Environmental Quality of the Built Environment in the Mediterranean

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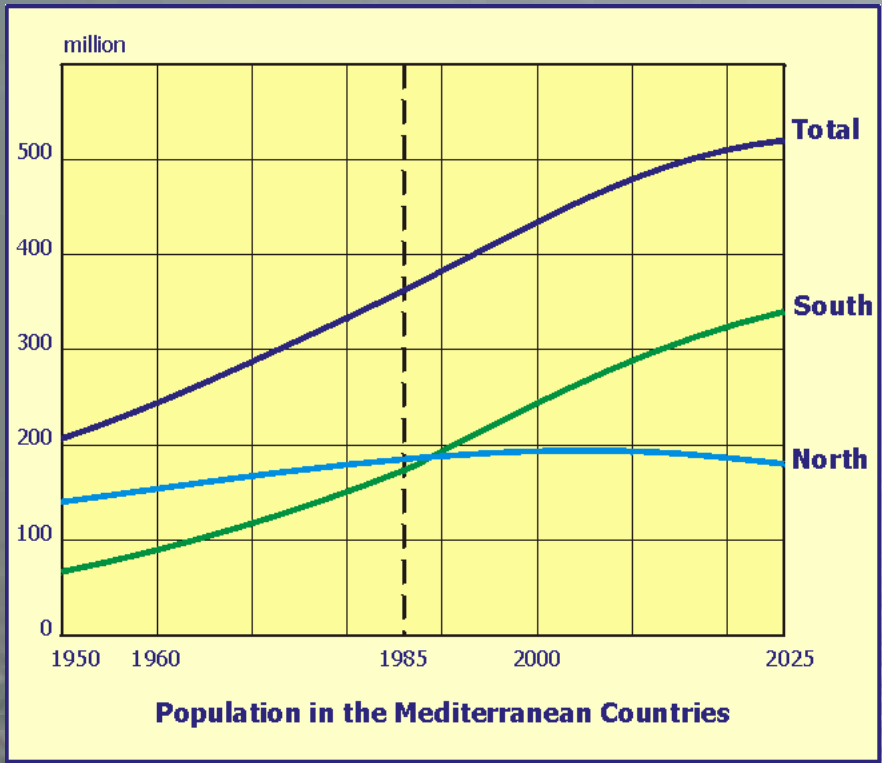
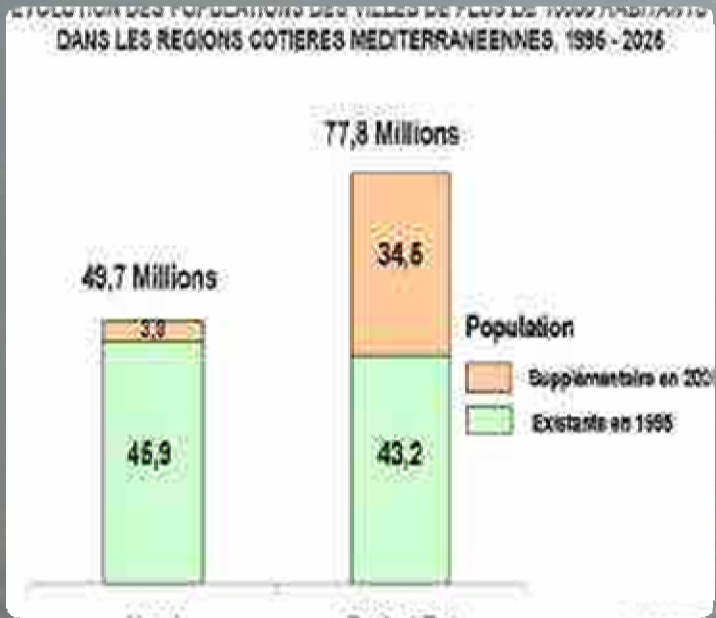
The trends



- 2000: more than 400 million inhabitants in 21 countries, 7% of the world population
- 2025: 554 million inhabitants, increasing by 4 million in the north, by 148 million in the south and east
- Coastal population grew from 85 million (1980) to 124 million (2000) - 46% increase

The trends



- Overall urbanisation rate: 64% in 2000, 72% in 2025
- Urban inhabitants: 275 mil. in 2000, 380 mil. in 2025
- 65% of coastline is urbanised
- 1449 coastal settlements with more than 10,000 inhabitants in 1995 (100% increase since 1950)

The trends

Rank	Urban Area	Population (2005)	Annual change (1990s)
1	Paris, France	10 136 000	0.2
2	London, United Kingdom	8 505 000	0.6
3	Ruhr area-Essen-Dortmund-Duisburg, Germany	5 214 000	– 0.1
4	Madrid, Spain	4 868 000	0.3
5	Barcelona, Spain	4 043 000	0.0
6	Berlin, Germany	3 764 000	0.1
7	Milan, Italy	3 695 000	– 0.3
8	Rotterdam-The Hague, Netherlands	3 345 000	0.5
9	Athens, Greece	3 247 000	0.3
10	Naples, Italy	2 887 000	0.0
11	Lisbon, Portugal	2 665 000	0.2
12	Rome, Italy	2 605 000	– 0.8

20	Warsaw, Poland	2 069 000	0.0
21	Brussels, Belgium	1 975 000	0.5
22	Vienna, Austria	1 893 000	0.2
23	Munich, Germany	1 656 000	0.2
24	Porto, Portugal	1 552 000	0.7
25	Leeds, United Kingdom	1 520 000	0.3
26	Frankfurt, Germany	1 489 000	0.2
27	Lyon, France	1 465 000	0.4
28	Copenhagen, Denmark	1 417 000	0.3
29	Marseilles, France	1 374 000	0.2
30	Lille-Kortrijk, France & Belgium	1 368 000 [1]	0.1
31	Valencia, Spain	1 362 000	0.1
32	Stockholm, Sweden	1 273 000	1.0
33	Turin, Italy	1 267 000	– 0.9
34	Stuttgart, Germany	1 239 000	0.3

We face an important change of the climate.

Ambient temperatures increase.

Heat waves are more frequent.

Hot spells have a longer duration.

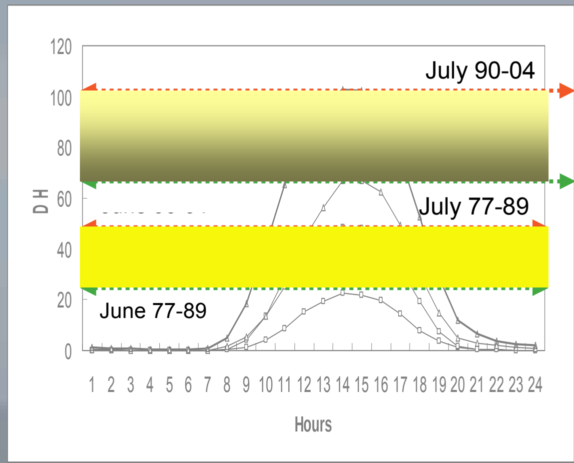
Poor design and uncontrolled development of urban areas increase the heat island intensity.

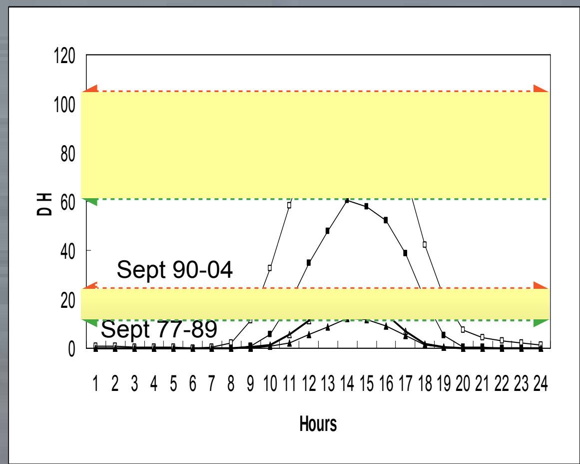
Human beings are more vulnerable and have to respond.

In Athens the number of hours as well as the Degree Hours over 30 degrees have been substantially increased during the period 1990-2004, compared to the corresponding value of the period 1977-1989. The phenomenon is statistically significant.

For July and August the increase is close to 30-40 %.

The phenomenon appears during the whole day period.

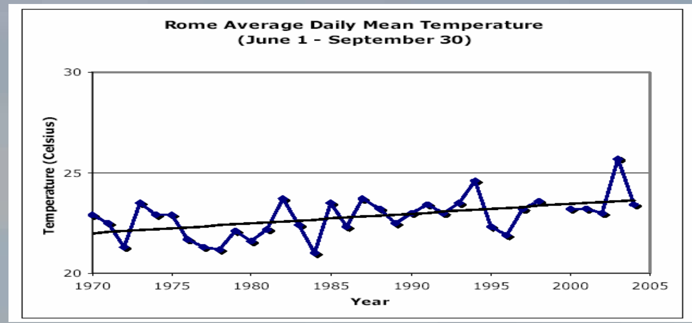


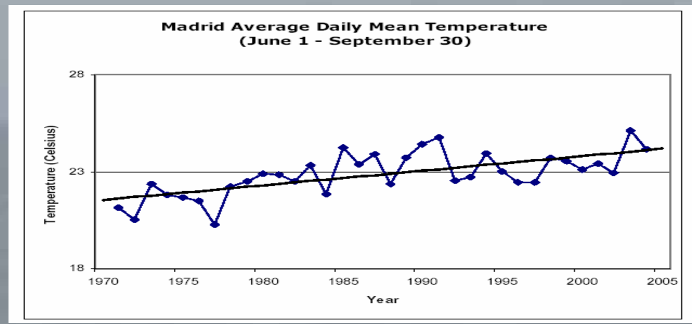


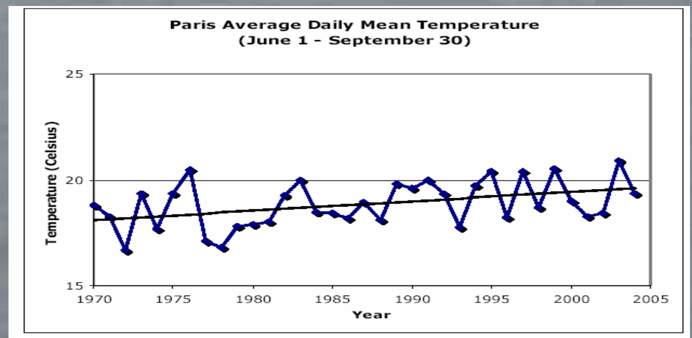
The Proof

Many climatological studies have shown an Important increase of the average mean daily ambient temperature in most southern European cities, like Paris, Madrid, Rome and Lisbon.

Temperature increase is between 2-3 Degrees. Also, an important increase of the cooling degree days has been recorded.





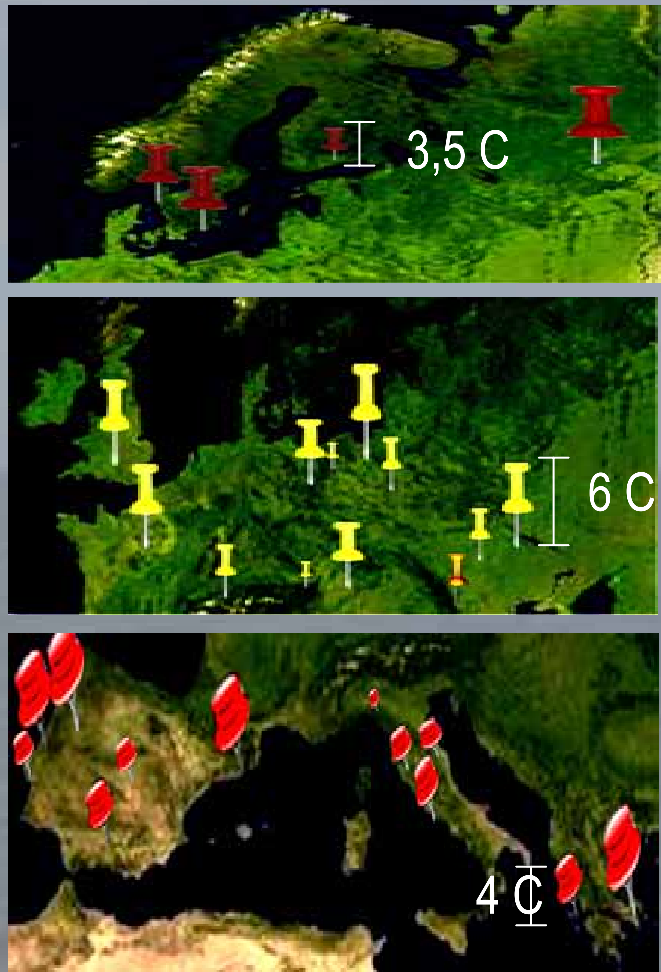


The Proof

Heat Waves in Europe are more frequent. High temperatures increase the vulnerability of citizens and in particular of low income people. Studies in Europe, have shown that the greatest excess in mortality was registered in those with low socioeconomic status leaving in buildings with improper heat protection and ventilation.

The Proof

Heat Island intensity ranges between 1-10 C.
Heat Island is present in low, mid and high latitude locations.
It is observed during the day and the night period.
Especially in the south , heat island is very important during the day period contributing to a high increase of discomfort hours, increase of the cooling load of buildings and a very high increase of the peak electricity demand.



The Buildings

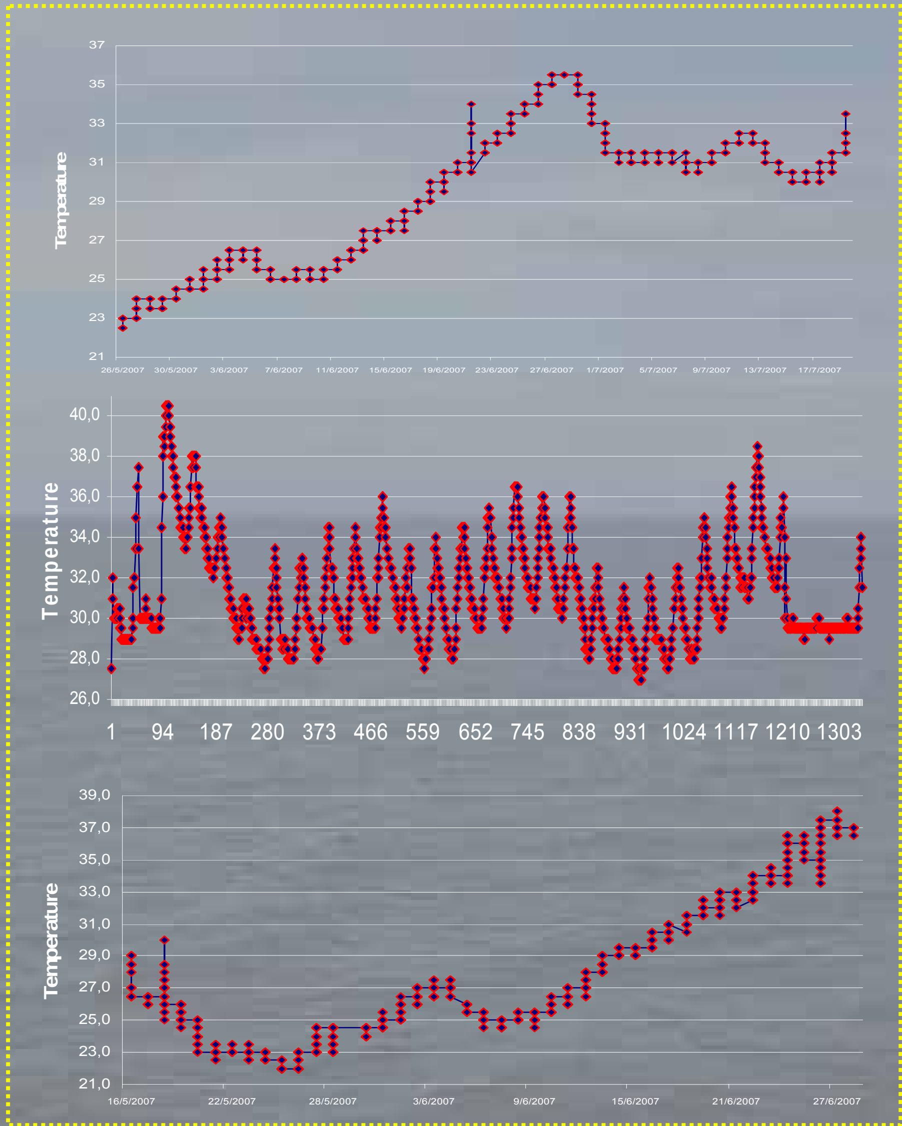
Low income population in both the developed and under development world is living in non appropriate shelters and is vulnerable to high ambient temperatures and extreme heat phenomena.
According to the United Nations more than one billion of urban citizens, live in non appropriate houses while in most cities of less developed countries, about one to two thirds of the population live in poor quality and overcrowded housing, without electricity and energy networks and are under the risk of environmental phenomena

The Buildings

Only 28 % of the Low income population in Greece lives in insulated houses while the corresponding figure for high income households is 73 %.
In parallel, only 8 % of the low income households are insulated and have double glazing while for high income the percentage is 63 %.
Finally, low income houses present a much higher infiltration rate at 50 Pa.

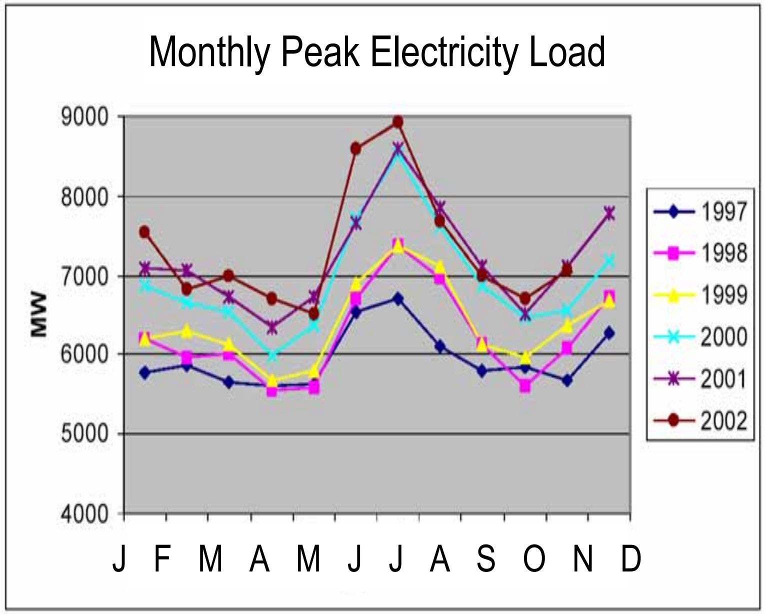
The Impact

Measurements of indoor temperatures in almost 60 low income houses without air conditioning, insulation and double glazing, have been performed in Athens, during the whole summer of 2007. For almost 50 % of the measurement period, indoor temperatures where higher than 34 C, presenting maximum close to 40 C. Hot spells of more than 38 hours above 30 C have been recorded.

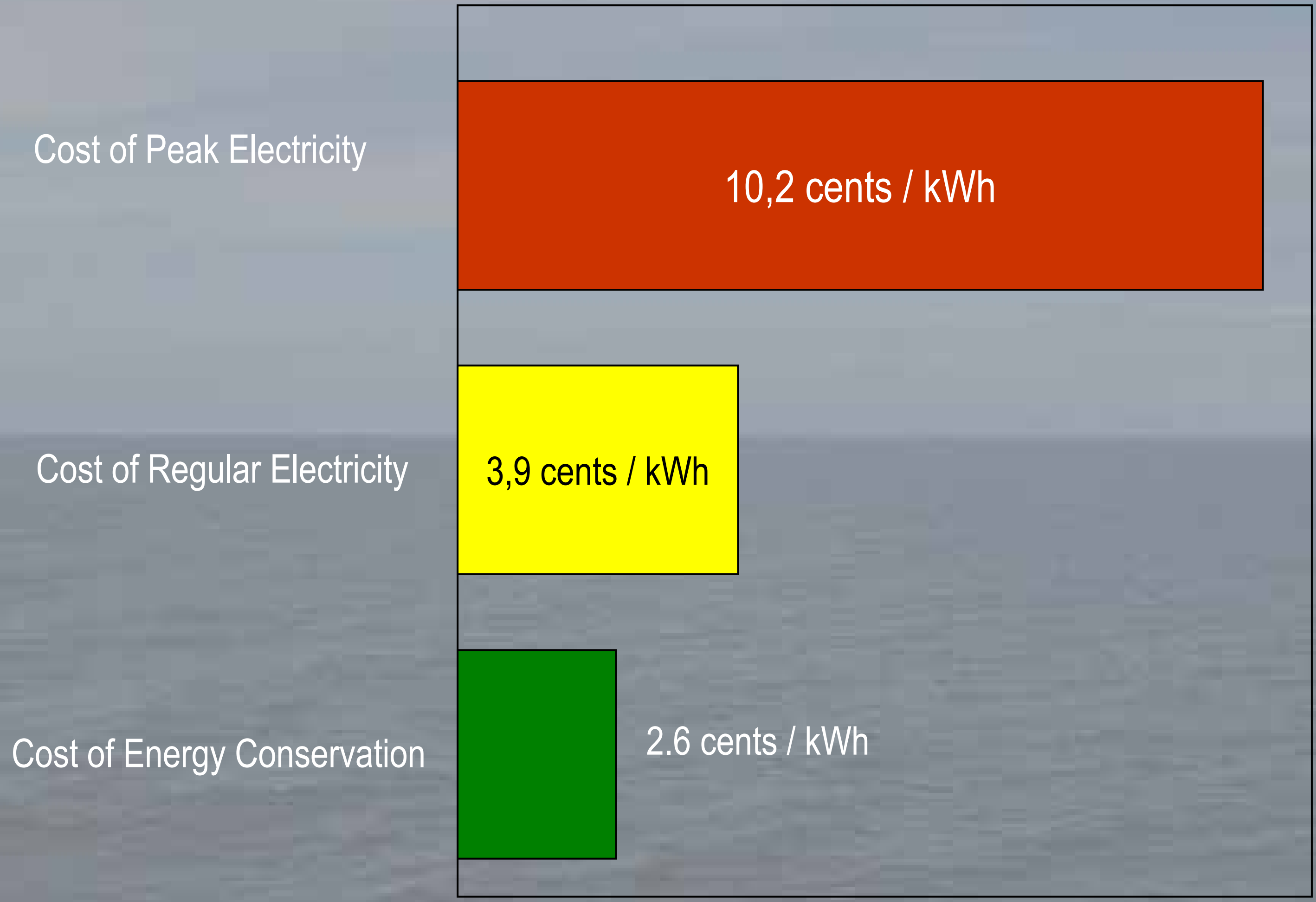


The use of air conditioning considerably increases the annual electricity expenses especially in the low income groups. As a mean value, the use of air conditioning increases the annual expenses to about 100 Euros per household, or 0,6 Euros/m2, or 12.5 Euros per person. The increase is much higher for the low income groups, where the relative increase of the cost because of the air conditioning use is close to 195 Euros/household, or 1.2 Euros/m2, or 87 Euros/person.

The use of air conditioning increases the peak electricity demand in most of the Southern European countries.
In parallel, this is the main reason of blackouts and electricity shortages.
Such a huge increase of the peak electricity demand oblige utilities to built additional power plants operating under a low utilisability factor, and thus, increase the cost of electricity



The Impact


Cost of Peak Electricity
10,2 cents / kWh
Cost of Regular Electricity
3,9 cents / kWh
Cost of Energy Conservation
2.6 cents / kWh

The Impact

Huge Increase of CO2 because of A/C

Unit: tonnes CO2	1990	1996	2010	2020
Austria	157	1 603	15 748	31 467
France	26 860	87 377	285 231	468 957
Germany	7 845	25 615	139 241	265 983
Greece	99 235	959 939	2 387 187	3 737 087
Italy	182 591	2 247 038	2 923 568	3 623 486
Portugal	147 358	358 099	1 038 841	1 519 546
Spain	n.a. (around 90 000)	1 124 255	4 381 826	7 130 489
UK	47 710	219 640	704 204	1 165 583
Other E.U	4 694	15 369	83 545	159 590
Total E.U	516 451 (606 451)	5 038 935	11 959 391	18 102 187

Addressing successful solutions to reduce energy and environmental effects of air conditioning is a strong requirement for the future.

Possible solutions include:

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1. Improvement of the urban microclimate to fight the effect of heat island and temperature rise and the corresponding increase of the cooling demand in buildings
2. Use of appropriate technology to improve indoor comfort conditions and reduce cooling needs

Especially for low income – vulnerable population, living in non protected shelters, The idea is not to maintain temperatures within the ASHRAE-defined comfort zone of (20–27°C) using energy driven systems, but to create buildings that will not threaten the lives of their occupants under adverse ambient conditions and even when power is lost or citizens can not afford to pay for it. In other words, buildings that increase the survivability of the citizens

Improving the Urban Microclimate

Techniques to Improve the Urban Microclimate and Heat Island Mitigation strategies concentrate on :

- the increased use of green areas,

-the use of appropriate materials, in particular of white and colored high reflective coatings,

- decrease of anthropogenic heat

- use of cool sinks for heat dissipation,

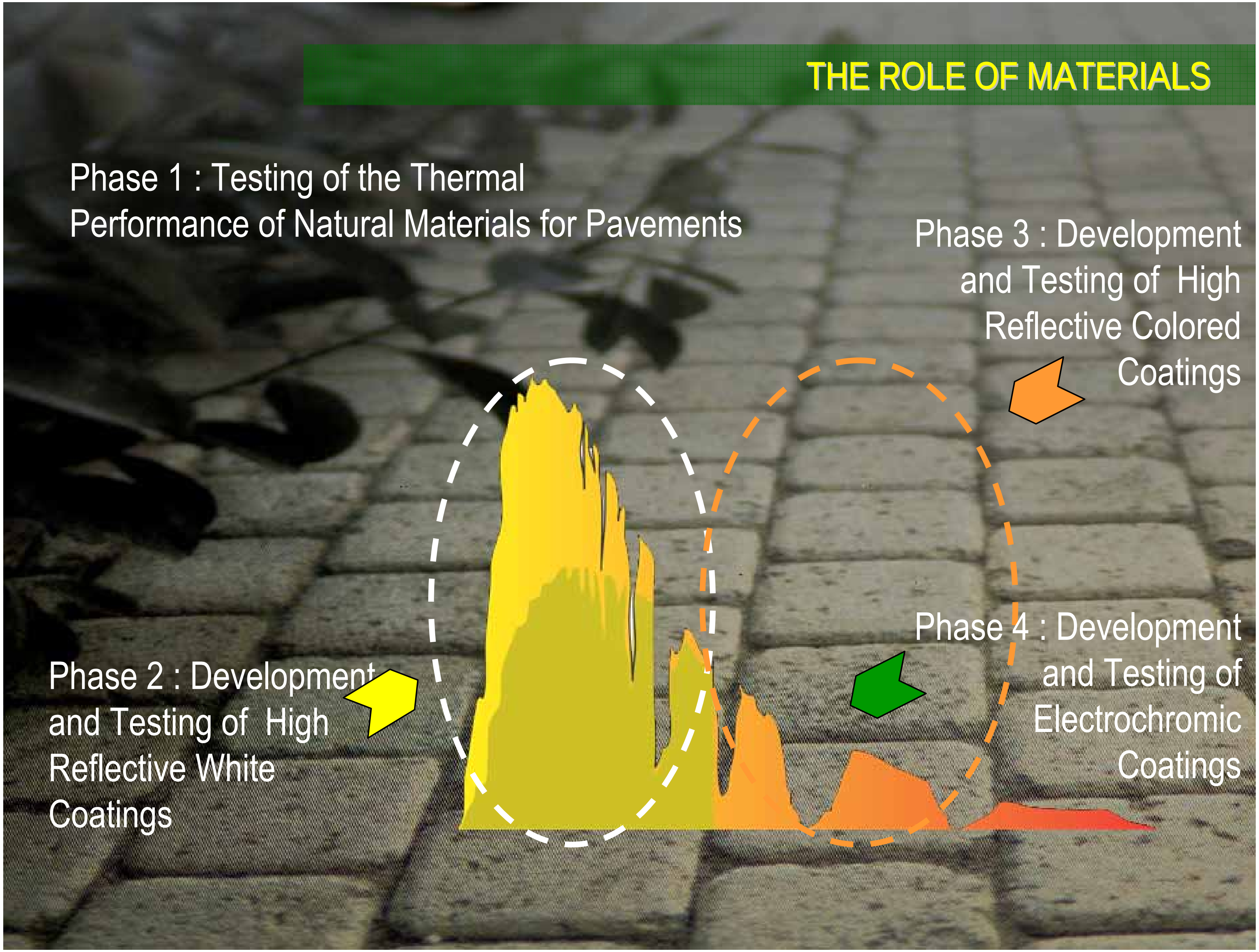
- appropriate layout of urban canopies involving the use of solar control, techniques to enhance air flow, etc.

UNEP ask children to design 'urban green' they wish ....

Unfortunately, the vision of adults on 'urban green' is very different......

Trees and green spaces significantly contribute to cool our cities and save energy.
Trees can provide solar protection to individual houses during the summer period while evapotranspiration from trees can reduce urban temperatures.
Trees also help mitigate the greenhouse effect, filter pollutants, mask noise, prevent erosion and calm their human observers.
Increasing number of buildings has crowded out vegetation and trees. New York has lost 175000 trees, or 20 % of its urban forest in the last ten years

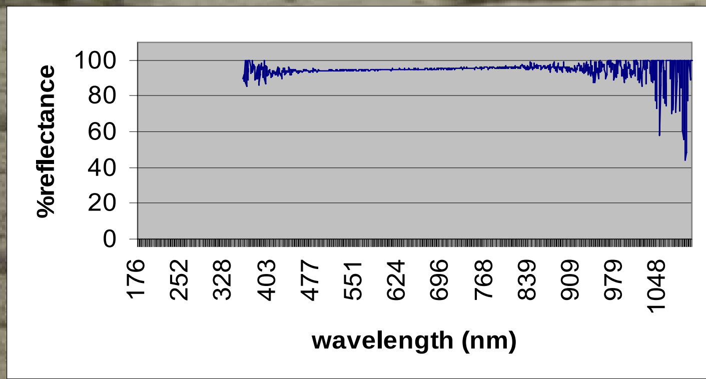
Planted roofs can contribute significantly to the mitigation of heat islands. Planted roofs present much lower temperatures than hard surfaces and decrease the ambient temperature through convection and evapotranspiration. In parallel, planted roofs contribute highly to the thermal protection of buildings, but do not replace the thermal insulation layer. Planted roofs may reduce the indoor temperature of insulated buildings up to 1 C. However, the cost of the system is quite high and is for sure not the more appropriate technique for vulnerable population.


THE ROLE OF MATERIALS
Phase 1 : Testing of the Thermal Performance of Natural Materials for Pavements
Phase 3 : Development and Testing of High Reflective Colored Coatings
Phase 4 : Development and Testing of Electrochromic Coatings
Phase 2 : Development and Testing of High Reflective White Coatings

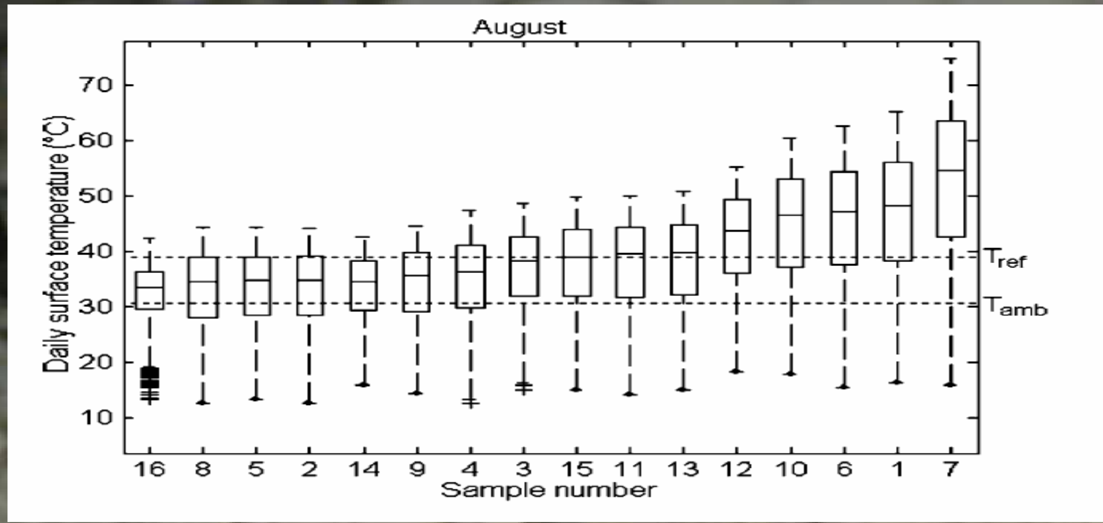
DEVELOPMENT OF HIGHLY REFLECTIVE WHITE COATINGS

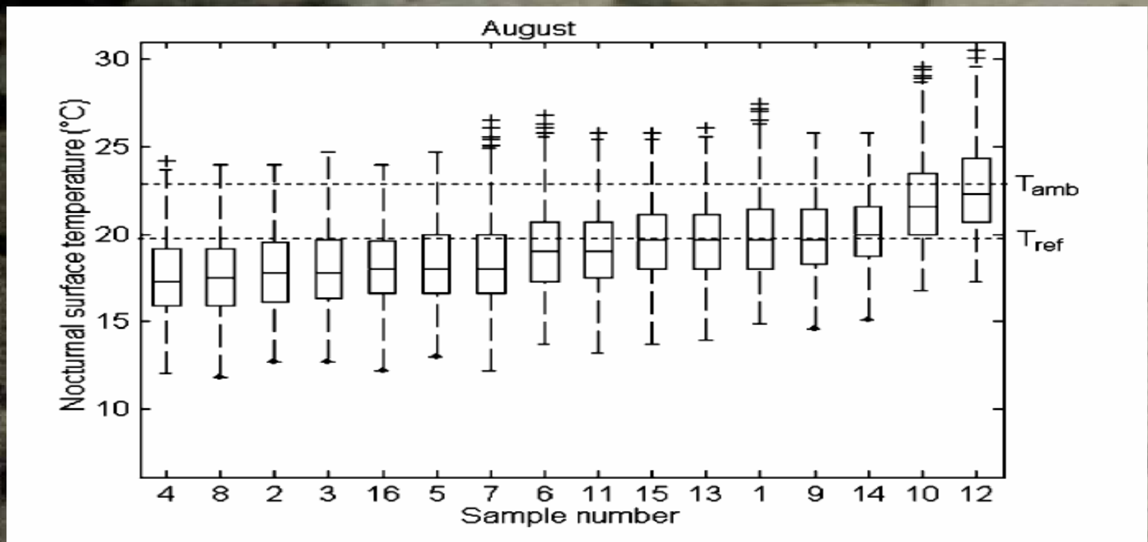
Sample description
Aluminum pigmented acrylic coating
Acrylic, ceramic coating
Acrylic, elastomeric coating
Acrylic, elastomeric coating
Alkyd, chlorine rubber coating
Aluminum pigmented, alkyd coating
Emulsion paint
Acryl-polymer emulsion paint
Acrylic latex
Aluminum pigmented coating
Acrylic insulating paint
Aluminum pigmented acrylic coating
Epoxy polyamide coating
Acrylic paint
Uncoated tile (reference)
Acrylic elastomeric coating

High Reflective white coatings have been developed and are available in the market. The coatings present very high reflectivity to solar radiation and very high emissivity. The new coatings have been compared in outdoor testing against existing white coatings for about 3 months, and found to present a very high performance

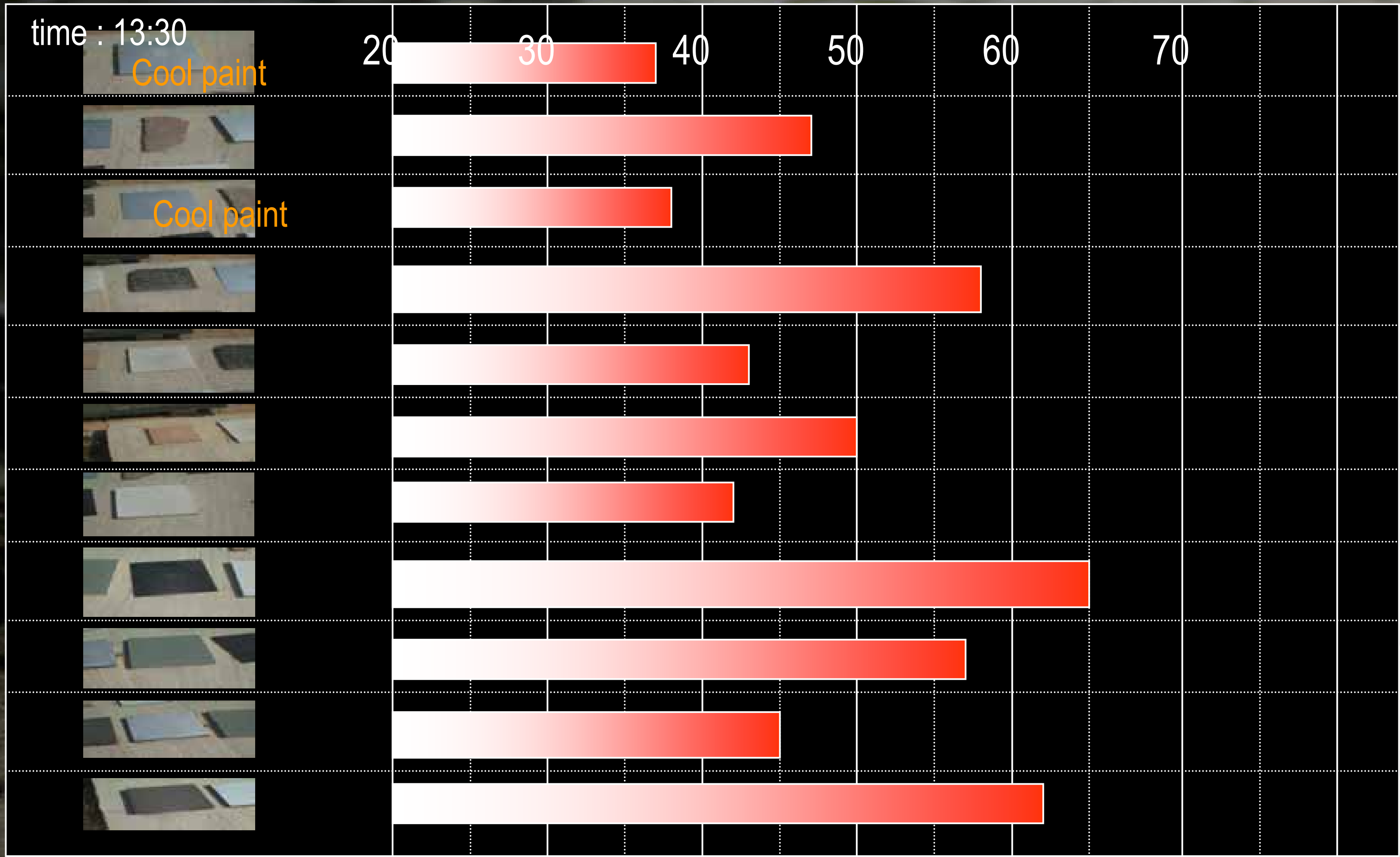


DEVELOPMENT OF HIGHLY REFLECTIVE WHITE COATINGS

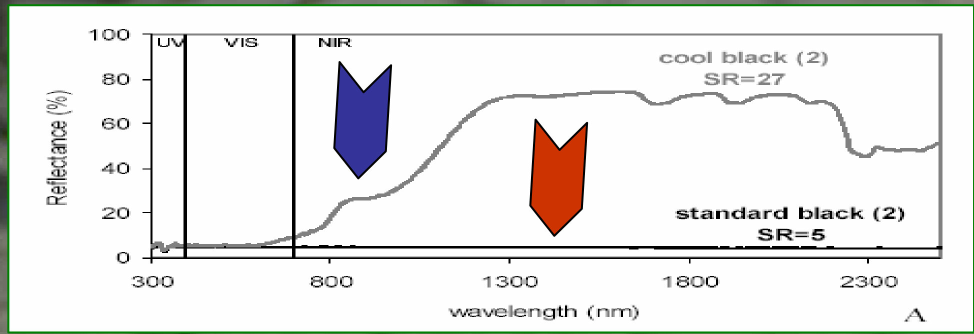


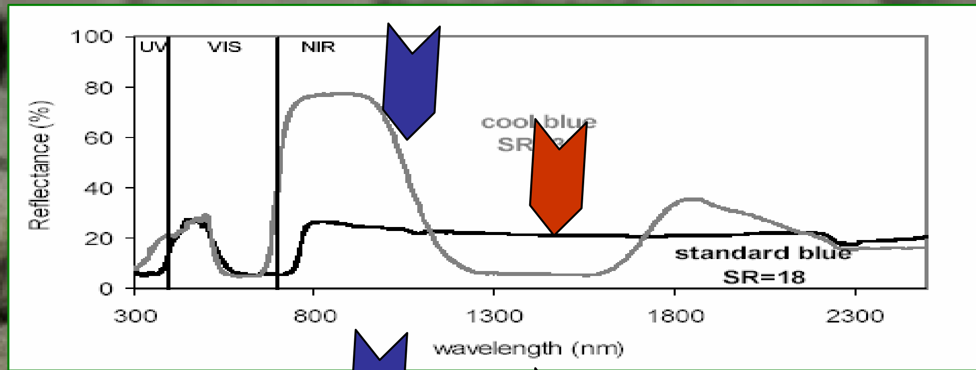


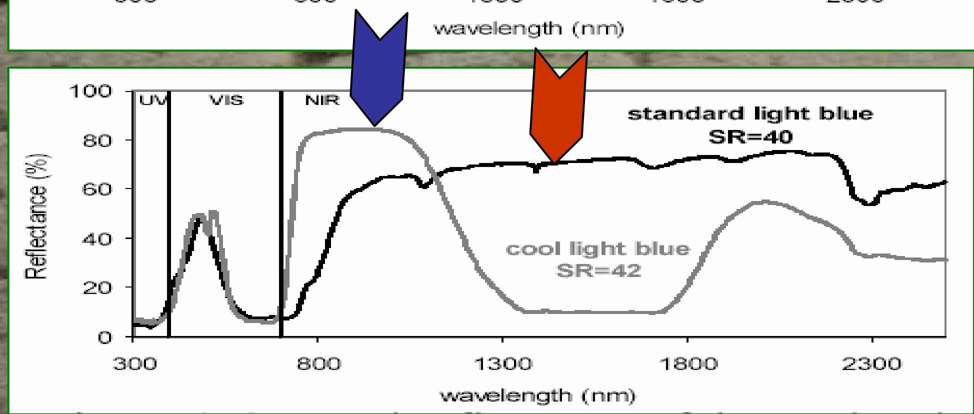
DEVELOPMENT OF HIGHLY REFLECTIVE WHITE COATINGS



DEVELOPMENT OF REFLECTIVE COLORED COATINGS

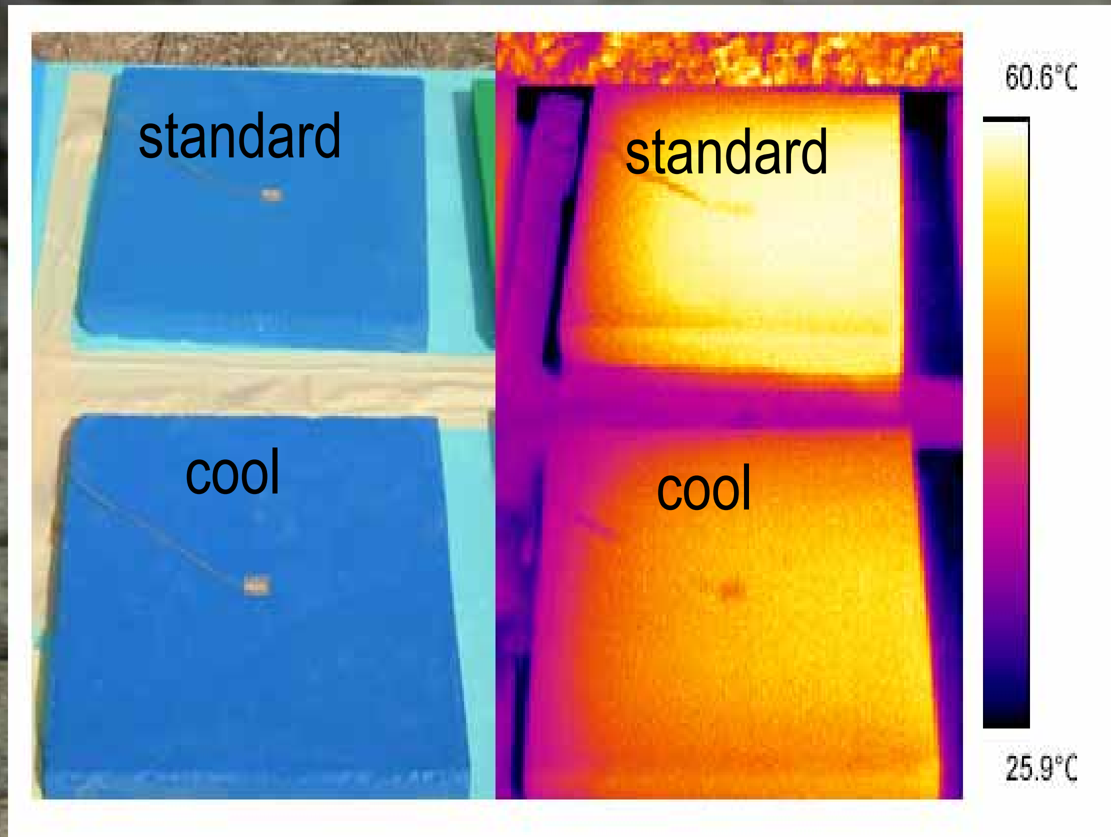




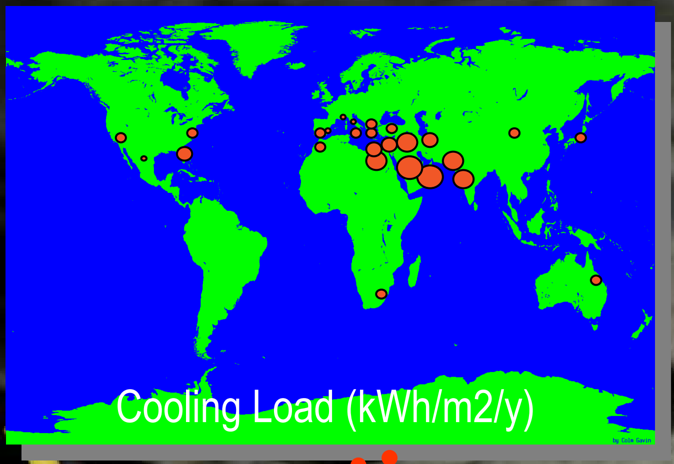


DEVELOPMENT OF REFLECTIVE COLORED COATINGS

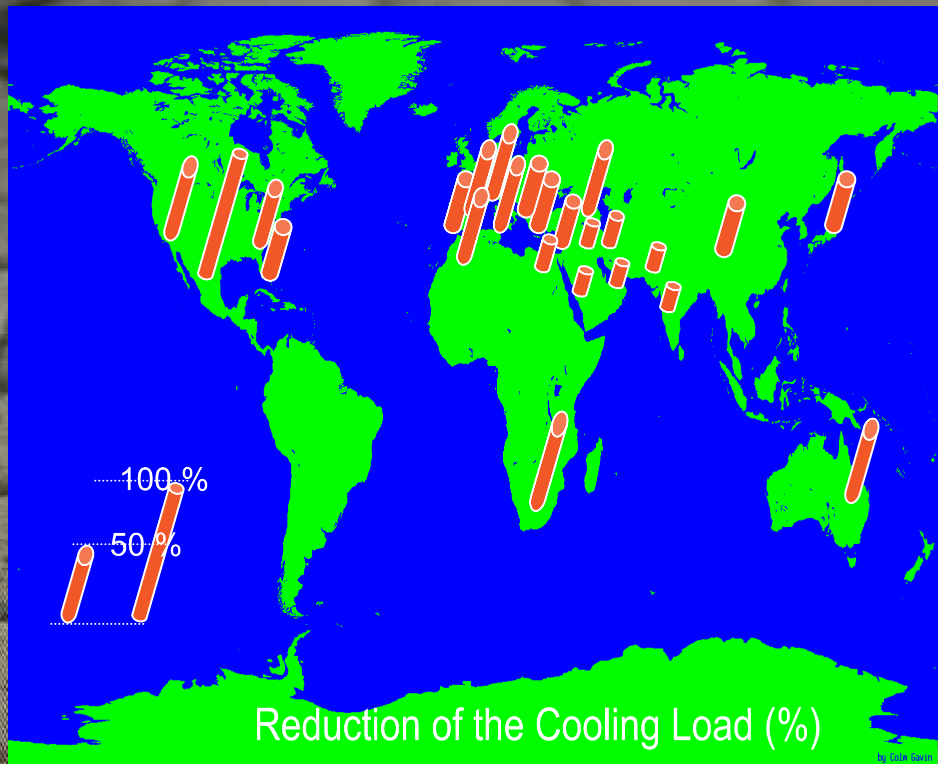
Parallel Testing has shown much lower surface temperatures for the cool paints. Temperature differences range between 2-10 C according to the reflectivity of the material and the incoming solar radiation



DEVELOPMENT OF REFLECTIVE COLORED COATINGS

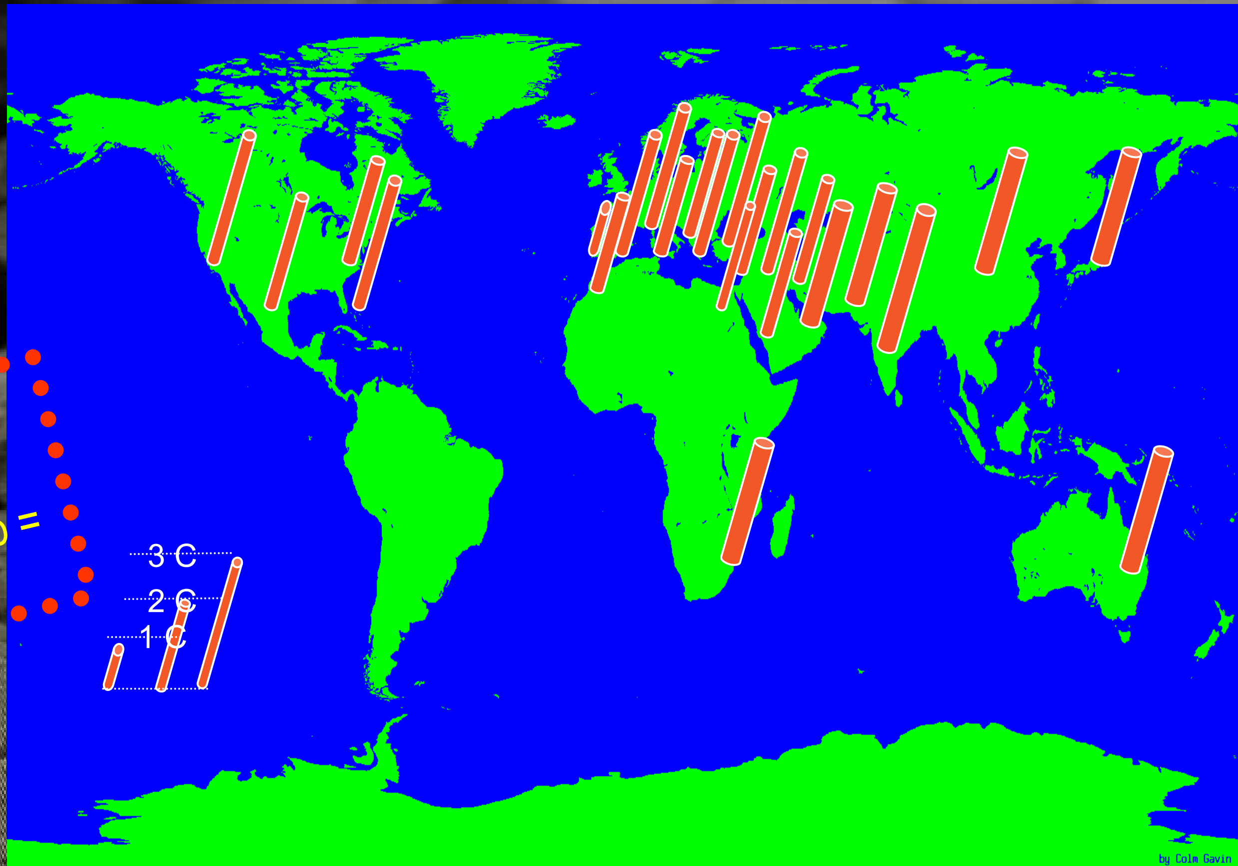


Increase of the albedo from 0.2 to 0.85

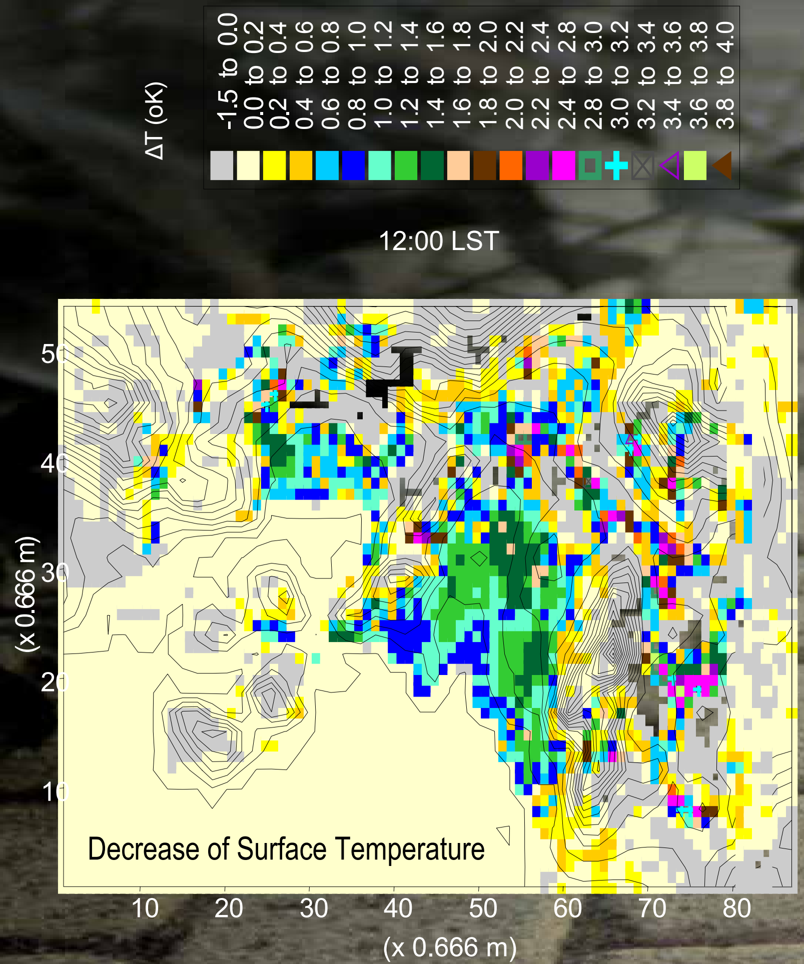


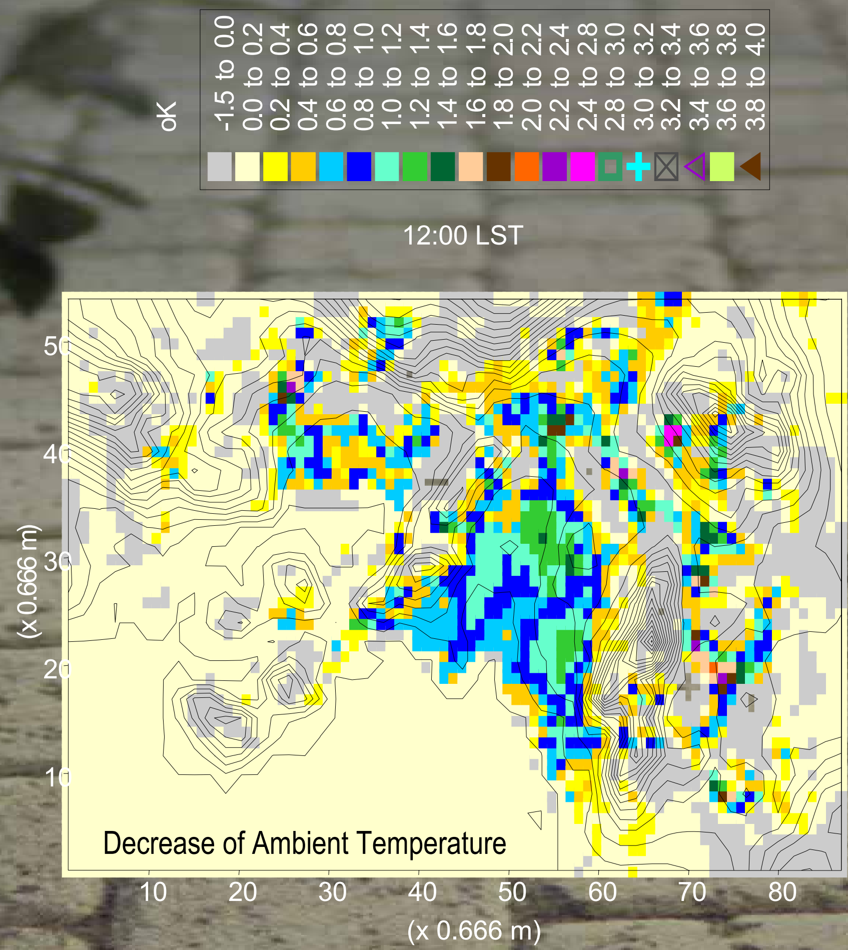
ENERGY IMPACT OF REFLECTIVE COATINGS

Decrease of the maximum indoor temperature, for Δρ = 0.65

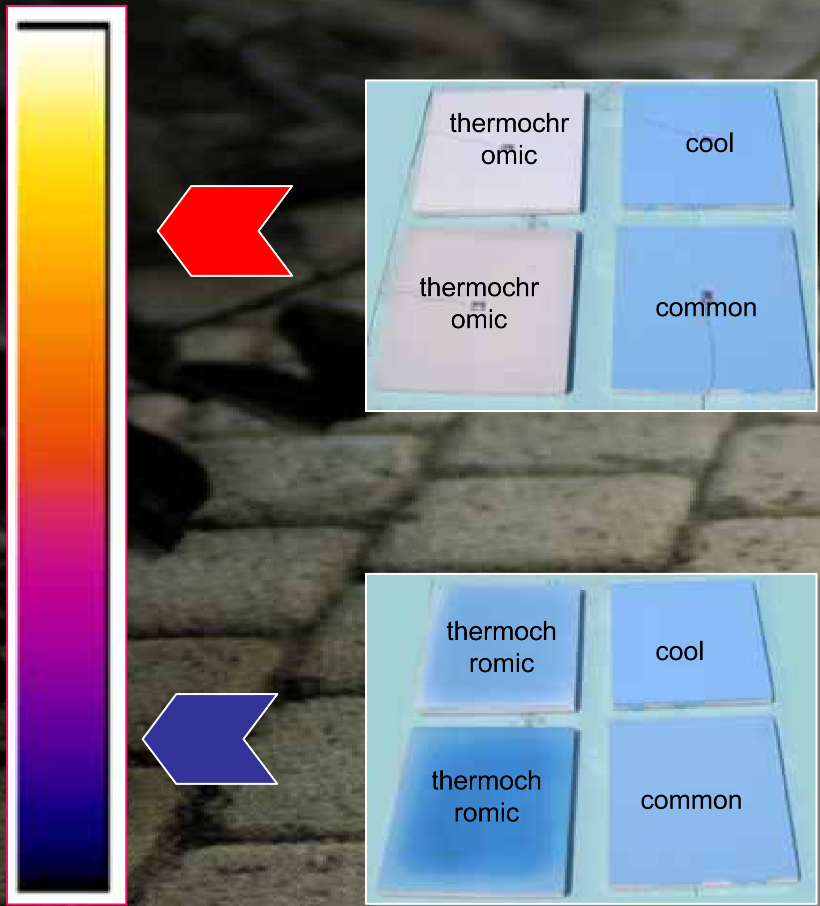


GLOBAL CLIMATE IMPACT OF REFLECTING COATINGS

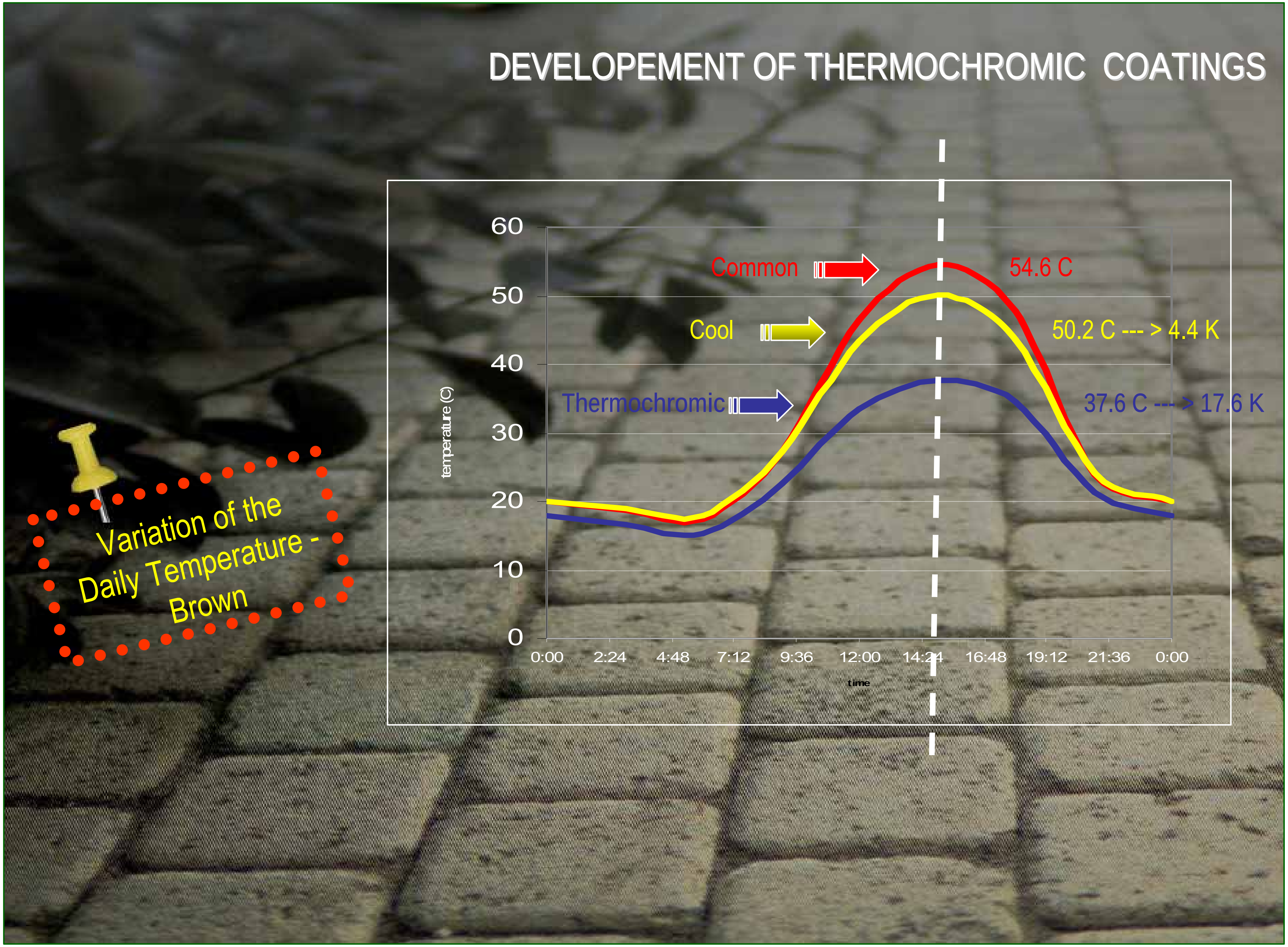


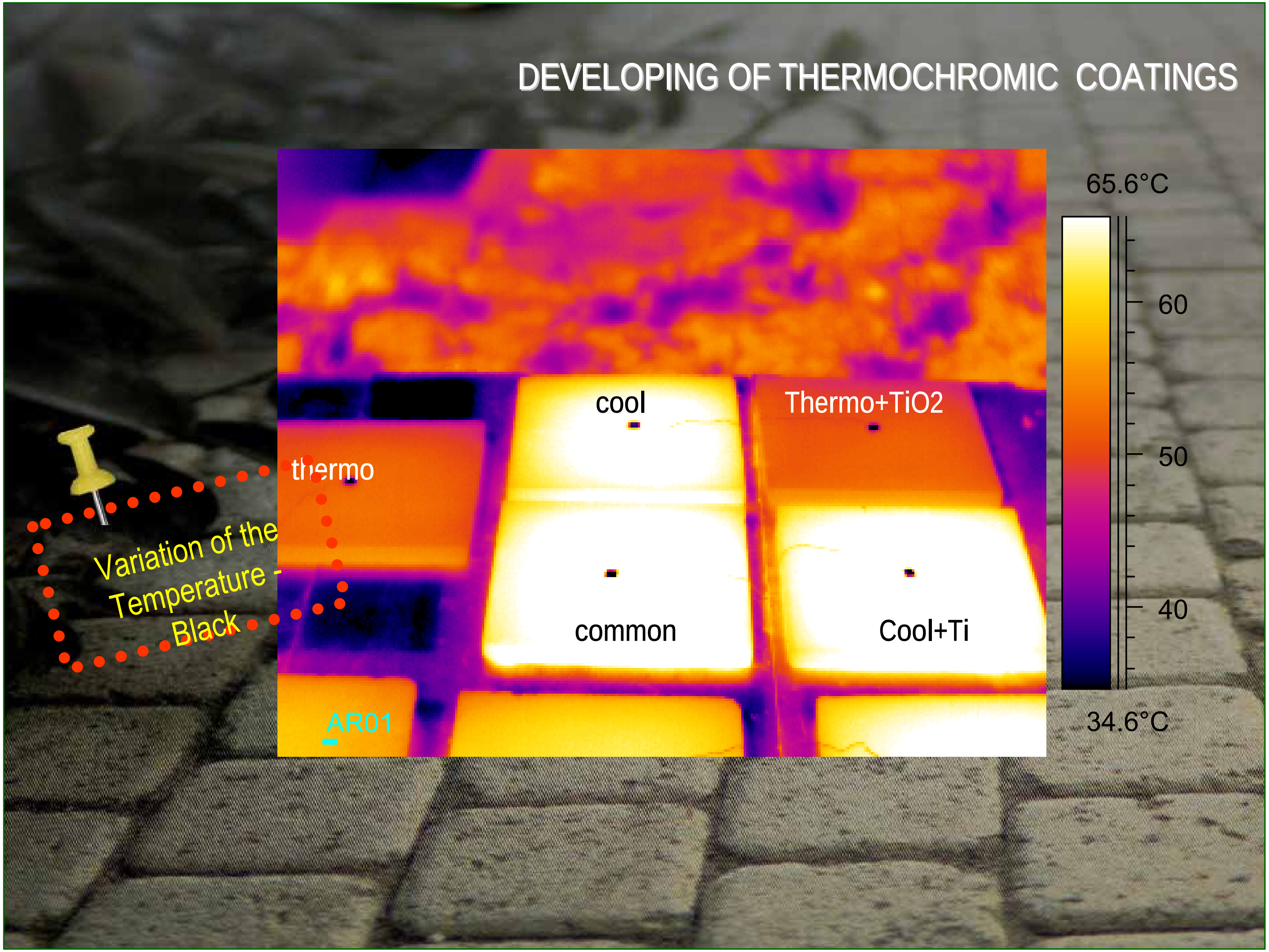


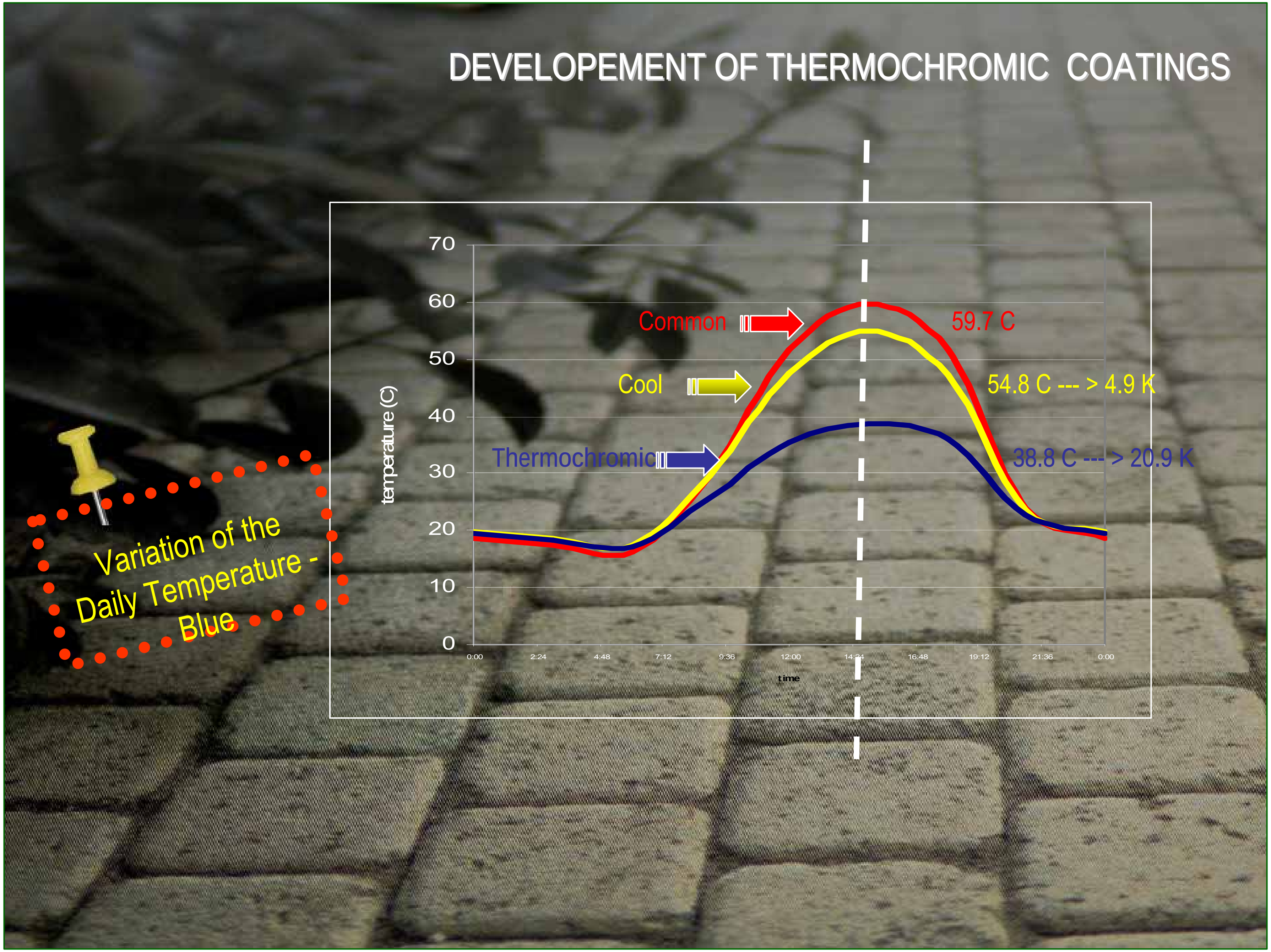
DEVELOPEMENT OF THERMOCHROMIC COATINGS



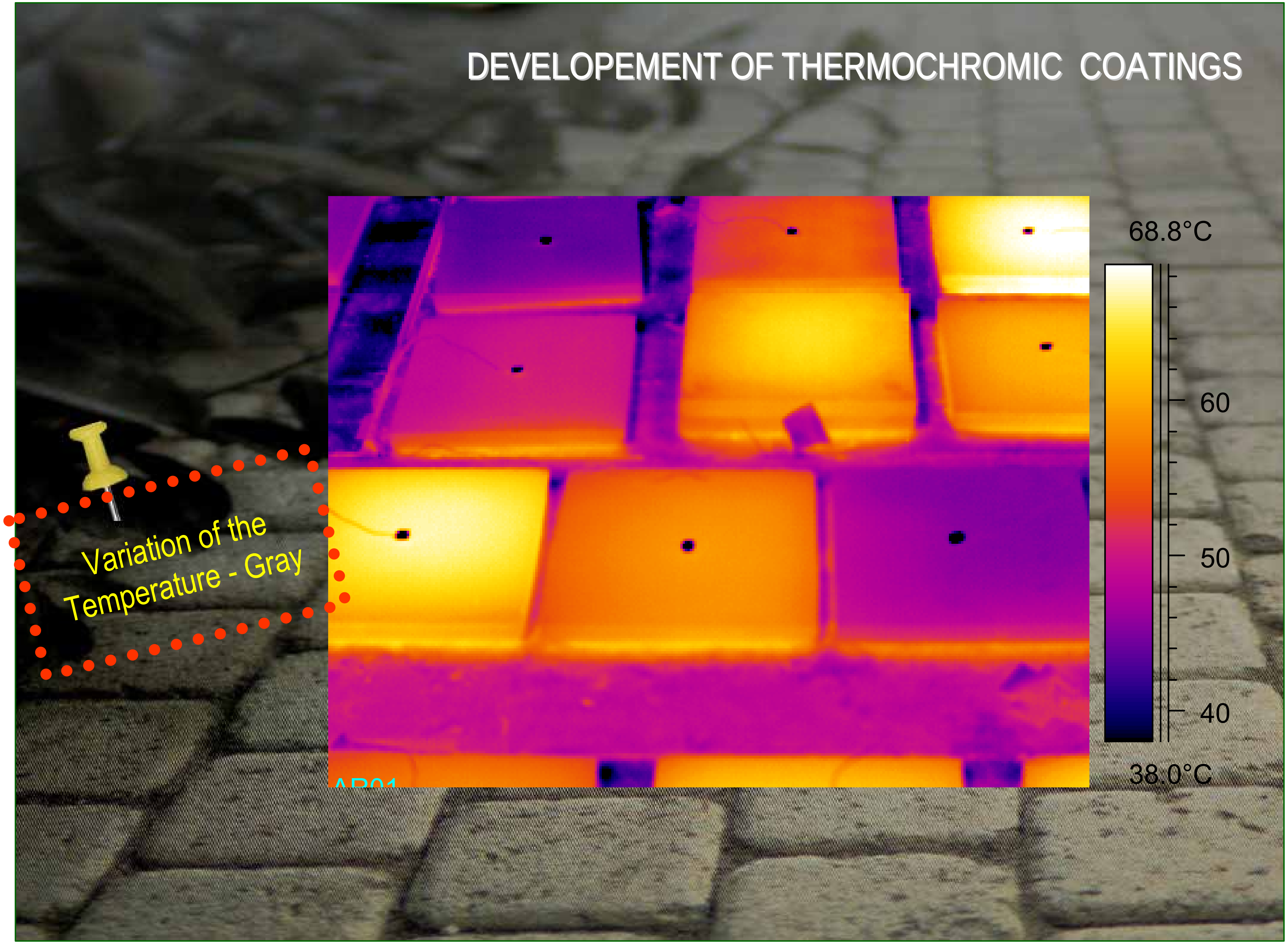
Thermochromic coatings change color as a function of the ambient temperature. For low outdoor temperatures, winter, the coatings may be dark presenting a high absorptivity. For higher ambient temperatures, summer, the coating becomes white presenting a high reflectivity. Thus, when applied on roofs or walls it may present the best performance all year round.


DEVELOPEMENT OF THERMOCHROMIC COATINGS
Variation of the Daily Temperature - Brown
Common
54.6 C
Cool
50.2 C --- > 4.4 K
Thermochromic
37.6 C --- > 17.6 K
temperature (C)
60
50
40
30
20
10
0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
19:12
21:36
0:00
time


DEVELOPING OF THERMOCHROMIC COATINGS
65.6°C
60
50
40
34.6°C
cool
Thermo+TiO2
thermo
common
Cool+Ti
AR01
Variation of the Temperature - Black



DEVELOPEMENT OF THERMOCHROMIC COATINGS
70
60
50
40
30
20
10
0
temperature (C)
0:00
2:24
4:48
7:12
9:36
12:00
16:48
19:12
21:36
0:00
time
Common
59.7 C
Cool
54.8 C --- > 4.9 K
Thermochromic
38.8 C --- > 20.9 K
Variation of the Daily Temperature - Blue


DEVELOPEMENT OF THERMOCHROMIC COATINGS
Variation of the Temperature - Gray
68.8°C
60
50
40
38.0°C

Anthropogenic Heat

Anthropogenic heat and in particular heat from cars contribute between 50 to 800 W/m2. The continuous increase of the number of cars in cities increases the heat added to the urban environment and contributes to higher temperatures. Anthropogenic heat increases urban temperatures up to 1-2 C. Sustainable transport and use of mass transportation can highly contribute to decrease heat release in cities

Solar Control of Open Spaces

Solar Control in open spaces using trees or artificial shading reduces exposure to solar radiation and improves comfort.

Solar Control

There is a very important development on solar control technologies.

However, simplicity is genius…

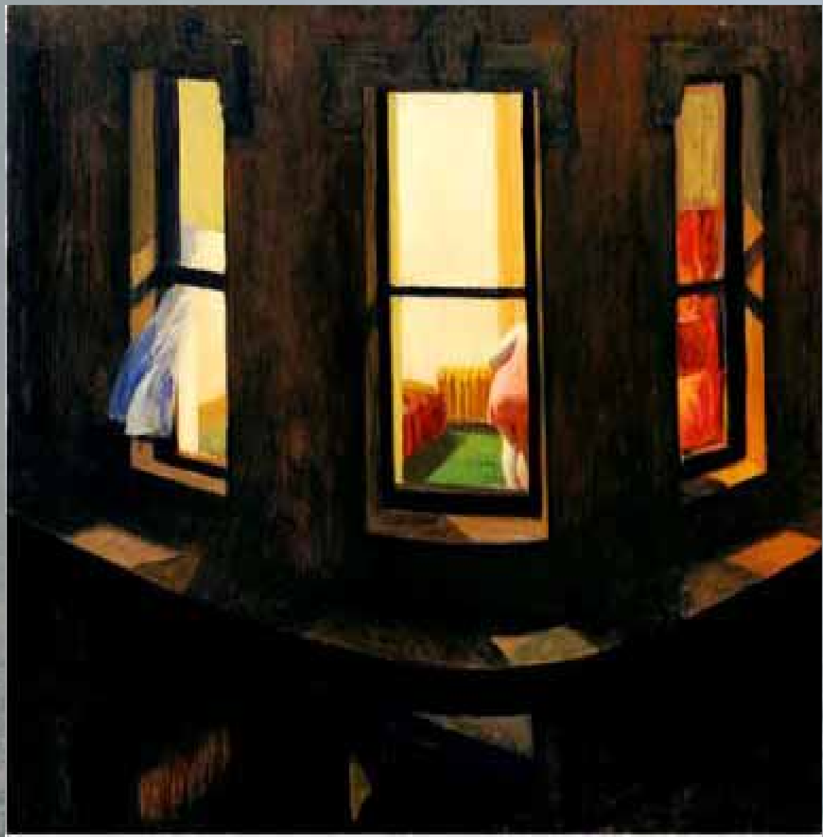
Integration of simple and efficient solar control components may improve thermal comfort and indoor comfort conditions.

In parallel, there is a tremendous progress of efficient glazing technologies and some of them, like low –e glazing, is available at low prices and can be used in low income housing without important increase of the cost.

Natural Ventilation helps to dissipate the excess heat of buildings to the ambient air, increase the indoor air speed improving comfort and reduce the concentration of indoor pollutants. Important developments concerning the integration of natural ventilation components in the urban environment as well as the use of night ventilation techniques have been achieved. New design tools are available while efficient industrial components are available in the market.

NaturalVentilation

Night ventilation technologies have been tremendously improved and can highly contribute to improve next days' comfort. Night ventilation can be the most effective cooling strategy for low income people. Experiments have shown that appropriate design of night ventilation techniques could decrease the next days' peak temperature up to 2 C and increase the comfort period by 60 %



Ceiling fans are among the most credible techniques to decrease energy for air conditioning and improve comfort. They can extend the summer comfort zone, i.e. improving the thermal comfort at higher temperatures (e.g. up to 29 °C). As such, they can have several substantial advantages :

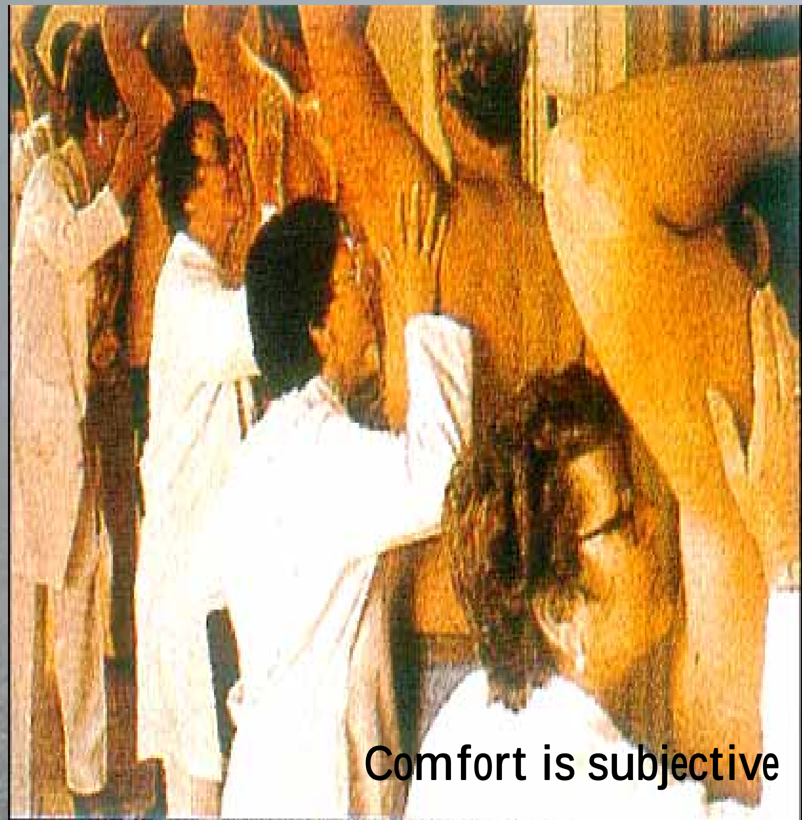
In non-A/C buildings, they can substantially extend the periods of acceptable thermal comfort conditions resulting in better thermal comfort and improved productivity;

in A/C buildings, they can reduce the use of air conditioning by setting the room thermostat at a higher temperature.

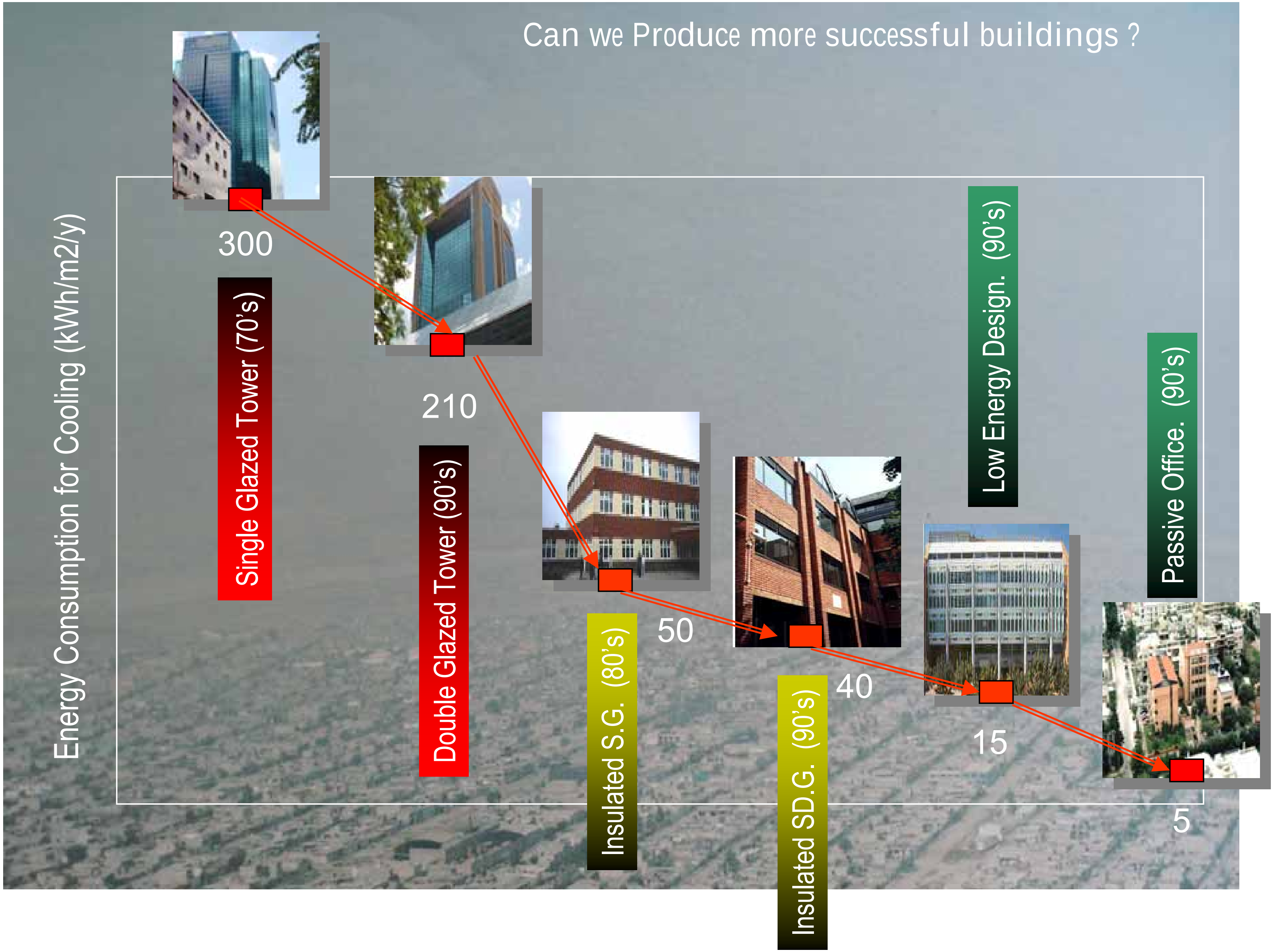
Comfort

New Adaptive Thermal Comfort Standards may highly contribute to decrease the energy consumption of buildings.

However, for low income population the idea is not to maintain temperatures within the ASHRAE defined temperature zone but to use the presented technologies to improve survivability of citizens and protect their lives under adverse ambient conditions



Comfort is subjective


Can we Produce more successful buildings ?
Energy Consumption for Cooling (kWh/m2/y)
300
Single Glazed Tower (70's)
210
Double Glazed Tower (90's)
50
Insulated S.G. (80's)
40
Insulated SD.G. (90's)
15
Low Energy Design. (90's)
5
Passive Office. (90's)

Some Conclusions

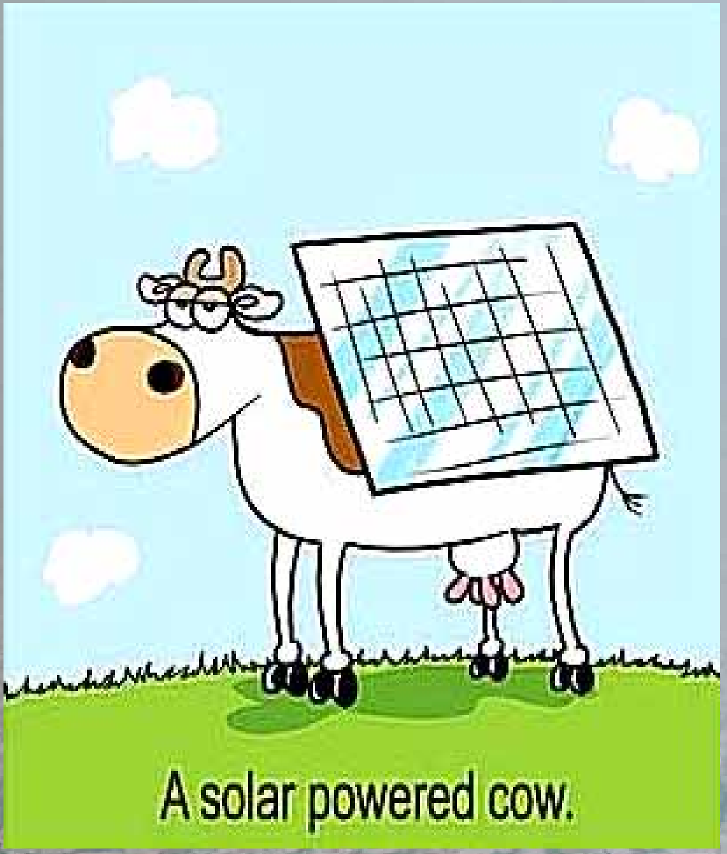
Humanity shows trapped in in a reality that is characterized by a permanent temperature increase.
This fact dramatically rises the percentage of vulnerable population influenced directly by the temperature increase.
Unfortunately the first victim of climatic change is the low income population that is unable use additional energy and advanced technology to compensate increased temperatures and achieve thermal comfort.

Sustainability and/or Survivability ?

Alternative movements put a lot of emphasis on sustainability issues and on the use of alternative energy technologies. This is an excellent option for most of the world and especially for those who can pay for it.

However, Persistence on the use of some quite expensive alternative technologies, ignoring the real needs of low income population, is a very elitistic policy. Installing PV's everywhere is not panacea.

There is a real need for appropriate technologies improving the survivability of vulnerable population.



Buildings have to be adapted to the local climate and should respond to the extreme weather conditions.

Passive cooling techniques have achieved a high maturity. Given the low cost they present can really contribute highly to improve the quality of life of vulnerable population and increase survivability.

Most of the new passive cooling techniques are available in the market and their use has to be promoted....

MORE REALISTIC GUIDELINES FOR REBUILDING IN NEW ORLEANS

Some Conclusions

Please finance research to improve survivability of vulnerable population in the Mediterranean