NATURE NEEDS YOU...
PROTECT IT !

COOL ROOF PRODUCTS
&
COOL ROOFING TECHNOLOGIES

ALL AROUND YOUR HOUSE...
ALSO ON THE ROOF!

COOL ROOFS IN EUROPE

INITIATIVES AND EXAMPLES

PROMOTION OF COOL ROOFS IN THE EU
PROJECT N. IEE 07/475/S12.499428

Promotional
brochure
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COOL ROOFS
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WE MAKE YOUR HOUSE COOL... WHEN IT WARMS UP!

COOL ROOF PRODUCTS AND COOL ROOFING TECHNOLOGY

What are Cool Roof products?

They are said Cool Roofs those products having the property to reflect solar radiation (solar reflectance) and re-emit a certain quantity of the heat absorbed (infrared emittance).
The Cool Roofs project technical committee has defined the International Validation Standards of thermal and solar reflectance properties which Cool Roof products must have, after having been certified and qualified as Cool Roof such products are entered in one of the three databases constantly updated every two years according to suitable protocols uniformly adopted by freelance labs accredited for certifications issuing.
Currently there are three databases:

1) **European Database:** held by the EU Cool roof Rating Council, this database lists the shields, membranes and paints produced by Laboratori Ecobios s.r.l.
2) **American Database**: held by the USA Cool Roof Council;
3) **USA-EU Database:** whose validity lays within the Europe- United States programme named Energy Star which has contributed to the standardization of evaluation criteria.

Databases highlight the certified properties by listing

- Product Name
- Database entry number
- Production Countries
- Product Typology
- Colour
- Solar Reflectance rate (in °C)
- Infrared Emittance rate (-)
- Maximum superficial temperature
- Total energetic refraction index (Albedo)

What is a Cool Roofing technology?

A Cool Roofing Technology is a system which optimises the Cool Roof products performance **adding new value** either to the existing buildings and to new built ones, safeguarding at the same time all the building standards, the typologies and technical properties adopted in the different climatic zones by technicians of the Countries of the whole planet.

Cool Roofs products are **used** both on **existing cohibentation systems** and on those of **new built constructions**, realized through the optimisation of thermal resistance and conductance rules, in order to protect them against solar radiation; so that it is possible and convenient to turn an existing

covering having optimal thermal conductance values into a Cool Roof by simply integrating the covering layer with a Cool Roof facing; Cool Roofing products and technologies are also alternative and can replace either traditional or currently used ones.

Cool Roofing products and technologies enable to achieve the following advantages:

Financial Benefits

a) Being **problem solving** products they increase the value of buildings which have contemporarily been thermo-protected and waterproofed, being thus a rapidly amortizing **investment.**

b) The roof and external envelope thermo-insulating effectiveness enables to employ the summer climatization system at low regimes and a **1°C decrease** of the internal temperature matches **an up to 6% saving** on climatization expenses; the energy saving allows to obtain a financial saving of up to the 60% on the expenses currently needed for summer climatization.

c) The reclaim from thermal shocks, micro-lesions, thermal bridges and cracks and the effective prevention of thermal excursions allow both to preserve buildings from premature ageing and their low cost ordinary maintenance in longer time intervals**.**

Environmental benefits

Energy saving: Cool Roofs products improve the buildings energetic effectiveness and consequently the energy demand which leads in turn to a reduction of CO_2 emissions in the environment; it has been calculated that a 185 sq. M. Cool Roof ceiling can reduce CO_2 emissions in the air of up to 20 tons per year.

Earth cooling : Cool Roofs products can contribute to Earth cooling because they can reflect solar radiation in correspondence of short wavelengths not kept by greenhouse gasses (near and visible infrared), on the contrary, in correspondence of long wavelengths radiation turns into heat.

Asbestos-cement coverings reclaim: Asbestos-cement employment has far back been banned and its disposal is problematic because:

a) Removing and disposing of coverings is too expensive, especially in those Country where they represented the solution to residential problems being thus heavily employed in construction procedures.
b) In order to completely remake the ceiling, it is necessary to remake the whole building supporting structures because the clay-cement ceiling is heavier than the asbestos-cement coverings needing removal.

The alternative to the disposal is the encapsulation by contemporarily making inert the asbestos fibres and waterproofing and thermo-protecting the facing covered with Cool Roofs products;

Other advantages are given by:

1) A better factory productiveness due to the elimination of the heat caused stress.
2) The energy saving for climatization of up to the 60% on the electric bill;
3) The capitalisation of the building inside the balance with all the benefits deriving from the bank reliability evaluation established by Basel 2.
4) The elimination of any shutdown bureaucratic danger due to the unsuitability of the building.

Improvement of residential and working comfort: the internal climatization of buildings is easily achievable and adjustable thanks to the installed climatizing systems; the "**external**" climatization is only possible with the "**passive defence**" of buildings against heat: by protecting the building against the absorption of solar radiation it is possible to improve the residential comfort, the productivity inside working areas and to eliminate the heat caused stress and conditioned air caused phobias.

Other Benefits

The employment according to the respective Cool Roofing technologies of high solar reflectance materials normally superior to the 80%, under the form of paints, shields, membranes, mortars, stuccos allow to intervene in order to solve the respective problems on: farm greenhouses, stables, containers, trucks, hard hats, tents, cars and means of transport, food storage silos, fuel tanks, touristic villages realized with various materials, beach locker rooms, ship decks and boats, polycarbonate coverings corrugated laminas and everywhere solar radiation reflectance is needed.

Cool Roofs Target.

Cool Roofs products and Cool Roofing technologies involve the following professional categories:

Architects and engineers: quality certifications of the products together with a laying technology accessible to all professional operators enable the professionals in the construction field to employ Cool Roofs products either in the maintenance of existing buildings or as a "**necessary investment"** for those one in progress having the certitude that Cool Roofs products:

a) Are eco-friendly
b) Are complying with UE REACH directive;
c) Allow to protect houses having an optimal thermal conductance which cannot be reduced by premature ageing of employed materials, having the "passive defence" of the roof and building external envelope been reinforced.

Construction Companies: such companies can eventually build **eco-friendly houses** which favours the energy saving and resist to thermal excursions; above all, they can prevent the formation of cracks, rain water infiltrations and avoid any possible complaint from buyers on houses handover; companies need to dedicate more financial resources to the roof and external envelope covering; they will be in this way more competitive compared to other companies which do not employ Cool Roofs products.

Maintenance Companies: in either ordinary or extraordinary maintenances they can:

a) Count on eco-friendly products for the waterproofing and thermo-protection of roofs, terraces, and flat roofs enabling thus the rain water storage for food purposes especially in those areas where it is scarce;
b) On equity of employed staff halve the work execution time compared to companies which do not employ Cool Roofs products and Cool Roofing technologies;
c) Match a new market demand relied to the industrial buildings wide coverings which by now need some urgent maintenances where Cool Roofs products and Cool Roofing technologies are the **winning ecological alternative** in terms of effectiveness, convenience and restoration of damages due to thermal excursions;
d) The high quality and versatility of Cool Roofs products improve the professionalism of **marginal workers** allowing them analogous performances to those by **specialized workers;**
e) The **warranty** of Cool Roofs products effectiveness to last in time is given by their laying according to **the state of the art** and by the accuracy of buildings owners to carry out the periodical maintenances as prescribed in technical datasheets.

Privates Customers and Public Administrations: the employment of Cool Roofs products allows an economic and reliable management of buildings in addition to the following advantages:

- They **improve** and hold the **sale value** of buildings;
- They **amortize the investment** through the financial savings derived from energy saving for summer climatization and from the opportunity to carry out cheap periodical maintenances in longer time intervals compared to the currently ones
- They **improve** the **living and residential comfort** and the quality of life in nurseries, schools, city halls, buildings used for congresses and execution of public functions, where heat makes the staying in precarious, unhealthy and uncomfortable.

New occupation from Green economy

Among cool roof product are very important thermo-refracting mineral shields and membranes as the result of an innovation strictly connected with the multi-mineral milk and vinegar emulsions which they are made of; handmade through the employment of ecological raw materials, they introduce a new company typology in the panorama of those already existing. Such companies need very poor investments concerning plants, machinery and equipments because their products are obtained with a cheap but intelligent technology within everybody's range.

Thermo-refracting mineral shields and membranes further than being produced inside companies and subsequently utilised by construction companies, can be either manufactured on site by professional operators themselves.

The scenario is that typical of an invention followed by a product and process innovation, within all economic operators' range, which generates an high added value chain whose investments are substitutive rather than adjunctive compared to those currently needed and which can be easily and rapidly recovered through the energy saving and the less expensive / more effective multi-year maintenances.

Cool Roofs products and the new Cool Roofing technologies apply as a winning ecological alternative to the traditional ones, constituted by tar and bituminous coverings for the waterproofing and thermal reflection of opaque surfaces both of the buildings roofs and external envelope coverings.

The multi-mineral emulsions which they are made of are furthermore usefully employed in both ordinary and extraordinary maintenances of buildings in order to introduce inside houses alkaline mineral products having an high hygiènisant power and remarkable dehumidifying and anti-moisture properties for living comfort improvement.

European Union

The **removal of the barriers** impeding the spread of Cool Roofs products and Cool Roofing technologies is under the EU responsibility which should provide for their obligatory employment in construction standards in order to contribute to the Earth cooling, the energy saving and to the development of a new environmental awareness by all the economic operators involved.

The Earth is **mankind's common good** and the EU think it appropriate to intervene in order to safeguard its health and to avoid any worsening of future generations' quality of life.

Climatic changes, which are globally happening because of the **Ozone Hole** and the consequent Earth overheating, generate heat waves, tropical storms and the rise in the level of seas and oceans due to the melting of the glaciers.

The EU through the EACI promotes by means of the project Intelligent Energy Europe N IEE 07/475/S12.499428 – Promotion of Cool Roofs in the EU - the valorisation of products and technologies useful for roofs and flat roofs cooling in order to reduce the conditioned air consumption during summer with the consequent reduction of CO_2 emissions in the environment, to mitigate the urban heat island effect contributing thus to the cooling of Earth made possible by the employment of thermo-reflecting products and technologies which reflects solar radiation under "short waves" form that are not kept by greenhouse gasses.

With this project the EU is trying to fill the gap mainly due to the fact that in the past the private economic interest was **in conflict** with the public one related to the energy saving and environment safeguard and therefore it has been developed the knowledge of adopting rules coherent with the **Earth cooling** aim by equalizing Cool Roofs products evaluation modes and criteria to those used in the USA.

The EU is getting behind in the promotion of active policies aimed to the valorisation of the environment and the quality of life on Earth through the energy saving deriving from the **integration of passive solar systems** that, if suitably sized, can notably contribute to reduce the thermal loads of residential, commercial and services constructions.

The Cool Roofs project is an **innovative project** which must be embraced by the intelligences and cultures of every single European Country even if it is not formally a member State.

The EU has the unquestioned duty to forward every single State to do their best in order to **develop an environmental awareness**, for this reason governments must be solicited on the medium-long run:

1) To include in Technical Institutes and in Engineering and Architecture Faculties some exam tests related with the energy saving correlated with Cool Roofs products employment
2) To provide for the obligatory employment in construction standards of Cool Roofs products for the thermo-reflection of roofs and external envelope of buildings;
3) **To subordinate to a formative accreditation**, by means of specific courses held by universities and professional orders, the **buildings energetic certification subscription** by those professionals who have not taken the exam test.

European structural funds must unequivocally count on **financial contributions** to be given to universities, professional orders and schools which in turn will provide for the formation and the accreditation of technicians, such funds shall be furthermore accessible to other European Countries which though not EU members have embraced its rules.

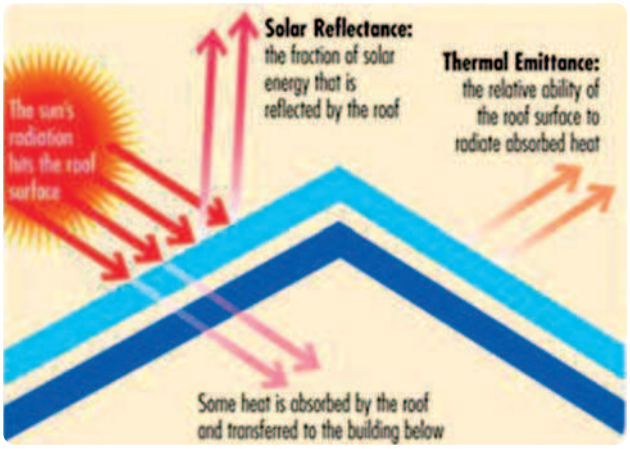
It is to be hoped that economic operators and private buildings managers and/or owners were pulled to purchase Cool Roofs products through:

- The application of a 4% reduced VAT;
- The provision for an income tax deduction of at least the 50% of the VAT inclusive expenses met;
- The grant of administrative and financial facilitations in order to provide incentives for the employment of Cool Roofs products in the restoration and maintenance of existing and new realized buildings.

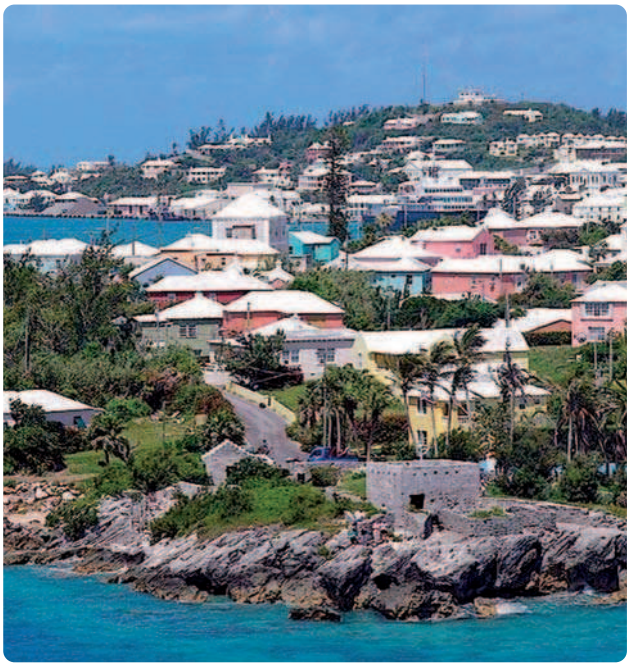
1. COOL ROOFS

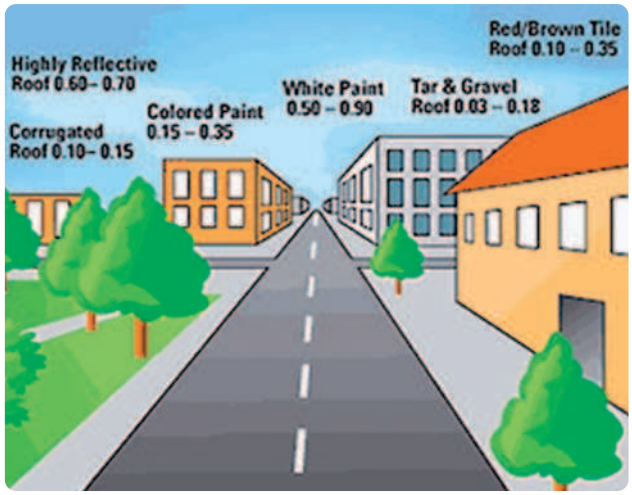
What is a Cool Roof

A Cool Roof is a roofing system able to reflect solar heat and keep roof surfaces cool under the sun. This is due to the properties of the reflective and emissive materials used which reflect solar radiation back into the atmosphere. As the roof stays cooler, this reduces the amount of heat transferred to the building below, keeping a cooler and more constant temperature in the interior.



The high solar reflectance (ability to reflect sunlight) and high thermal emittance (ability to radiate heat) of cool materials help roofs to absorb less heat and stay up to 28-33°C cooler than conventional materials during peak summer weather. Cool roofs can generate air-conditioning savings and peak demand reductions of 10-30% (measured in daily summertime use).





Benefits of Cool Roofs

- Energy savings and reduced energy costs because of reduced air-conditioning;
- Improved occupant comfort and health;
- Reduced roof maintenance and replacement expenses by extending the roof's life;
- Longer AC unit life due to decreased air-conditioning loads;
- Reduced "heat island effect" in cities and suburbs;
- Reduced air pollution and greenhouse gas emissions.

Materials for Cool Roofs

Nowadays, numerous roofing materials are rated with relatively high reflectance and emittance values, including materials for low and steep sloped roofs (white, colored, photo-catalytic, etc). This provides more choices for designers to employ aesthetic solutions, either for commercial and industrial buildings or residences, in both new construction and existing buildings.

Material databases are available in:

- EU Cool Roofs: http://www.coolroofs-eu.eu
- Cool Roofs Rating Council: http://www.coolroofs.org/products/search.php
- Energy Star roof products: http://downloads.energystar.gov/bi/qplist/roofs_prod_list.pdf

2. PROMOTION OF COOL ROOFS IN EUROPE

The EU project "Cool Roofs" aims to develop and implement an action plan for the promotion of Cool R.oofs in European countries. The main objectives are to:

- support policy development by transferring experience and improving understanding of Cool Roofs' contribution to reducing heating and cooling consumption;
- remove market barriers and simplify the procedures for Cool Roofs' integration in buildings;
- positively influence the behaviour of decision-makers and stakeholders;
- facilitate the development of favourable legislation, codes, permits and standards.

The project's work plan is developed in four axes: technical, market, policy and end-users. The expected results are the:

- Creation of a database of available materials;
- Evaluation of available testing procedures;
- Implementation of five demonstration projects, as shining examples of Cool Roofs' capabilities in improving the thermal conditions and reducing the energy consumption in buildings;
- Development of an efficient strategy to encourage policy makers to support Cool Roof technologies as a means to achieve policy goals of energy efficiency, sustainable development and climate change mitigation;
- Increased awareness of all stakeholder groups, including end-users.

The project is funded by the European Commission within the framework of the Intelligent Energy for Europe, and its duration is from September 2008 to February 2001.

EU Cool Roof Council

The EU Cool Roof Council (EU-CRC) was founded on February 2009, within the framework of the Cool Roof Project, aiming to merge all the driving forces for the promotion and adoption of Cool Roofs in EU. The EU-CRC aims to accelerate the transfer of knowledge, to remove market barriers, to help manufacturers to develop Cool Roofs products, to educate the public and policy makers and to develop incentive programs. For this purpose the EU-CRC brings together all relevant actors, i.e. universities and research institutes, industry and market actors (manufacturers, suppliers, distributors, roofing contractors, energy service companies, consultants), non-profit groups (local authorities, chambers, professional associations, government), as well as end users. The EU-CRC has established 6 Committees:

- **Technical Committee**, to define Cool Roofing materials
- **Documentation Committee**, to compile information on Cool Roof technology
- **Policy Committee**, to prepare, propose and influence new policies in EU
- **Marketing Committee**, to identify market barriers in order to overcome them
- **End users Committee**, for the dissemination to stakeholders
- **Legal Committee**, for the legal aspects of the EU-CRC.

More information about the activities and how to join the EU-CRC: http://coolroofs-eu-crc.eu.

3. COOL ROOF CASE STUDIES

Five case studies were implemented, within the framework of the Cool Roof project, to demonstrate cool roof capabilities in real buildings, in terms of improving the thermal conditions in non-air conditioned buildings and reducing the energy consumption in air-conditioned buildings. The case studies were monitored, in regard to their energy performance and indoor environment, before and after the implementation of a cool roof technology. The buildings were selected to achieve maximum geographical and building typology coverage aiming to promote the benefits coming from this technique with reference to cooling energy demand and peak savings all around the EU. The corresponding activities were performed at two levels:

- experimental monitoring in real buildings treated with Cool Roof techniques (*hardware task*)
- numerical analysis of the same buildings with a number of variants (*software analysis*)

The findings of the case studies show 10-40% energy savings and 1.5-2°C reduction of the indoor temperatures, depending on the climatic conditions.

3.1 FRANCE

Le Parvis: Collective Dwellings, Poitiers

The building

"Le Parvis" was built in 1995, in the Saint-Eloi quarter in Poitiers, and is composed of 87 dwellings with 4 floors. The building (Fig.1) is owned by the SIPEA Contractor and is composed of collective dwellings intended for low income households. It has a slightly sloped roof (11.8%), was constructed with steel cladding, was insulated with a 100mm mineral wool and sealed with asphalt.

Figure 1. Collective dwellings in Poitiers

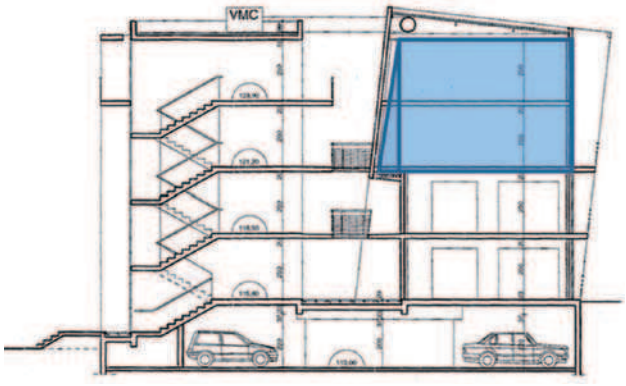


Figure 2. Duplex flat chosen for the case study

The roof slope faces east and is not shaded by adjacent dwellings. This Cool Roof case study focuses on the dwellings under the roof which are all duplex apartments of approximately 100m^2 each (Fig.2). The walls are insulated with 100mm polystyrene and the windows are made of PVC with double glazing. The attic above each duplex apartment is also insulated with 200mm mineral wool. The studied building has no cooling system for summertime, which is the common practice in most parts of France. So the impact of the Cool Roof's technology application is evaluated in terms of indoor temperature difference for the studied duplex flat compared to the adjacent duplex flats.

Cool Roof technology

The roof was coated with a cool paint, manufactured by Soprema (Model R' Nova), at the end of July 2009. The cool paint's solar reflectance is 0.88 and infrared emittance 0.90.

Evaluation results

The monitoring started on the 1st of June and ended on 31 August 2009. The cool paint was applied on the 28th of July. Figure 3 presents the surface temperature evolution.

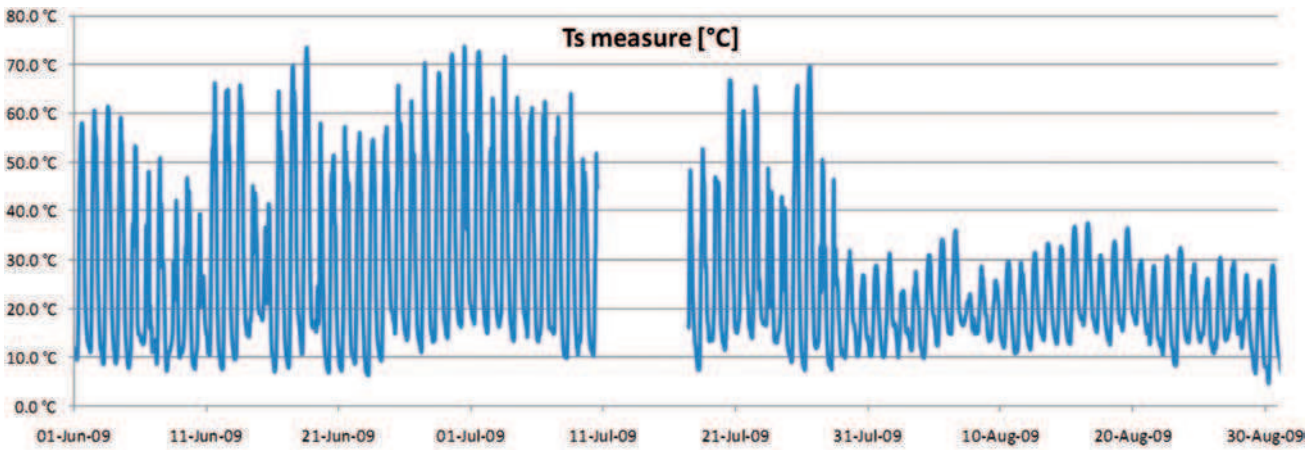


Figure 3. Surface temperatures before and after the Cool Roofs application

The temperatures evolved with the same daily variation, with high maximum temperatures differences. During the night, the minimum temperatures were very similar. The predicted mean surface temperature for the cool painted surface is 21.6°C compared to 34.1°C for the default roof surface for the summer period. The difference in the indoor operative temperature (Fig. 4) is less visible due to the good insulation of the attic: the mean operative temperature in the room decreased from 24.9°C to 24.2°C. In this case, with a very well insulated roof, there is a predicted gain of approximately 1°C on the maximum operative temperature, from 30.2°C to 29.3°C.

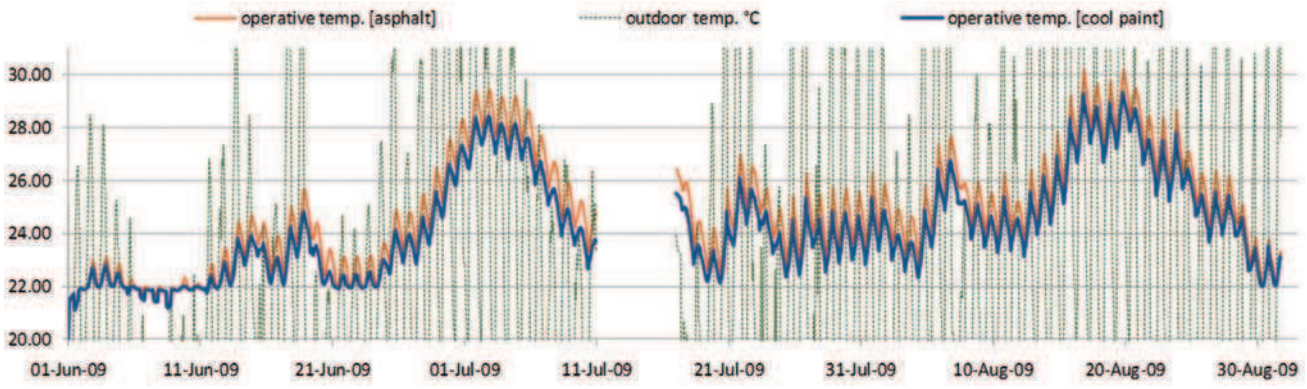


Figure 4. Operative temperatures evolution before and after the Cool Roofs application

3.2 GREECE

3.2.1 School building in Kaisariani, Athens, Greece

The building

This case study involves a 410m^2 school building located at the Municipality of Kaisariani, a densely built urban area near the centre of Athens (Fig.5). It is a rectangular, two floor building with a school courtyard and was constructed in 1980. The load bearing structure of the building is made of reinforced concrete and an overall concrete masonry construction which is not insulated. The school building is occupied by 120 children and 15 adults (the school staff) and is non-cooled and naturally ventilated. There is an installed heating system using natural gas.

Figure 5. School building in Kaisariani, Athens, Greece

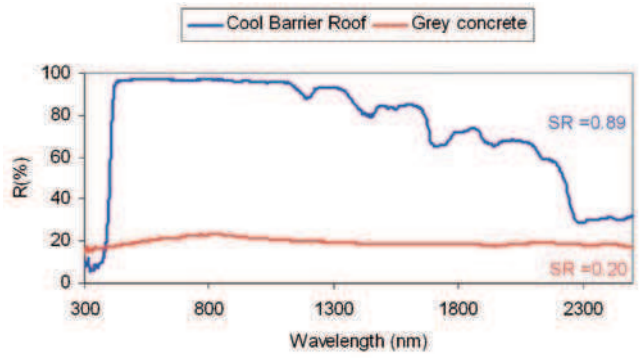


Figure 6. The spectral reflectance of the roof surface before (grey concrete, SR=0.2) and after the Cool Roof application (ABOLIN Cool Roof barrier, SR=0.89)

Cool Roof technology

The initial roof surface was covered by cement and gravel having a solar reflectance of 0.2. The cool material used is a white elastomeric coating (Cool Roof Barrier by ABOLIN) with a solar reflectance of 0.89, infrared emittance 0.89 and SRI 113.

Evaluation results

After the Cool Roof application, the indoor air temperature was reduced by 1.5-2ºC during summer and 0.5ºC during winter. The annual cooling energy load reduction was 40% and the heating penalty was 10%. A significant decrease in the surface temperature, reaching 25ºC during summer, is recorded after the Cool Roof application. Daily fluctuations of the surface temperature are significantly reduced suggesting a longer lifespan of the material, as thermal fatigue is more likely with greater temperature swings (Fig.7, Fig.8).

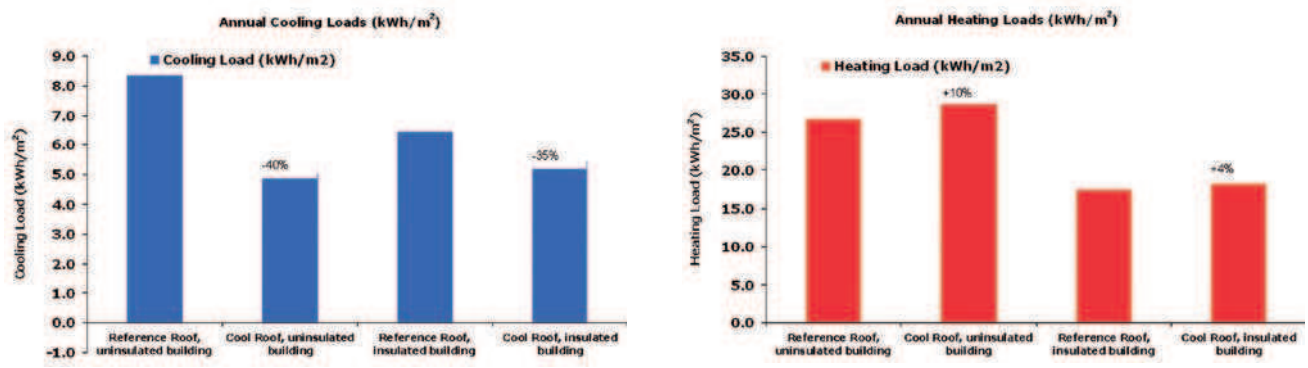


Figure 7. Annual heating and cooling loads (for the actual un-insulated building and for the same building with increased insulation)

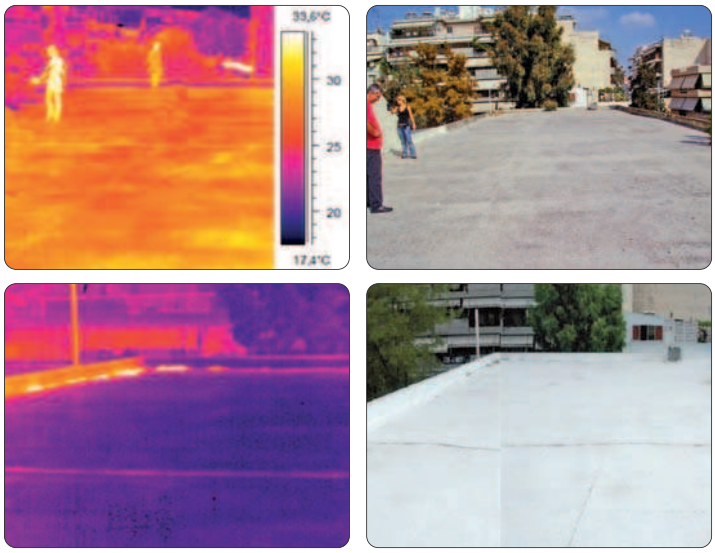


Figure 8. Visible and infrared images of the roof surface, depicting the surface temperature differences prior and after the Cool Roof application

3.2.2 Laboratory building in Iraklion, Crete, Greece

The building

A bioclimatic building housing an administrative office for research programs, within the Technological Educational Institute of Crete campus in the suburbs of Iraklion, was selected for the Cretan case study (Fig.9). Constructed in 1997, the building was initially designed using bioclimatic techniques in order to minimise its heating and cooling needs. Part of the building's electricity demand is covered by a hybrid energy system consisting of a 1000W wind turbine and a 450Wp photovoltaic array.

The building covers a total area of approximately 50m^2 and it is actually a uniform area, with a kitchen, a bathroom and two other rooms. The walls and roofs of the building have increased insulation. Moreover, approximately half of the building's ceiling (at the north side) is covered by a pitched roof with tiles. The structure of the building's floor consists basically of one layer of a 15cm massive concrete. All windows and doors have aluminium frame with double glazing and are coated to protect the building from sun exposure during summer.

Figure 9. Bioclimatic house in the Iraklion suburbs

Figure 10. The roof after the cool coating was applied

Finally, at the south of the building, there is a shading mat. The large glazing area on the building roof is aligned to the south, so as to function as a heating storage system during winter. Although it was initially designed to be a passive house, air conditioning is needed during summer due to increased cooling loads. The energy consumption is estimated as 38 kWh/m^2 for cooling and 7 kWh/m^2 for heating, according to a 2008 audit.

Cool Roof technology

The cool coating used was a cool white paint manufactured by ABOLIN named Cool Barrier Roof with solar reflectance 0.89 and infrared emittance 0.89. The coating was applied on 15 July 2009 (Fig.10)

Evaluation results

The indoor temperature decrease -before and after the Cool Roof application- reached 1.5ºC C in summer and 0.5ºC in the winter. The heating and cooling load reduction -due to the Cool Roof application- is approximately 27%, while the total energy efficiency is almost 19.8%, even though there is an increase in the energy consumption for heating that reaches 37%. This is because the energy consumption for heating is a small portion of the total energy demand for the specific building. The surface temperature decrease is depicted in Figure 11. The Cool Roof application is the most effective solution compared to increased insulation or window improvement, for the specific building, as illustrated in Figure 12.

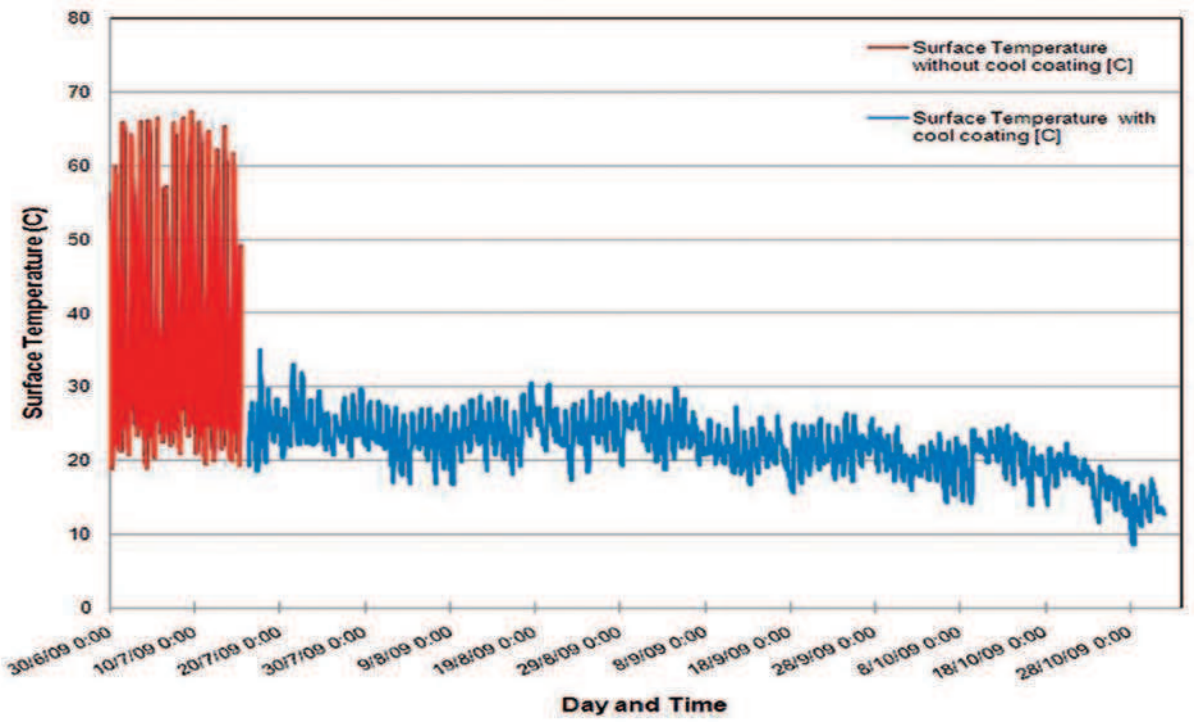


Figure 11. The roof's surface temperature before and after applying cool coating

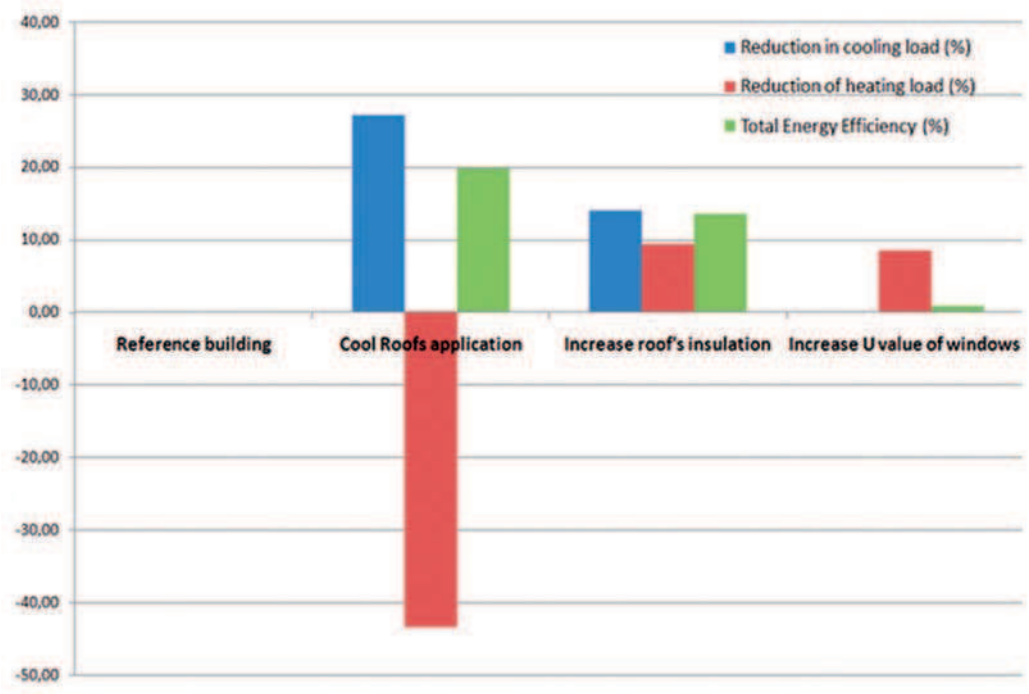


Figure 12. Comparison of different energy efficiency scenarios

3.3 ITALY

Public building in Trapani, Italy

The building

The building selected for the Italian case study (Fig.13) is a part of a school complex, hosting offices and laboratories and is located in Trapani, a town on the west coast of Sicily. It is greater than 700 m^2, has one floor and the load bearing structure is reinforced concrete. The walls have not been insulated and are made of *tufo* -a typical material in the area, and the windows are single glazed with non-thermally designed aluminium frames. The building is naturally ventilated and a compression heat pump was installed in summer 2009 in order to provide cooling and heating. The windows have been covered with internal shading.

The building's occupancy has a strong variation during the day and throughout the year, hosting from a dozen employees in the afternoons to up to 200 people during the summer with teacher recruitment activities. The office activities typically run from 08.00 to 17.00; laboratory activities run from 08.00 to 13.00.

Figure 13. The building in Trapani application of the cool paint

Figure 14. View of the roof with a partial application of the cool roof paint

Cool Roof technology

The initial roof surface was covered with cement and stone tiles, whose solar reflectance was estimated to be 0.25. For the study, the roof was covered with an eco-friendly cool paint based on milk and vinegar by Laboratori Ecobios. This product has a solar reflectance of 0.86 and a thermal emittance of 0.88.

Evaluation results

After the Cool Roof application, the percentage of hours in which the indoor temperature is above 25°C decreases from 78% to 52% (Fig.15). The percentage of temperatures above 27°C decreased from 54% to 15%. Before the Cool Roof application the daily mean indoor temperature was 1.8°C warmer than outside. After the application the indoor air is 0.9°C cooler than the outdoor temperature. The surface temperature of the cool roof is up to 20°C cooler than the original roof. The annual cooling energy demand is reduced by 54%. The cooling energy savings for the same building, if insulation is considered, is estimated around 28%. Comparisons of the Cool Roofs application with other techniques demonstrate that this is the most efficient solution to reduce the cooling demand of the Italian case study building (Fig.16).

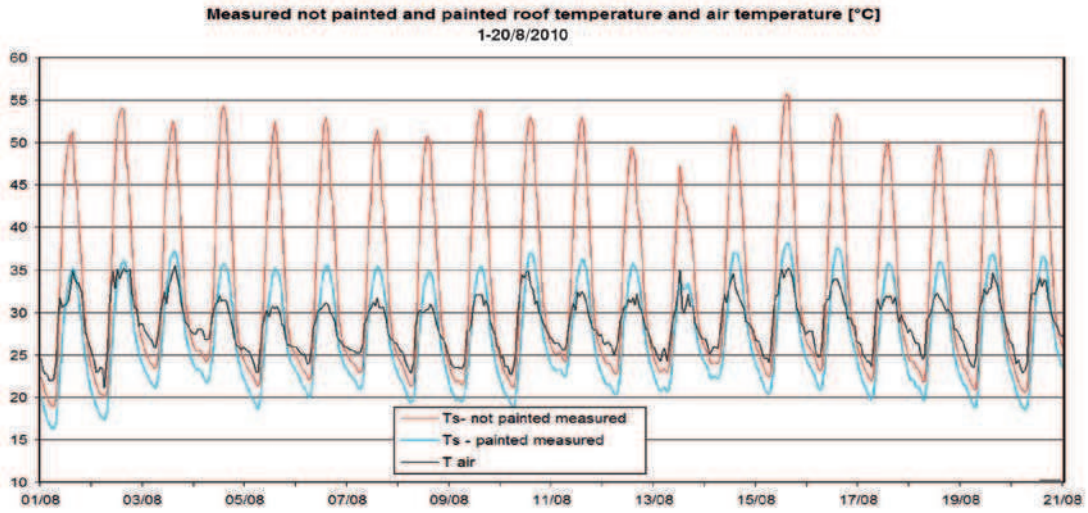


Figure 15. Comparison of cool and original roof surface temperatures in August 2009

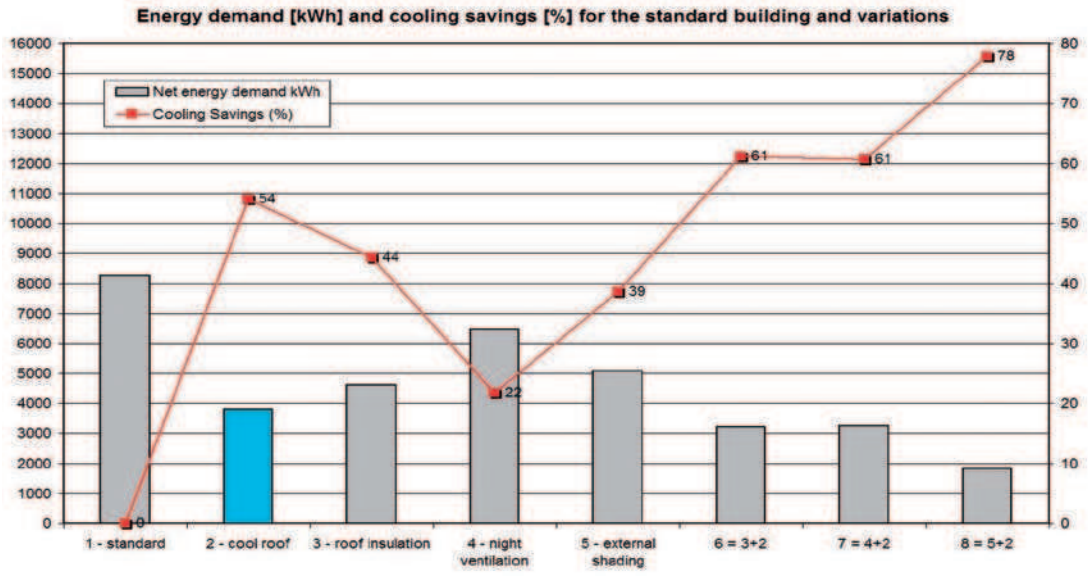
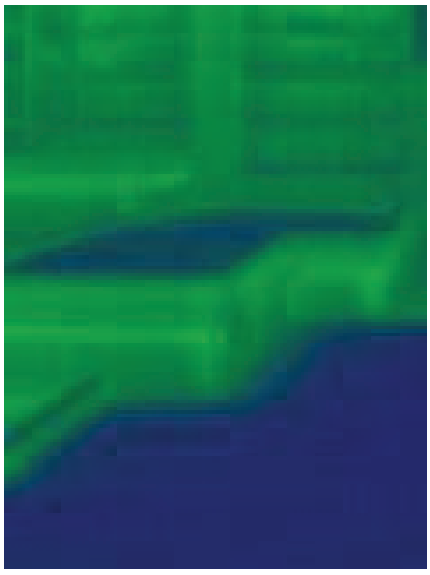


Figure 16. Potential cooling savings using Cool Roofs and other techniques
(including roof insulation, night ventilation, external shading and Cool Roofs in combination with these techniques)

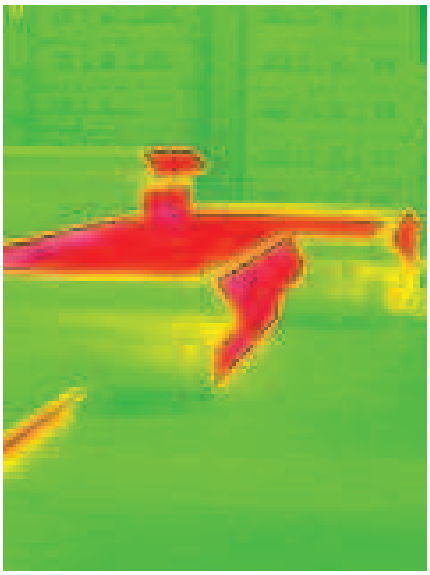
1 - original marble stone-concrete tile

2 - painting the roof

3 - positions of the infrred camera



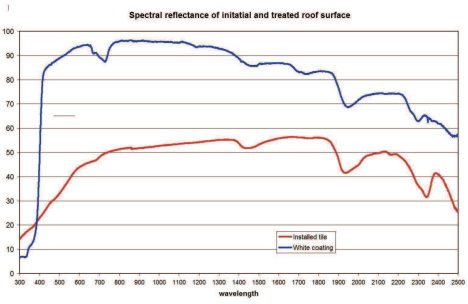
4 - h.07-00



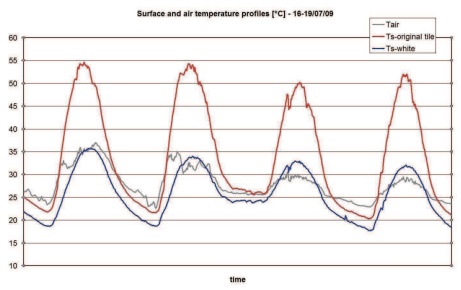
5 - h.16-00

Solar time	T white	T tile	T air
7	24,5	29	26,3
8	23,5	28,9	25,6
9	26,5	32,5	31,1
10	29	37,5	31,4
11	30	45	34,3
12	30	47	37,8
13	39,5	53	32,7
14	40	55,5	33,5
15	40,5	55	31,3
16	37	52	32,1
17	36,5	49	32,7
18	35,5	46	30,8
19	29,5	38	27,3
20	27,5	35	27,4
21	25,5	33	27
22	25,5	32,5	26,6

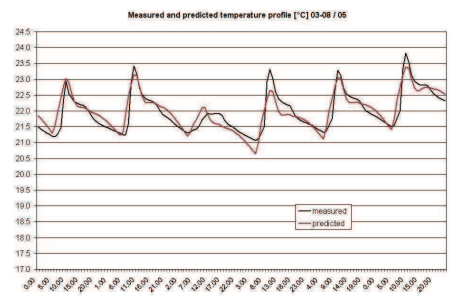
Infrared measures



7 - spectral data of roof materials



8 - surface temp profiles



9 - model tuning measured and predicted profiles

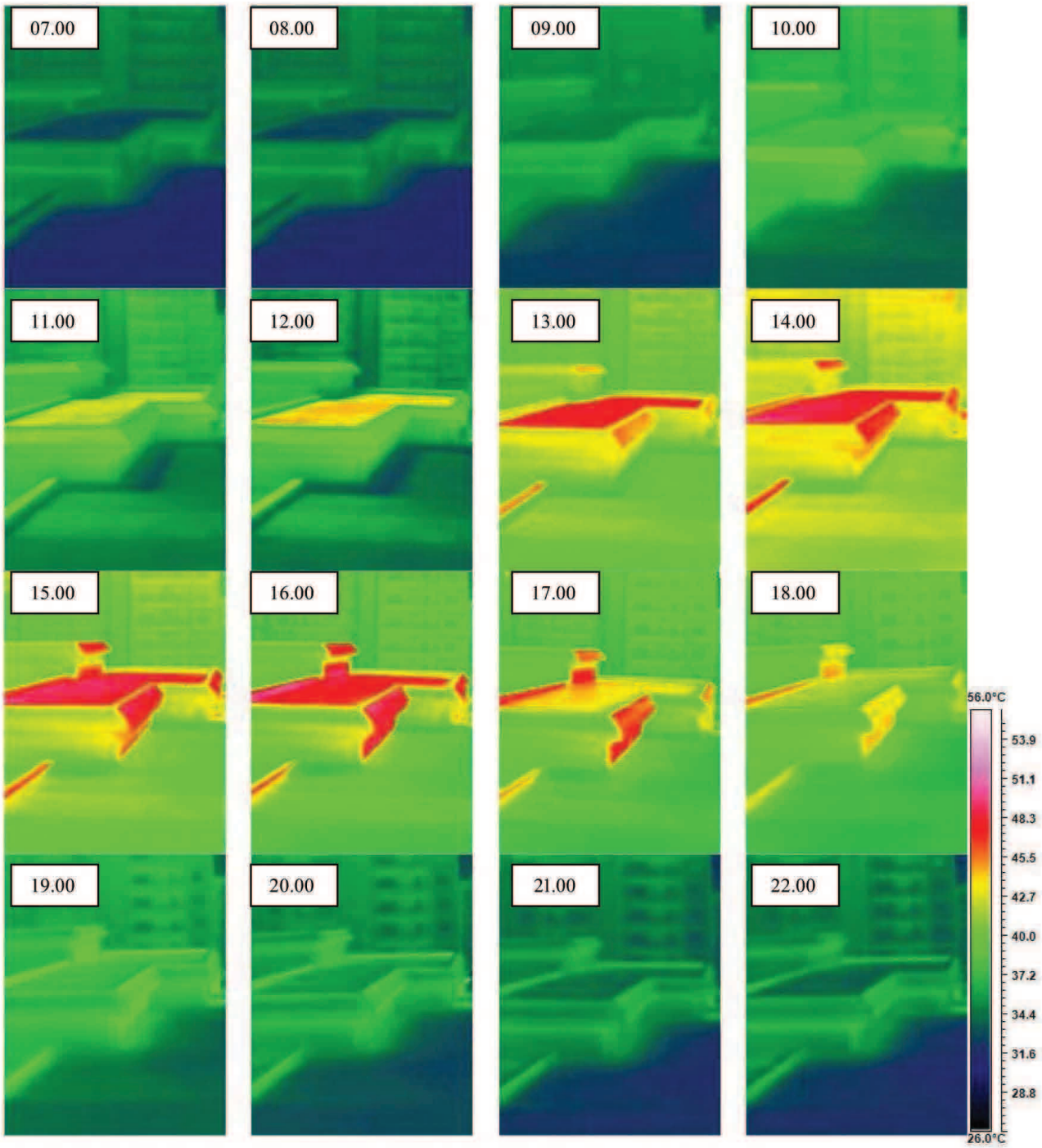


Figure 5.12 Thermographic analysis of the painted roof vs non painted roof

5.4 Model development and calibration

The building was modelled in a number of different thermal zones (see Figure 5.13).
The data for the description of the building were entered through TRNbuild interface.
The building had to be described in its:

- Orientation: through azimuth angle:
  - North-East: 203 °; South-East: 293 °; South-West: 23 °; North-West: 113 °.

3.4 UK

Office at Brunel University, Uxbridge, West London, UK

The building

The Estate Office at Brunel University consists of an open office area and three separate office rooms and is located at the top floor (flat roof) of a four floor building constructed in 1995 (Fig.17). It is heated with perimeter radiators and is naturally ventilated. The roof is made of a 0.15m thick concrete slab with a 0.04m insulation layer on top covered with a layer of water proofing material (asphalt). The external wall structure is made of concrete block work and is insulated externally.

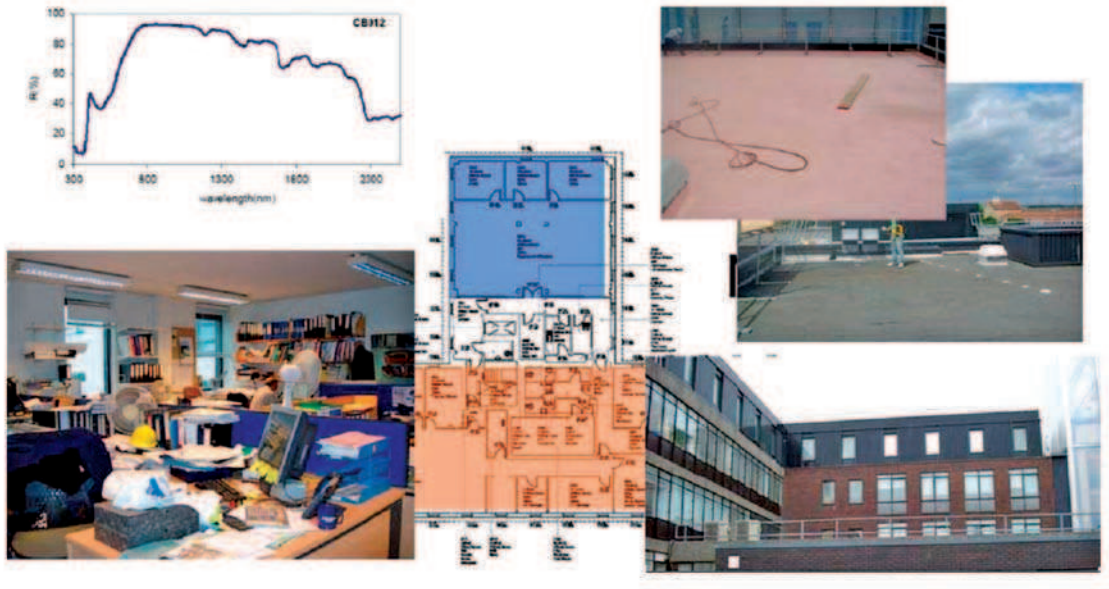


Figure 17. Floor plan and photos of the office and roof including the solar reflectance of the cool material applied

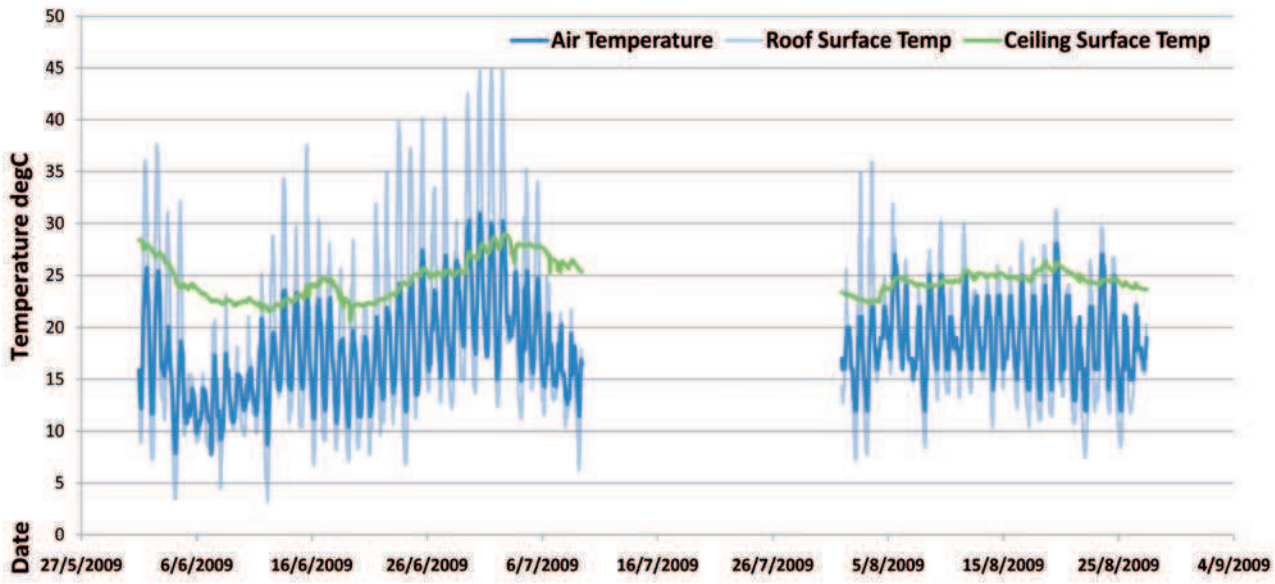


Figure 18. Measured surface and air temperature before and after the Cool Roof application

Cool Roof technology

Abolin's "Cool Barrier 012 (CB012)" was applied on the roof with an SR of 0.6 (measured on site after application) and an emissivity rating of 0.88. The reflectivity of the original roof was 0.1. The building was monitored from April 2009. Cool roof materials were applied in July 2009 and monitoring continued until October 2009 (Fig. 18).

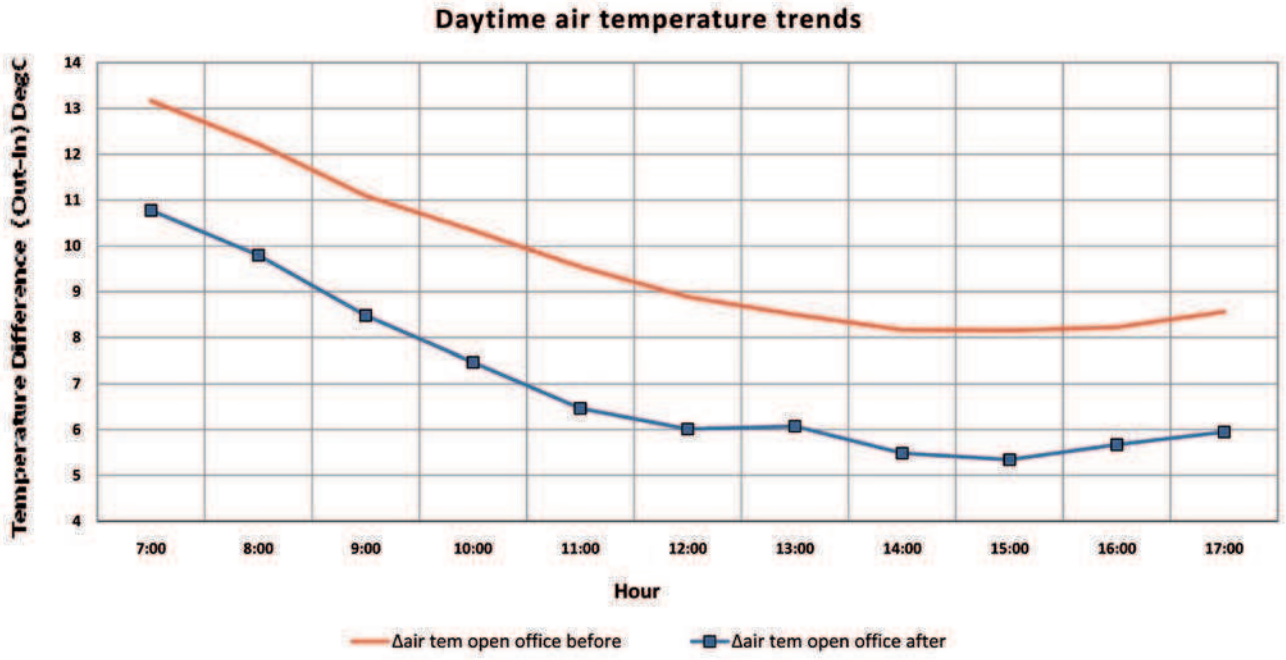


Figure 19. Measured daytime air temperature trends (external-internal difference), before and after the application of cool roof materials

Evaluation results

The measurements have shown that the:

- external surface temperature was reduced
- internal surface temperature was reduced by an average of 2°C in the middle of the day
- internal air temperature was reduced by an average of 3-4°C in the middle of the day.

Modelling with a calibrated model has shown:

- Overheating hours during the summer are significantly reduced with the application of cool roof materials resulting in an increase of the surface albedo (Fig.19).
- Cooling load is decreased; although there is a heating penalty, the overall contribution is positive.
- Optimum surface albedo is estimated between 0.6 and 0.7 with air exchange rate of 2 air exchanges per hour. This combination creates an overall heating and cooling load reduction of 3-6% depending on the set-point temperature for winter and summer.
- Increasing insulation levels would decrease the potential energy benefits in heating and cooling demand.

In conclusion, this case study analysis indicates that applying a Cool Roof technology could be beneficial for the moderate climate of South East England (suburban London), in terms of increased thermal comfort in the summer and could decrease overall energy use for heating and cooling. However, the energy savings are dependent on building related construction and operation conditions.

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www.grbes.phys.uoa.gr

Technological Educational Institute of Crete
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Perdikis Bros Co.
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Municipality of Kessariani
www.kessariani.gr

Brunel University
www.brunel.ac.uk

Greater London Authority
www.london.gov.uk

University of la Rochelle
www.leptiab.univ-larochelle.fr

SIPEA Habitat
www.sipea-poitiers.fr

Italian National Agency for New Technologies,
Energy and the Environment
www.enea.it

Regional Province of Trapani
Sector for Land Environment Natural Resources
www.provincia.trapani.it

Ecobios Laboratori
www.ecobios-solaria.com

Federation of European heating and
air-conditioning associations
www.rehva.eu

Athena Consulting Group
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Intelligent Energy Europe

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