Using fan-forced ventilation to cool buildings in northern Australia

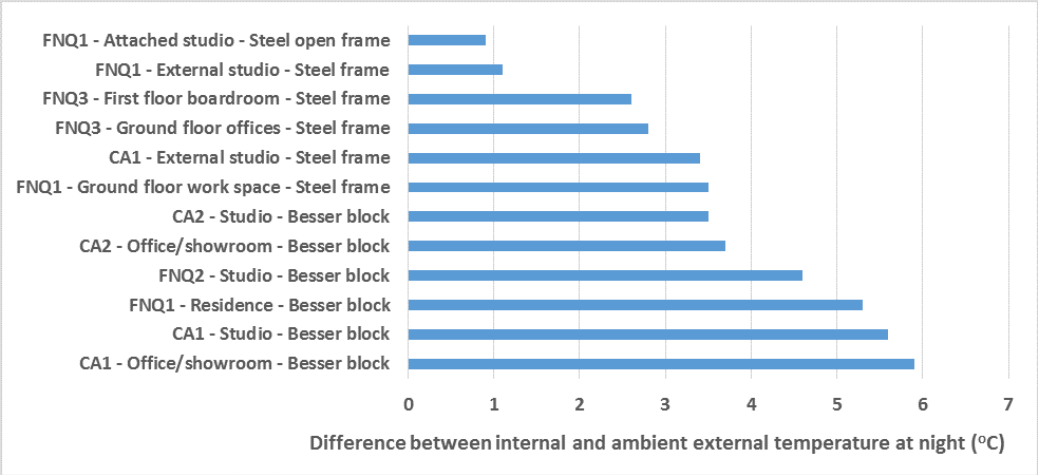
Findings from the study: Comfort and electricity use in remote Australian buildings

Building ventilation

Fan-forced ventilation is widely used to cool buildings in Central Australia and Far North Queensland by flushing air from a building and replacing it with cooler fresh air from outside. This information sheet describes how to cool buildings using forced ventilation alone or as a supplement to air conditioning. It refers only to ventilation used for cooling.

Ventilation in high thermal mass buildings

High thermal mass buildings are typically built with concrete blocks or bricks, which can store large quantities of heating or cooling energy. The stored heat is not always desirable; the building may become excessively warm from waste heat generated by appliances such as ovens or computers, from the body heat of people working in the building and from unshaded concrete and bricks collecting heat from the sun. Air conditioners may not be able to remove all the heat stored during a day; over summer, building temperatures can get progressively warmer. If this is the case, it could be worth flushing out some of this unwanted heat using the cool night air to cool the building ready for the next day. The figure shows just how much cooling might be achieved for high thermal mass buildings made of concrete or bricks if the inside temperature can be brought back to be the same as the temperature outside.



Ventilation in low thermal mass buildings

Low thermal mass buildings are typically built using panels supported by a steel or wood frame. The figure above shows that these buildings cool down quickly at night without much need for night-time ventilation. However, if there is no air conditioning, then ventilation may be essential during the day with the intake air coming from an area that is well shaded and with vegetation that can cool the outside air naturally.

During winter, spring and autumn, ventilation may be sufficient to maintain a comfortable temperature in the building, but this is less likely in summer when air conditioning might be essential. For a building that is to be used all year, a combination of ventilation and air conditioning is worth considering. If rooms in a building have facilities for both cooling ventilation and air conditioning, then it is important to ensure that the cooling ventilation is shut when the air conditioner is running.

Controlling the ventilation

A fan ventilation cooling system should have a differential temperature control, that is, one that measures the difference between temperatures inside and outside the building, so that the cooling fan and vents only operate when the temperature outside is preferred to the temperature inside. For example, in summer the temperature outside may be cooler than inside particularly at night between midnight and 7 am, and cooling ventilation may then help to reduce the building temperature. A timer or automatic switch should also be used to ensure that the cooling ventilation fan is off and vents closed if an air conditioner is running.

If the cooling ventilation is also being used to introduce fresh air to the building, the controller should ensure that there is sufficient ventilation for adequate fresh air to circulate.

Night-time cooling ventilation is most often used in temperate and dry climates. Excessive humidity may mean that using fan ventilators for cooling at night is not appropriate in tropical and subtropical humid climates because of the risk of condensation and mildew unless the ventilation is adequately controlled to manage humidity.

If a ventilation system is used in humid climates, care should be taken to limit the relative humidity so that there is no condensation inside the building that may cause mildew. For example, a humidistat might be set up to close some of the vents, shut down the ventilation fan and switch on the air conditioner if necessary. This is particularly important in tropical climates and where humidity sensitive equipment or artworks are stored. Under these circumstances, the potential for excessive humidity may mean that using fan ventilators for cooling at night is not appropriate.

Points to consider

1. Ventilation is usually cheaper to run than air conditioning. A building can be ventilated using a motorised fan (forced ventilation), or it can use natural ventilation (breezes and air flows) that use the tendency for hot air to rise so it can be removed through vents.
2. Some buildings may not be suitable for natural ventilation. For example, buildings that are close together and screened from natural breezeways might rely entirely on air conditioning. Fan ventilation at night when the air conditioners are shut down could help keep such buildings cool.
3. It isn't possible to use ventilation to cool a building below the outside air temperature so it's desirable to draw the intake air from well-shaded areas.
4. Well-selected vegetation can provide two kinds of cooling for the air outside a building: i) shading to stop concrete and brick surfaces heating up, and ii) evaporative cooling as foliage takes water from the ground and evaporates it from its leaves.
5. Night-time cooling ventilation is generally used in dry or temperate climates. It is less suitable for tropical climates where humidity may cause condensation and mildew.

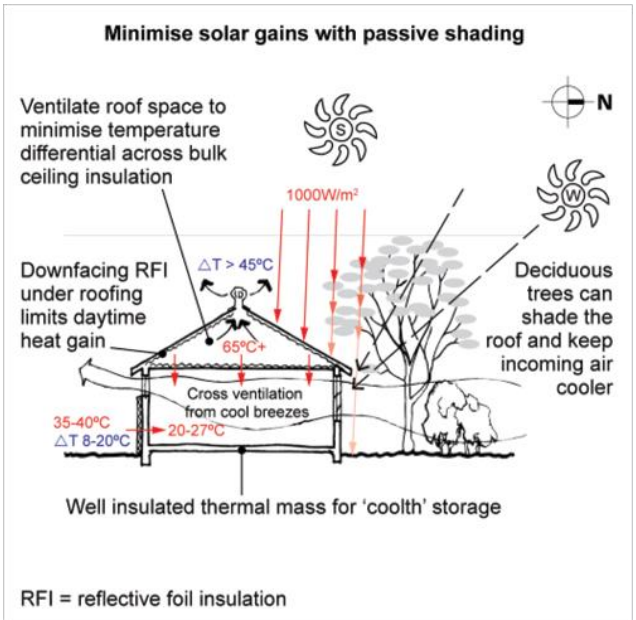


Image from http://www.yourhome.gov.au/passive-design/passive-cooling

Reardon C and Clarke D. 2013. Commonwealth of Australia (Department of the Environment and Energy).

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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 use fan ventilation to 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.