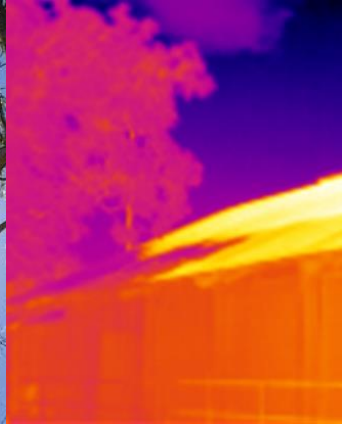
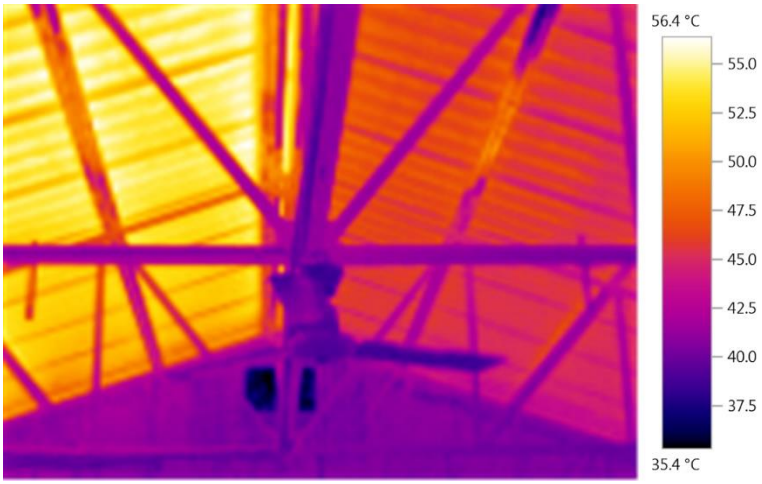
Managing hot roofs with aluminium foil

Findings from the study: Comfort and electricity use in remote Australian buildings



How hot can a roof be?

When you stand in the sun the heat can be intense. This heat is an invisible part of the light that comes from the sun, and it's called infrared radiation. Many objects radiate a lot of heat when they are at high temperatures, including hot steel roofs. For example, in the midday sun a 40 x 10 metre corrugated steel roof over a large studio or workplace can radiate as much heat as 30 electrical radiator heaters. The figure below is an infrared picture of heat being radiated from a roof into a building.



There are several ways to manage this heat:

- Paint the roof white
- If you have a ceiling, put insulation on top of the ceiling
- Fit air vents
- Line the roof with low emissivity foil
- Provide shade from trees.

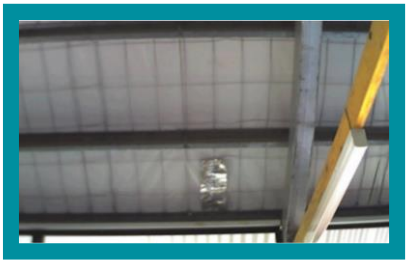
What can be done about it?

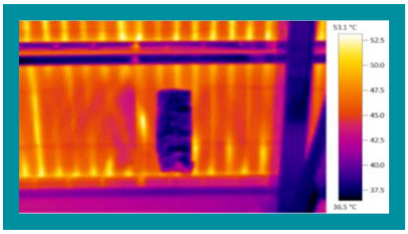
Paint the roof white: Painting the roof white can reflect a lot of radiated heat and reduce roof temperatures by 10–12°C in tropical climates. However, white painted roofs need cleaning and repainting to continue being effective.

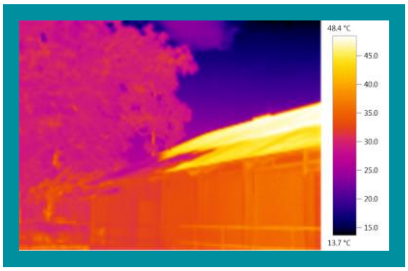
Insulating the ceiling: Insulation can help keep the cool air inside a building and prevent heat from entering. For example, insulation on top of a ceiling can save up to 40% of the electricity used by the air conditioner. This could save hundreds to thousands of dollars a year, depending on the size of the building.

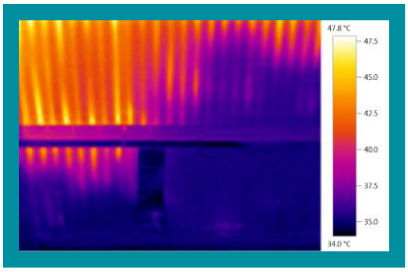
There are three ways that insulation keeps the heat out of your house:

- It can stop heat from getting into the building through uninsulated walls and ceilings. Insulation can do this because it contains billions of tiny pockets of air, and heat can't easily pass through small air pockets.
- Large volumes of air move around a building, carrying heat. This is called convection, and insulation provides a barrier to convection because air cannot easily pass through insulation.
- Heat can move through a house by radiation, for example, when the sun heats up a roof to a high temperature the roof radiates that heat into the building like an electrical radiator heater. Because insulation keeps the ceiling cool it can reduce this radiated infrared heat.









From top down:

Studio roof in visible light. A white polymer sarking sheet is suspended underneath the roof

Infrared image of the same roof; the dark rectangle is an aluminium foil that provides a region of low thermal emissivity.

The roof outside the building is partially shaded by a tree. The infrared image shows both absorbed and reflected radiation.

Infrared view of the steel roof from inside the building showing the tree shadow and the drop in roof temperature on the shaded area of about 10°C, or reduced radiation of ~180 watts/m²

Fitting air vents: If you don't have a ceiling, you can stop heat from coming in through the roof on air currents by putting vents in the roof and around the walls. When fitting vents, it is important to consider if they are large enough to leak cool air away from the air conditioned building. If so, they will need to be closed automatically or manually when the air conditioner is running. This saves energy as well as avoiding condensation and high humidity in the building.

Fitting low emissivity foil (aluminium reflective insulation): A lot of heat can be radiated into a building from the roof. This radiant heat can be stopped by fitting reflective foil insulation under the roof. It works best when there is a small air gap between the roof and the foil. Face the shiny side of the foil downwards to the floor. This foil might get quite warm, but it won't radiate much heat into the building.

Warning

You should never use foil insulation on the ceiling as that can be an electric shock hazard if it accidently touches wiring. The foil is ineffective on the ceiling anyway.

FOR MORE INFORMATION ABOUT THIS RESEARCH, CONTACT:

Dr Peter Osman

P: +(61) 2 9490 5526 M: +(61) 411 440 339

E: peter.osman@csiro.au

Visit: http://crc-rep.com/research/regional-economies/climate-change-adaptation-and-energy-futures

This pamphlet is one of a set of four that aims to reduce electricity bills and improve thermal comfort in community and enterprise buildings in remote regions of Australia. The findings are based on applying CSIRO's knowledge base and research capacity in designing thermally efficient buildings to address enterprise needs in the hot arid and hot humid climate zones of remote Australia. CSIRO partnered with Charles Darwin University and the University of South Australia as part of the Cooperative Research Centre for Remote Economic Participation to conduct a research project in which the physical properties of eight community buildings (art centres) were studied to provide a realistic assessment of where design improvements could be made and operating practices enhanced. It was clear from the study that managers were already very careful in their use of electricity. However, we found substantial technical changes could be made in the building design and appliance selection and operation that could lead to substantial reductions in cost and improvements in thermal comfort. This pamphlet focuses on ways to reduce roof temperatures and by doing this reduce the load on air conditioners and/or maintain reduced temperatures in the working environment. The recommendations should be of particular interest to architects, builders and building managers. The full report of the research can be found at Osman P, Havas L, Ambrose M and Clark G. 2017. *Comfort and electricity use in remote Australian buildings*. CRC-REP Research Report CR018. Ninti One Limited. Alice Springs. http://www.crc-rep.com.au/resource/CR018_ComfortElectricityUseRemoteAustralianBuildings.pdf.