	Low slope Initial Aged <sup>(2)</sup>			> 82 > 64
ASHRAE Standard 189.1	Low slope			78 (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.

Concerning the prefabricated type, cool roofs are manufactured in a factory and arrive on site as a prefabricated unit, making it quick and easy to install. The largest use of prefabricated roofs is new-build construction. The ‘cool’ component of the roof is applied as part of the manufacturing process, often in the form of a cool coating or solar reflecting granules. Some examples include:

**Single-ply Membranes:** Single-ply roofing is a flexible or semi-flexible roof membrane typically constructed using bitumen, rubber or plastic. They are supplied on rolls of 15 to 40 meters’ length and 1–3 m width. The thermoplastic single-ply membranes are PVC or TPO based with built-in reinforcement layer(s) and they are mechanically or adhered fastened.

**Coated Metal Roofs:** A range of metals is used in the manufacture of coated roofs with the majority being steel-based although aluminium can be used as an alternative. Metal roofs can be sold as panels or tiles and are considered very durable, with service lives of many years (some have guarantees over many decades).

In Cool Roof On-Site products roofing type the cool element such as a coating, a membrane or roofing felt, is applied in the field directly onto the roof structure. The material can be applied in situ to almost any roof substrate ranging from flat bitumen to metal and is used widely in the refurbishment sector for cool roofs. Some examples include:

**Applied Roof: Coatings** It may be argued that applied coatings should be considered part of the coatings sector. We choose to include it in the cool roof landscape because applied cool coatings are being used to turn existing roofs into ‘cool’ ones. Cool coatings come in a range of colours and solar reflectance values.

**Elastomeric Roof Sub-Segment:** Elastomeric roofs can also be called thermoset membrane or rubber roofing and are a flexible membrane system based on compounded rubber materials.

### Cool Roofs in the European context

In Europe, the foundation of the European Cool Roofs Council (ECRC) has given an important boost in the cool roofs technology and market. The European Cool Roofs Council is a non-profit European association aiming to develop scientific knowledge and research in relation to “cool roof” technology and to promote the use of cool roof products and materials in Europe, including developing a product rating programme for such products and materials. It is a voluntary organisation that brings value by promoting the benefits of cool roofing products to regulators, policy makers, consumers and other stakeholders.

The ECRC has three strategic objectives:

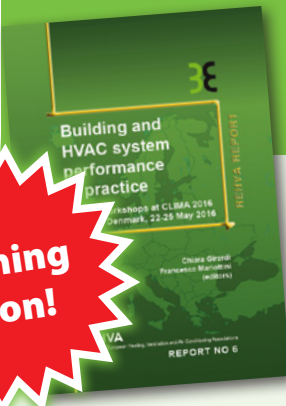
1. Formulation of cool roof product rating programme in Europe.
2. Inclusion of cool materials in European Standards, Energy Assessment Methods.
3. Promotion of the benefits of cool materials to engineers, stakeholders, etc.



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In achieving these objectives, the ECRC has launched the ECRC initial product rating program in 2015, participates in relevant CEN committees for measurement standards development and collaborates with a public affairs and communications company in order to position cool roofs as a sector of importance to relevant EU policies.

## The interlaboratory comparison

As stated previously, one of the core objectives of the ECRC is the development of a Product Rating Programme, in which roofing product manufacturers will be able to label various roof products with radiative property values rated under a strict programme administered by the ECRC. The radiative properties that are reported by this product rating program are the solar reflectance and the infrared emittance.

In order to provide the ECRC with information regarding its product rating programme an interlaboratory comparison (ILC) of the measurement methods of reflectance and emittance has been organized and conducted between 12 European laboratories able to perform (one or more) of the above mentioned measurement procedures. The main results of the ILC are summarized below: Regarding the measurement of reflectance using a spectrophotometer equipped with an integrating sphere and the differences in the average SR values determined by using different solar irradiance spectra, it was found that the observed differences are in the range of 0–4%SR and they are more important for spectrally selective materials. These differences contribute to the total uncertainty of the measurement method indicating that the use of single solar spectrum would provide comparable and “fair” results in the framework of a product rating programme. A strong correlation between the SR determined by a spectrophotometric techniques and reflectometers was found indicating that both method can be used for the determination of the solar reflectance. Also ASTM and EN standards for the measurement of thermal emittance using portable emission meters gave comparable results for infrared emittance of flat roof products.

Aiming to assist in the development of a European standard for the measurement of solar reflectance and infrared emittance, the ECRC has identified and participates in a CEN Technical Committee (CENTC254, WG16) working on this subject and has provided this information to facilitate the WG’s work. The work within this Committee is still ongoing.

## The product rating program

In 2015 the ECRC Product Rating Program was launched. The purpose of the ECRC product rating program is to provide a uniform and credible system for rating and reporting the radiative properties (solar reflectance and thermal emittance) of roofing materials. In the framework of this program, manufacturers and sellers have the opportunity to label roofing products with the measured values of their Initial Radiative Properties. These properties are determined and verified through testing by accredited/approved testing laboratories and a process of random testing of rated products. Laboratories participating in the ECRC product rating program should be ISO17025 accredited (or under accreditation) for the measurement methods adopted by the ECRC and should participate in specific quality assurance procedures. Any roofing product can be tested as long as it is in compliance with the specifications and requirements defined in the ECRC Product Rating Program Manual. Rated products are granted the ECRC label and are published in the ECRC Rated Products Database on the ECRC website. Furthermore, taking into account that in order to assess a cool roof product’s long-term performance it is necessary to measure the aged product’s radiative values, the ECRC is currently actively working towards adopting a system for the rating of aged products. Aging, caused by weathering and soiling [12], [13] can alter the radiative properties of roofing materials and significant differences in the ageing process have been recorded among product types & different climatic conditions. Products suffer significant loss of SR, especially those with high initial solar reflectance while products with very low initial solar reflectance ( $SR_{in} < 0.2$ ) tend to become more reflective as they age. Ageing significantly affects the performance of cool roofs by increasing the roof surface temperature and by reducing, the cooling load savings by an average 20–30% and therefore aged cool roof product rating is critical. The ECRC aged product rating program will consist of natural weathering for a period of three years in weathering test sites located in European climatic regions that represent the anticipated cool roof market in Europe.

## The EU legislation and perspectives

Cool Roof Council aims to raise industry profile at a European Level. Initially ECRC has identified three key objectives that must be achieved for the success in raising the profile of passive cool roof solutions. The most important step here is to enhance the visibility of the ECRC so that it becomes an instantly recognizable organization to relevant policy makers generally.



Moreover, ECRC aims to have that level of organization knowledge in place and a clear understanding of policies currently open for debate, where we can inform the positive attributes of cool roof technologies and how these capabilities can be part of the solution to mitigate climate change.

Finally based upon these two foundation blocks to be able to clearly articulate and position the benefit of the cool roof sector appropriately in difference EU policy areas.

Five initial areas of possible policy interest have been identified with specific insight provided on each individual area, timelines what kind of debate may be possible. Those are:

- Directive on Energy Performances in Buildings: is one of the Eu's main pieces of legislation when it comes to the consumption of energy in buildings and was identified as open for review during 2016.
- Energy Efficiency Directive: which in the future will work towards the establishment of a set of binding measures to help the EU reach its energy efficiency targets for 2020.
- Heating and Cooling Strategy: which is seen as a first step towards and integrated approach to heating and cooling policies under the EU energy legislature.

- Circular Economy Package: The new Circular Economy Package (CEP) was published by the European Commission on 2 December 2015.
- Renewable Energy Directive Developing an overall policy for the production and promotion of energy from renewable sources in the EU.

As this work has developed ECRC recognises the need to have very clear unambiguous articulate messages that clearly explain the objectives and the benefits of cool roofs. The main benefits that should be communicated are included in **Figure 2**.

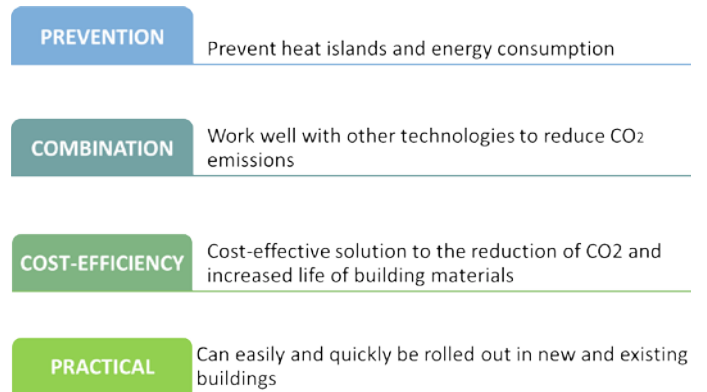


Figure 2. The main benefits of cool roofs.

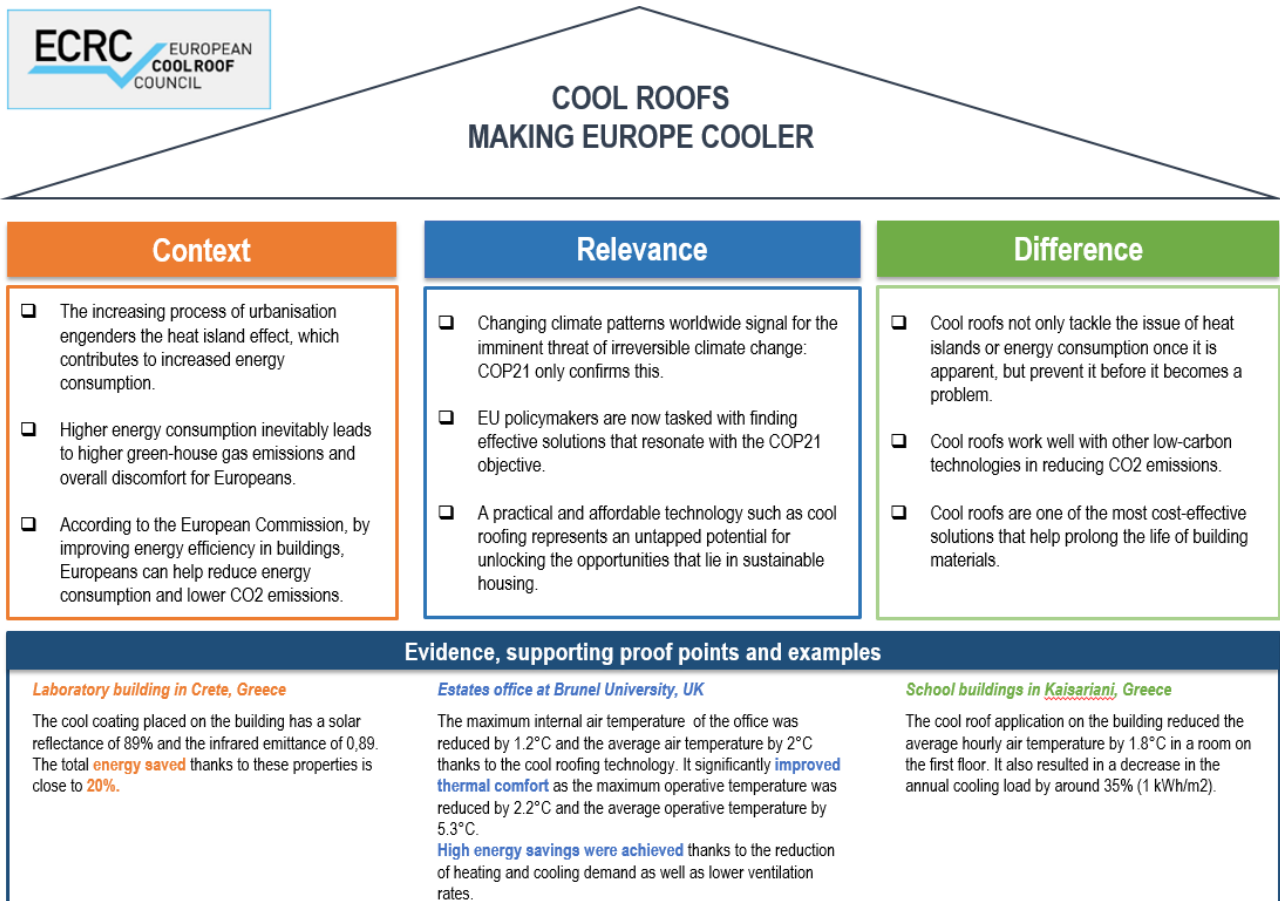


Figure 3. The message house for cool roofs.

The approach being taken to develop this for the ECRC is to create a message house approach. The message house is depicted in **Figure 3**. The context, relevance and difference of cool roofing technology supported by evidence, proofs and examples leads to the main message which is “Cool Roofs can make Europe cooler”.

### Conclusions and prospects

Cool materials are an environmentally friendly and passive technique that contributes to achieving energy efficiency in buildings by lowering energy demand for cooling and improving the urban microclimate by lowering surface and air temperatures. The various types of cool materials and cool roofs are analysed

showing that there is a significant variety that can cover all applications ranging from on-site paints to tiles and membranes. Significant progress is performed in international level to define the characteristics and properties of cool materials both in initial and aged state. In terms of the European policies, cool roofs can play a significant role to at least four objectives, namely the Directive on Energy Performances in Buildings, the Energy Efficiency Directive, the Heating and Cooling Strategy and the Circular Economy Package. A clear understanding and further promotion is needed in order to include cool materials’ properties in the EU standards. European Cool Roofs Council has a great challenge towards that direction. ■

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