

Radiative Cooling in Temperate Climate

A case study into the science and performance of SkyCool, a spectrally selective radiative cool roof coating, in a temperate climate.

Using mechanical air-conditioning to achieve a safe and comfortable internal temperatures within large open-span industrial facilities is a costly exercise to install, operate and maintain.

Mechanical cooling systems (Heating Ventilation & Air Conditioning) can make up to 60% of the operating electricity demand for many buildings in warm climate zones.

This paper evaluates a more advanced cool-roof technology that requires zero energy to achieve sub ambient internal temperatures within any sized building even during the peak of summer.

To sustainably cool buildings efficiently we longer require large demand for grid-supplied power or locally generated power via renewables to power HVAC equipment.

Today it is possible to eliminate the need for mechanical cooling and keeping internal temperatures at safe, comfortable levels.

CASE STUDY

The Albany Tennis Centre, just north of Auckland, has employed such technology in their installation of the “SkyCool” coating to cool their 5,000m² indoor tennis arena. Mechanical cooling was priced prohibitively and deemed potentially ineffective as the large ground level doors would permit the cooled air to be largely lost out to the surrounding environment.



During tournaments the players comfort level was insufficient to enable them to perform at the best of their ability.



It's well known that a metal surface when exposed to direct solar radiation will reach temperatures approximately twice that of the shade ambient temperature. Much of this heat load is then conducted through to the interior of the building heating it to well above the external ambient temperature.

This solar heat load makes up approximately 75% of the total heat load with the remaining 25% consisting of fresh air ventilation, thermal conductivity of walls and windows and internal heat loads.

It makes sense to combat the largest heat load right at its source. If this 75% can be reduced, or as in the tennis centre's case, eliminated then the remaining 25% has a much reduced impact within the building.

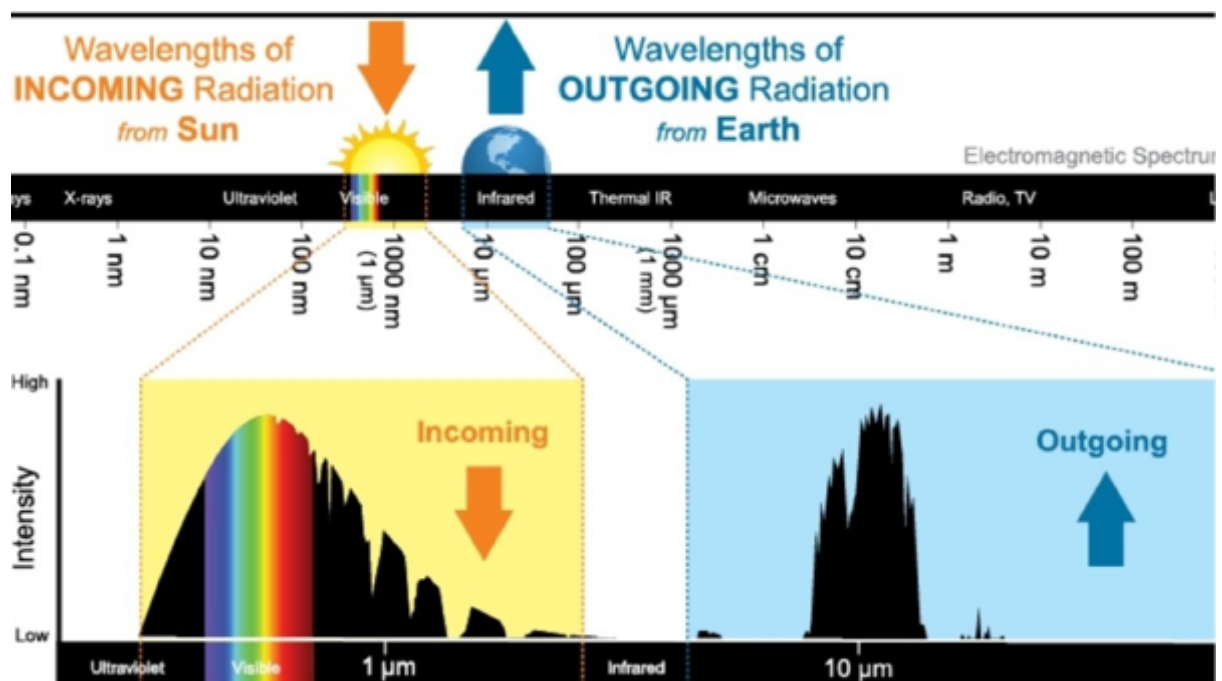
The Science.

A unique application of the technology is employed in the “SkyCool” cool-roof coating to remove the solar heat load.

SkyCool, is applied to the upper surface of the steel. This unique material reflects over 90% of the incoming solar radiation. To render the surface safe for anyone accessing or overlooking it from taller offices, it absorbs all of the harmful ultraviolet radiation.

SkyCool has the additional unique ability to radiate its absorbed energy from within the building at the outgoing “atmosphere to space window”, as seen below in the blue section of the chart. Energy radiated at this frequency is not affected by the atmosphere unlike all other exposed surfaces on earth. SkyCool tunes its out-going infrared radiation through the 8-13 micron bandwidth which allows thermal energy to leave our planet. This is the frequency that regulates our climate, acting like the heat window in the top of a greenhouse. SkyCool exploits this natural aspect of earth cooling mechanism.

In the diagram below the spectral emittance is shown as blue areas. The black region within that region is the 8-13micron frequency window. This is the frequency window that SkyCool exploits to provide its remarkable cooling. When this is combined with the highly infrared-reflective surface a powerful cooling coating is created – which operates day and night under clear skies.

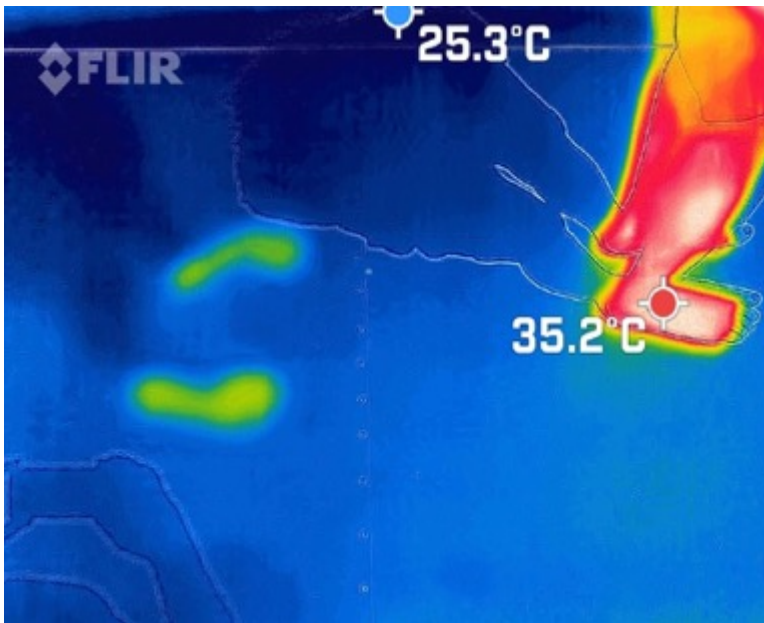


THE ATMOSPHERIC WINDOW

Effect in the built environment.

When the entire upper surface of a metal roof is coated with SkyCool, the temperature of the roof remains below the prevailing ambient shade temperature day and night by around 5°C. This also stabilises the internal airspace to maintain a more constant temperature with minimal fluctuations usually of only several degrees.

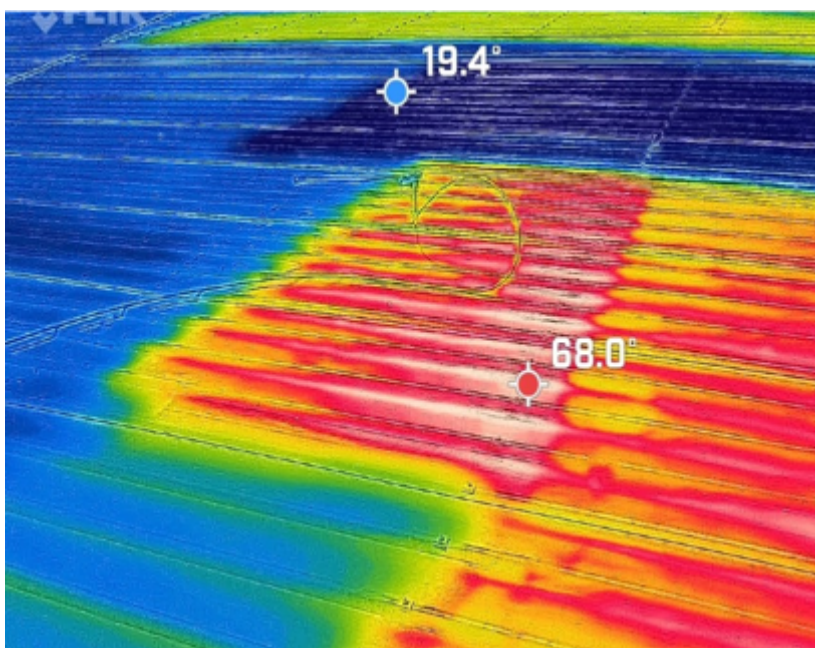
The cooling effect is illustrated in the following images where warm footprints can be seen contrasting with the cool SkyCool surface on a 31°C day.



Ideally, this degree of cooling is what large facilities seek to achieve using HVAC.

However, this sustainable approach does not require any form of energy input, regular maintenance or plant acquisition.

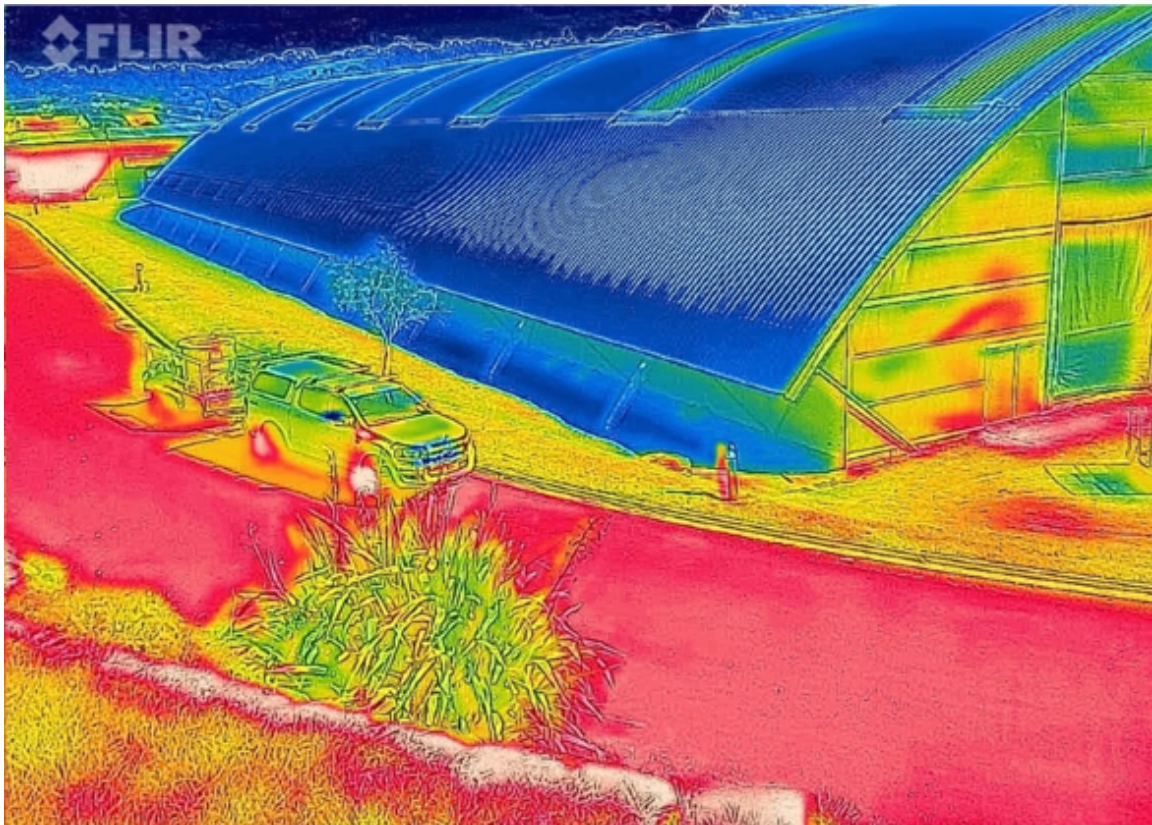
The cooling effects are immediate.



This images was taken during application on a day where the ambient shade temperature was around 32°C.

The uncoated roof is up to 68°C, while the coated region has dropped nearly 41°C down to 19.4°C.

The completed project for the Albany Tennis Centre



SKYCOOL PASSIVE COOLING TECHNOLOGY



SkyCool Provides a cool comfortable internal temperature to any large span metal roofed building, in any warm to hot climate zone whether it be for enjoyment as demonstrated here or production purposes and/or sensitive goods storage.

In facilities where stock storage is close to the roof there will be approximately 1°C of difference from ground to roof level, as shown below. The hot regions of this roof are the skylights at 26°C.

As the ideal free to operate cooling technology, SkyCool comes with a 10 year performance guarantee.

