Case study
Cool Roof Energy Savings

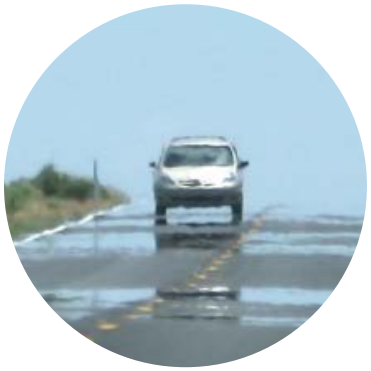
BLUESCOPE

Study finds
cool roof energy savings significantly underestimated

Colorbond® Coolmax®

Case study
Cool Roof Energy Savings

A Stockland and BlueScope study has found that the effectiveness of cool roofing to reduce a building's cooling load can be up to two to four times greater* than that estimated using traditional energy modelling methods due to unaccounted above-roof micro-climate heating effects for large roof areas.



BlueScope building science innovation specialist, Mr Jamie Adams, compared the micro-climate above a roof to the phenomenon of urban heat islands, where dark and dense building materials absorb more heat than lighter-coloured natural surfaces, such as fields and forests.

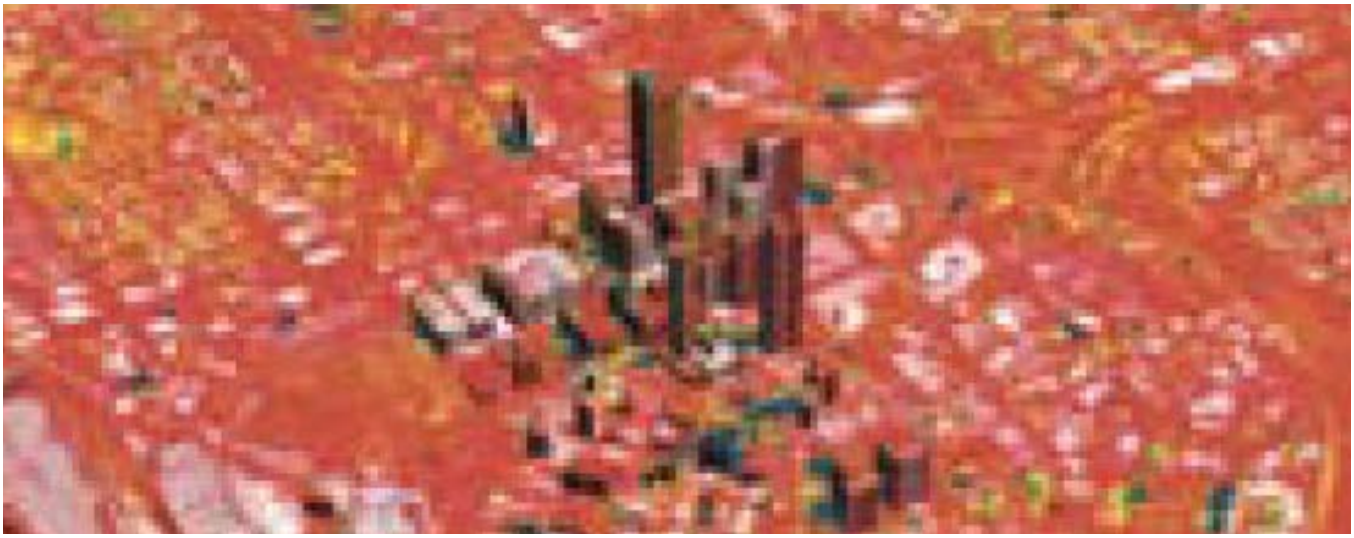
"In hot weather the air layer above roofs is subject to greater convective warming, creating a micro-climate," said Mr Adams. "It's much like the tarmac of a dark, hot road, where a blanket of heated air shimmers above the surface.

"A cool roof effectively reduces the amount of hot air above it on a hot sunny day by using materials that have high Solar Reflectance. This minimises heat absorption by the surface. Cool roofs also have high Thermal Emittance to maximise the roof's ability to shed away the heat that it does absorb."

He said that although cool roofs reduce the micro-climate heating effect, this is very rarely factored into energy modelling. "The problem at present is that energy savings provided by a cool roof aren't accurately recognised – especially on larger roofs – because energy simulation software packages commonly used by ecologically sustainable development (ESD) professionals don't factor in the heating effects of the air in the micro-climate above the roof.

"Current energy modelling tools tend to only assess simple first-order effects, which assume the roof and any plant equipment is immersed

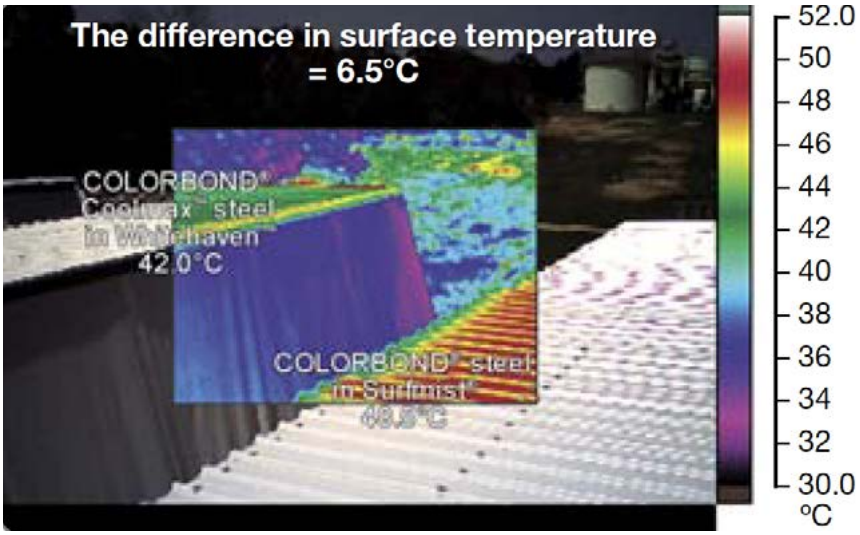
"A cool roof effectively reduces the amount of hot air above it on a hot sunny day by using materials that have high Solar Reflectance"



in ambient air that is unbiased by any localised heating effects. However we know there are second-order compounding effects such as the convective warming of the ambient air in the micro-climate above the roof which can have a significant impact on the energy model. This warming can impact ventilation air-conditioning loads."

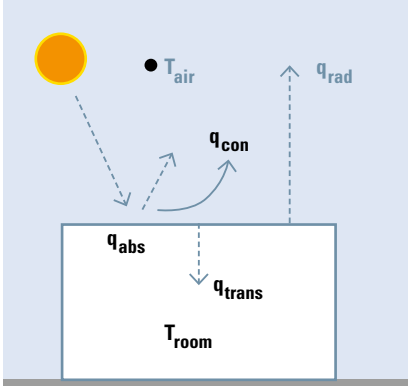
Mr Adams said the degree of unaccounted savings a cool roof can provide varies depending on roof size and other situational factors. "For a small roof, the likelihood of the roof surface significantly heating the air is small, and the normal first order assumptions are reasonably valid. However, it is now known that on larger scale roofing, the local air temperatures above the roof do increase and become like a heat 'bubble', creating the roof's own micro-climate which compounds heating effects and can increase HVAC energy consumption. It is here that we have an opportunity to save both capital and operational costs (as well as energy generation emissions) through more energy-efficient designs using cool roofing."

Aware of the impact a highly solar-reflective, cool roofing material can have on reducing the urban heat island effect, BlueScope developed COLORBOND® Coolmax® steel in the colour Whitehaven™. "Coolmax® is essentially a super solar-reflective, high thermal-emittance, thick-film tailored pre-painted steel," explained Mr Adams. "It has the highest solar reflective performance in our COLORBOND® steel range."



1st order effects

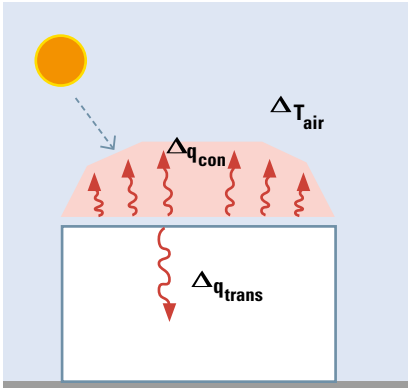
Unbiased ambient air



Reasonable for small roofs with no mecahnical equipment on roof

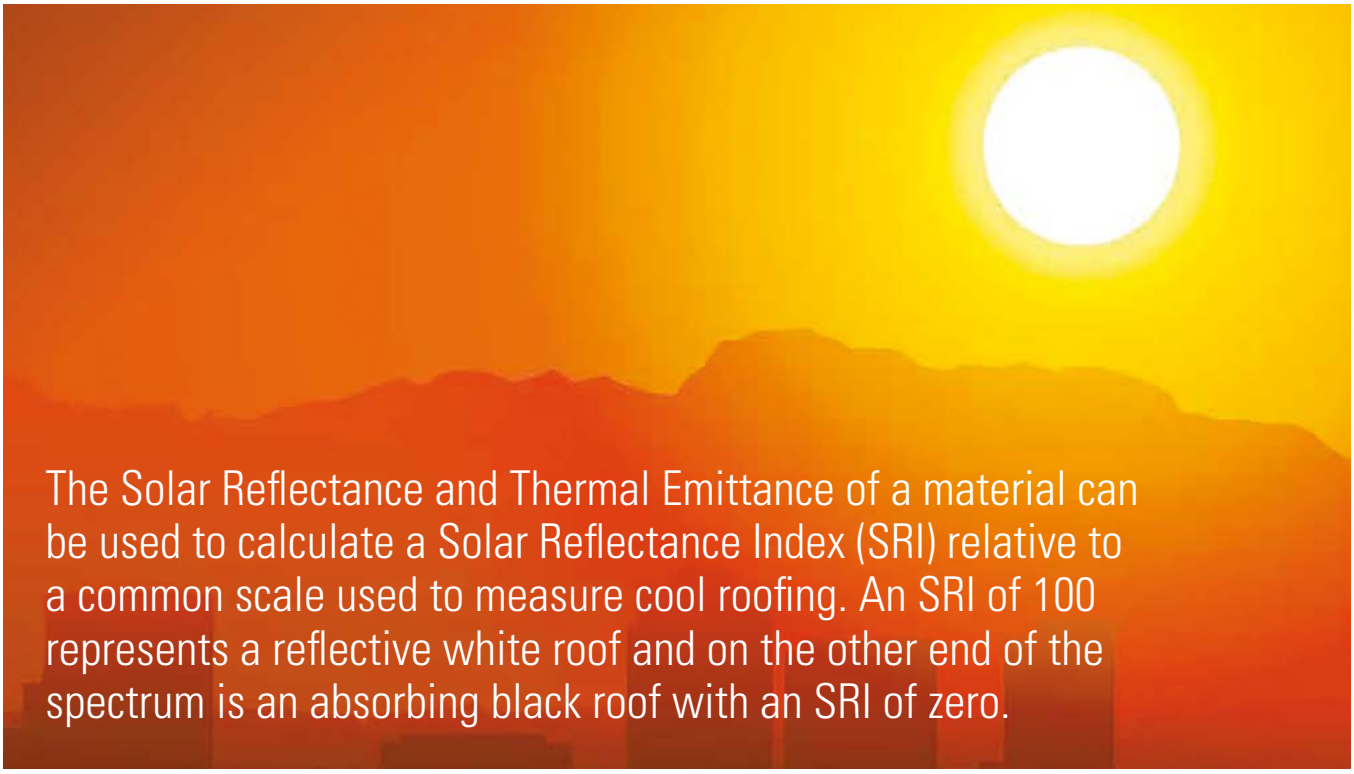
2nd order effects

Local warming of ambient air
- additional roof loads
- warmer ventilation air
- condensing temparatures higher, cooling efficiency lower



2nd order effects become particurlarly important for large roofs

Case study
COLORBOND Coolmax® steel and Green Star



Aside from the clear energy benefits that are now understood, BlueScope sustainability manager, Mr Ross Davies, pointed out that COLORBOND® Coolmax® steel can also contribute to Green Star projects due toits contribution to Urban Heat Island Effect management.

"The Green Star Heat Island Effect credit requirements for roofing materials specify an initial (new) SRI of greater than 78. COLORBOND® Coolmax® steel has an initial SRI of 95. This is not only indicative of its high solar reflective performance but also can provide an effective and easy way to qualify for a Green Star point."

Solar Reflective Index (SRI)

100	90-70	60-40	30-10	0
Ultra White	white	Medium	Dark	Jet Black

Colorbond®

	SRI
Whitehaven®	95
Surfmist®	82
Classic Cream™	82

The COLORBOND® steel colours shown all meet the GreenStar® tool UHI credit requirements for roofing material with a Solar Reflectance Index greater than 78.

Case study
Stockland Hervey Bay Shopping Centre

To determine just how much the inclusion of micro-climate effects in energy modelling can impact cool roof energy savings, BlueScope and Stockland initiated a study using a Stockland shopping centre's 15,000 square-metre roof as the test bed.

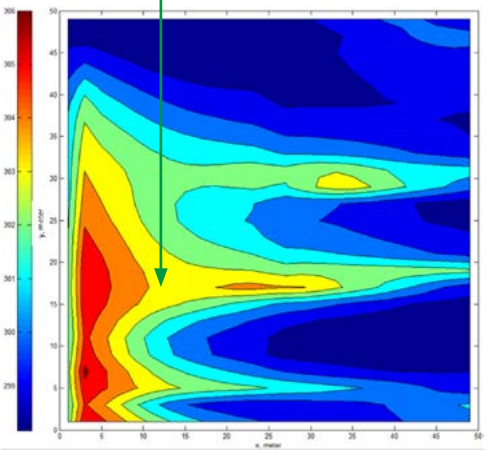
The shopping centre roof at Hervey Bay on Queensland's Sunshine Coast was previously made from unpainted ZINCALUME® steel. The study compared the thermal performance of that material with COLORBOND® Coolmax® steel in the colour Whitehaven™.

Stockland national environmental sustainability manager, Greg Johnson, said the company is actively seeking ways to make its assets such as shopping centres more resilient. "We do a lot of climate adaption and resilience work for our assets, particularly in regions that our future climate change scenarios indicate will experience an increase in extreme heat days," Mr Johnson said. "We seek ways to make our assets more resilient by minimising heat gain through the building envelope, to maintain indoor comfort and reduce energy demand.

"We saw the adoption of cool roof technology as a key way of doing this. In line with our ongoing commitment to sustainable design we decided to explore the practical benefits of BlueScope's COLORBOND® Coolmax® steel as part of our Hervey Bay shopping centre redevelopment, with a view to assessing whether it could help us reduce up-front capital costs associated with air-conditioning equipment and to reduce energy consumption over the building's life cycle. From the study, we aimed to gain a quantitative understanding of the energy savings and other benefits we could expect when considering second-order effects."

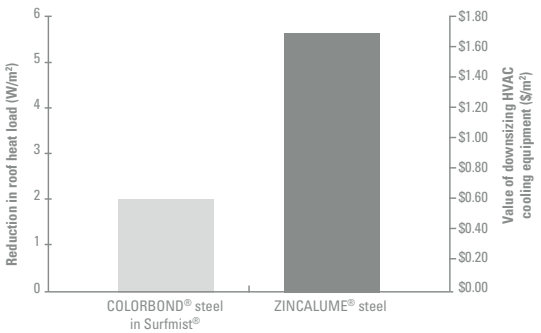
Stockland and BlueScope engaged a series of consultants including Lendlease sustainable design manager and member of The Australian Institute of Refrigeration Air Conditioning and Heating (AIRAH), Mr Graham Carter. Mr Carter, who along with University of Wollongong Sustainable

A 4.7ºC warming (bias) of air temperatures above the roof for a low wind high heat load condition



"From the study, we aimed to gain a quantitative understanding of the energy savings and other benefits we could expect when considering second-order effects"

Potential HVAC Cooling Equipment Savings



PotentialHVAC Cooling Equipment Savings by specifying COLORBOND® Coolmax® steel over other roofing materials (On basis of theoretical heat flow through for R3.2 roof on hot day, 1 = 1000 W/m2, Tout = 34C, wind = 0.5m/s, Cooling equipment valued at $300/kW).

Building Research Centre lecturer, Mr Buyung Kosasih, had previously identified major shortfalls in present thermal energy assessment methods in a technical paper called Not So Cool Roofs.

In it, the duo also contends that the effect of micro-climate created by a heat-absorbing roof is ignored by the vast majority of cooling load calculation and energy simulation tools and that this omission is a key factor in underestimating cool roof energy savings.

They observe that cool roof energy savings in operational buildings has been much higher than forecast using common energy simulation tools. "With five to 25 per cent of total annual cooling load not accounted for in first-order techniques, our tools need to evolve to represent conventional and cool roofs more accurately," they said. "The implications of not accounting for the roof micro-climate above larger roofs are significant, and should be addressed within our industry."

Mr Carter's experience was called on to model the second-order effects of the micro-climate above the Stockland Hervey Bay shopping centre's different roof types.

This was done along with EMF Griffiths simulating first-order effects using conventional energy simulation tools for each roof type that did not bias local above-roof air temperatures.

The University of Wollongong then conducted parametric 3D Computational Fluid Dynamics (CFD) analysis to characterise the roof micro-climate as a function of the convected heat from each roof surface.

BlueScope's Jamie Adams said the study results were fed into an air-stream model package to determine the results. "The energy savings of specifying COLORBOND® Coolmax® steel over ZINCALUME® steel predicted from conventional energy simulation using only first-order effects were less than five per cent However, with the second-order effects understood and added to the modelling, the savings were predicted to be closer to ten per cent.

"The amount of potential unaccounted savings for these building types varies depending on roof size, climate, insulation level and roof-top plant location but the upshot is that the for large roofs, our study showed that traditional building simulation model under-predicts the energy savings derived from cool roofing by a factor of two to four."

Mr Adams encouraged ESD consultants and the industry professionals who engage them to investigate second-order effects when simulating cool roof energy savings. Mr Adams also acknowledges that this can be challenging when current tools need to be updated; in the meantime consideration should be given to adjusting first order savings by a multiplier to account for second order benefits. "Doing so will help ensure that the ability of cool roofs to minimise heat gain, maintain indoor comfort and reduce energy demands is not undervalued, and more energy-efficient outcomes can be achieved."

Project details

Project: Stockland Hervey Bay shopping centre
Location: Hervey Bay, Queensland
Principal steel products:
Roof: COLORBOND® Coolmax® steel in the colour Whitehaven™
Architect: ??? ????
Builder: ?????
Engineer: Lendlease ???
Client: Stockland

For more detailed findings from the Stockland Hervey Bay shopping centre study or to further discuss the impact of second-order effects on energy modelling, please contact

steel.com.au/colorbond
To learn more about COLORBOND® steel

1800 022 999
For more information

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