Natural Ventilation

Providing fresh air and passive cooling to increase occupant comfort, health and well-being while reducing energy demand

What's included in this fact sheet:

This fact sheet will assist you in understanding the importance of natural ventilation and how to make the right design decisions to optimise opportunities for natural ventilation. It provides tangible examples of the most common design features and demonstrates how these can increase or reduce natural ventilation in a space.

Why is designing for effective natural ventilation so important?

Natural ventilation is the movement of a sufficient volume of fresh air through a dwelling, room, or building to replace indoor air. It is best achieved by having window openings across multiple aspects, or with windows located in different areas, to allow for effective natural ventilation.

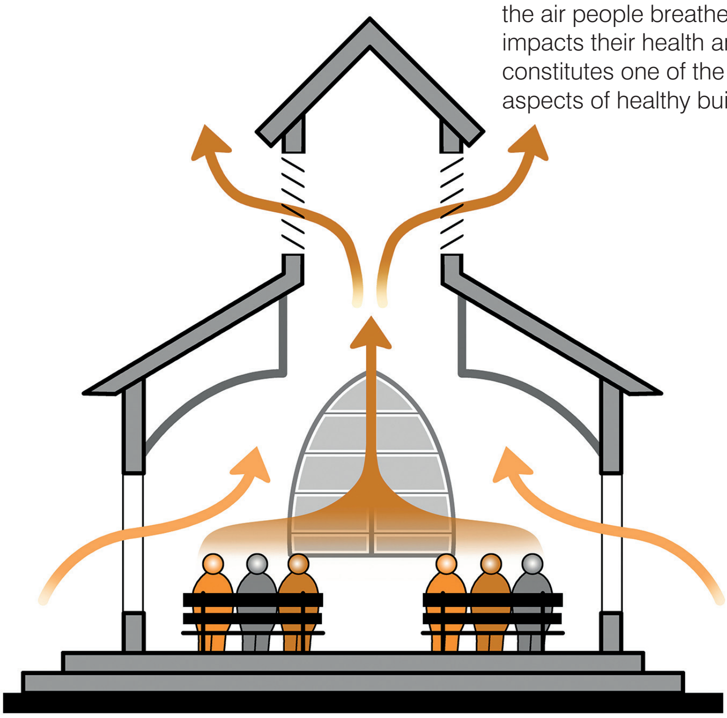
Good indoor air-quality is essential for healthy and comfortable living and working environments. Poor indoor air-quality is a significan contributor to poor health and fatigue. The quality of the air people breathe indoors directly impacts their health and well-being and constitutes one of the most important aspects of healthy buildings.

In most situations, optimising natural ventilation is the most affordable and effective way to manage indoor air quality. The use of natural ventilation also reduces the need for air conditioning energy use. In office and other commercial buildings, natural ventilation also reduces the need for mechanical ventilation.

Considering options for natural cross ventilation is best undertaken in the early stages of a project when decisions are being made about building orientation and building depth, the configuration of different internal spaces and the external building envelope.

What is natural ventilation?

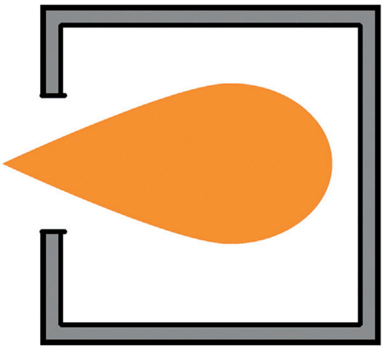
Natural ventilation is when fresh air can freely enter and exit a building or room, using only 'passive' elements of the building envelope such as doors and windows. Natural ventilation is created by pressure differences between the inside and outside of the building induced by wind and air temperature differences.



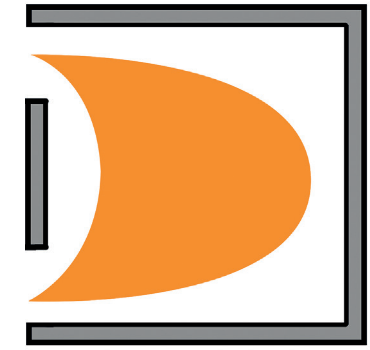
Utilising the stack effect for natural ventilation

How to design for effective natural ventilation?

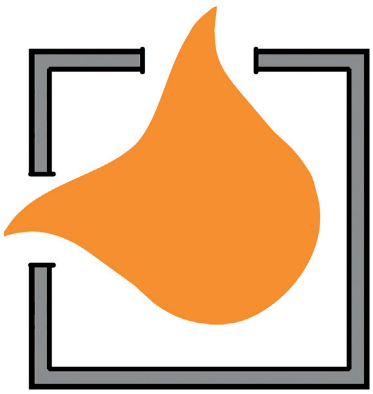
Placement of windows openings - plan view



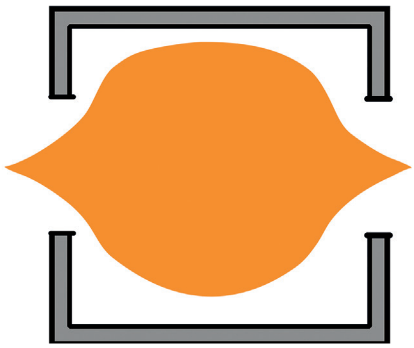
Single opening



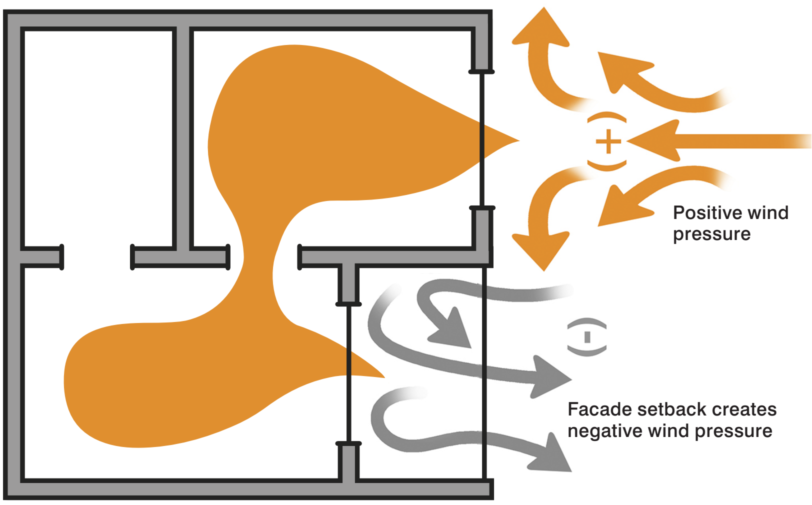
Two openings same wall



Two openings adjacent walls



Two openings opposite walls



Ventilation via pressure differentials

Best practice design for optimising natural ventilation.

Natural ventilation can be achieved by:

- Natural cross ventilation, which occurs when an internal space has two or more openings on different orientations so that breeze can flow through the space to flush out hot and/or stale air.
- Passive, stack or buoyancy ventilation, which relies on the effect of rising hot air and requires high and low level openings so that warm air is flushed from higher openings and cooler air is drawn in through lower openings. This is more effective in spaces that don't rely even on single sided ventilation.

Cross ventilation

Useful rules of thumb for cross ventilation:

- The length of the breeze path should be a maximum of 18 metres.
- Ventilation openings should be at least $1m^2$ in size.
- Any doors in the breeze path should be provided with door catches. Where the doorway is a front door, a security screen door must be provided.
- Ventilation openings on adjacent walls should be at least 3 metres apart.
- There should not be more than 1 doorway or opening between ventilation openings.

How to design for effective natural ventilation?

Single aspect ventilation

Better natural ventilation can also be achieved for single aspect spaces by having openings that can be left in an open position in at least two areas of the spaces to create a breeze path. Consider design solutions such as:

- Minimising the depth of the rooms that have the single aspect orientation to a maximum of 5 metres.
- High- and low-level ventilation openings located in different verticals planes to the single sided aspect orientation.
- Minimum opening size of 1m² with careful consideration of window size, opening type and location.
- Operable windows to all rooms with connecting doors located at the rear of the rooms to allow for a clear breeze path between ventilation openings and around internal walls, obstructions & partitions.

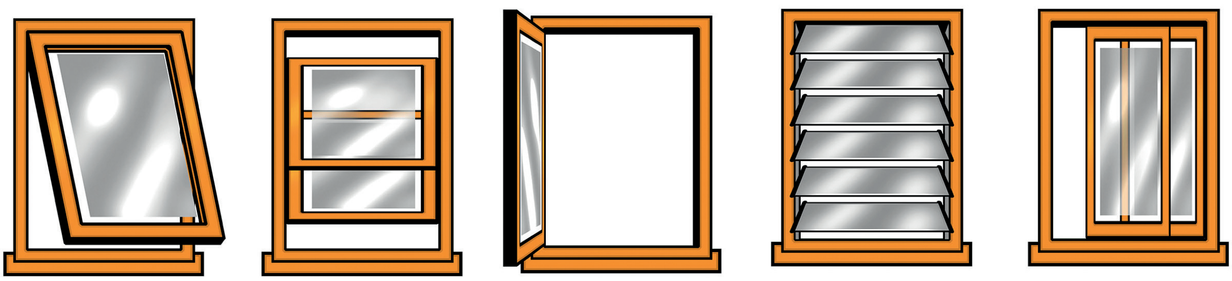
Ensuring the layout of the space is designed to generate different air pressures across the façade and façade openings. In order to achieve this the following needs to be implemented:

- Provide inset balconies to the façade of a single aspect space. The provision of an inset balcony changes the pressure distribution on the façades of the space, particular to an apartment, which can be utilised to induce better performing single sided natural ventilation. Protected openings on balconies will typically have a lower air pressure to those on an exposed part of the façade. Refer to image at bottom of adjoining page 2 of 4.
- Avoid single aspect spaces that have a slap façade/flush façade without an inset balcony. Flush facades do not generate the necessary pressure difference across the façade to induce effective natural ventilation to the space.

Selecting Doors and Windows

Doors and openable windows maximise natural ventilation opportunities by using the following design solutions:

- Adjustable windows with large effective openable areas.
- Windows that provide safety and flexibility.
- Windows which the occupants can reconfigure to funnel breezes into the building.
- Casement and sliding doors/windows are best suited to achieve these design considerations in a residential context.
- Louvre windows can also be used. However, it is typically difficult to completely seal these in a closed position, leading to unwanted heat losses and drafts during colder months.
- Awning windows are typically not effective when it comes to promoting good levels of natural ventilation. Despite the window size being large, the actual window opening is significantly smaller. On top of that, awning windows typically open at the bottom which does not help when aiming to flush warm and stale room air in summer, as warmer air accumulates higher up.
- Bottom hung awning windows are effective as they allow ventilation openings to the façade at higher and lower levels encouraging passive/ stack ventilation to occur.
- Tilt and turn windows provide flexibility to the building occupant and can operated in both tilt and turn to provide a different form and orientation of ventilation opening to best suit the external conditions.



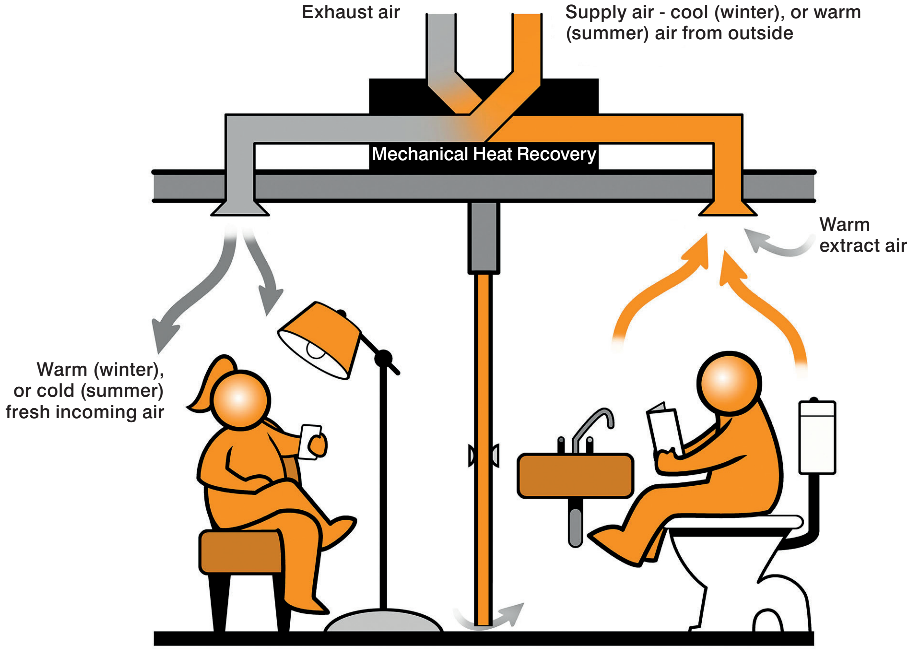
	Awning window	Double hung window	Casement window	Louvre window	Sliding window
Pro	• Opening typically restricted to 125mm	• High and low level ventilation	• Up to 100% opening for large air flow rate • Can be easily cleaned if opening to the inside	• Up to 95% opening for large flow rate • Opening less than 125mm	• Up to 50% opening for large flow rate
Con	• Less flow rate • Opening at the bottom which further reduces airflow	• Good protection from rain	• Opening greater than 125mm a restrictor may have to be applied for NCC compliance	• Typically single glazed and leaky in winter	• Opening greater than 125mm a restrictor may have to be applied for NCC compliance

When natural ventilation is limited due to site constraints

Where sufficient natural ventilation cannot be achieved due to constraints such as external noise or poor outdoor air quality, consider providing ventilation by passive ventilation and/or energy-efficient mechanical air exchange systems such as heat recovery ventilation. Using a mechanical heat recovery system as shown in the image, fresh filtered air is continuously supplied at low velocity and preconditioned via the exhaust air stream. These two air streams never get in contact with each other, however exchange energy (heat) in the heat recovery unit.

Modern heat recovery units can exchange as much as 90% of energy, which makes them a great contributor to any low energy and high comfort home or commercial space.

On the contrary, it is important to understand that typical split system air-conditioners do not provide air exchange or ventilation. These systems purely heat or cool a room by recirculating internal air past a heating/cooling coil. Unless the split system is connected to an outdoor air duct, internal air within a space is being recirculated, and not exchanged.



Mechanical ventilation with heat recovery

Natural Ventilation to Common Area Corridors in Apartment Developments

Common area corridors in some older apartment buildings are internal and have no access to natural ventilation. The amenity of these corridors is poor and the air is often stale and carries odors. Considering the layout of apartments and the common corridors to allow the corridors to have façade access will allow the corridors to be naturally ventilated.

This lowers the energy intensity and associated costs of the development. It should also be noted that corridors with windows let in daylight and generally provide a more friendly, safe and inviting environment.

Natural and mixed mode ventilation in Commercial Developments.

Natural and mixed mode ventilation is becoming a viable option for commercial developments. Mix mode ventilation is the combination of both, natural ventilation and mechanical ventilation serving the same space. Mixed mode ventilation and cooling operation is an effective method of reducing mechanical ventilation and cooling energy.

If designed correctly, the space can be functional and maintain adequate ventilation rates and thermal comfort to operate without the need for mechanical ventilation, this could be further enhanced through the integration of a central atrium serving commercial developments with larger floorplates.

There are a numbers of benefits to mixed mode ventilation strategies:

- Reduced energy consumption. Designing a space within a building to be used in natural ventilation mode reduces the reliance on mechanical ventilation and the associated energy required for cooling.
- Improved air quality. Mixed mode ventilation systems ensure that air is flowing into your building when appropriate. This will improve the air quality, which in turn will improve your health and of those living and working in the building, increasing productivity and concentration levels.
- Connection to the outdoors. When a mixed mode ventilation building is operating via natural ventilation you are provided with immediate access to fresh air from the external environment. This provides you with a connection to the external environment, also improving your health and increasing productivity and concentration levels.

Reduced carbon emissions.

- Mixed mode ventilation systems have a lower greenhouse gas emissions comparable to purely mechanical ventilation systems due to a much lower energy consumption.

Best Practice Guidelines on Natural and Mixed Mode Ventilation strategies

Council's Best Practice Standards

Council's Best Practice Standards

BESS best practice requirements

All habitable rooms must meet the rules for either cross ventilation or single-sided ventilation, as follows:

Cross ventilation

- A breeze path between 2 ventilation openings either within the room or from one room to another.
- Breeze path length less than 18m measured between ventilation openings and around internal walls, obstructions & partitions.
- Ventilation openings located either in opposite or adjacent external walls or an external wall and an operable skylight.
- Size of ventilation openings greater than 2% of total floor area or 1m2, whichever is greater. The opening is the maximum allowable clear open area for the window. i.e. if floor area of room is $55m^2$ then clear open area of window / door must be at least $1.1m^2$.
- No more than 1 doorway or opening $<2m^2$ between the ventilation openings.
- Where the breeze path travels through an internal door, that door must be provided with door catches.
- If on adjacent walls, ventilation openings must be at least 3m apart at their closest point. This is to ensure the space has reasonable ventilation throughout and not just in one corner.
- If relying on a courtyard adjacent to a ventilation opening the courtyard must have a minimum depth of 3m from the window or be a minimum size of 9m2

Single-sided ventilation

- Maximum permissible depth of room 5m.
- Separated openings high and low or split across the width of the room/ facade (each 5% of the floor area) are preferred.

Mechanically Assisted Natural Ventilation

- Delivering fresh air rates of between 2.5 - 5 L/s/m2 (results should be supported by calculations)

Where can I find out more?

Technical Manual Passive Design, Your Home
www.yourhome.gov.au

BESS Tool Notes Natural Ventilation
bess.net.au/tool-notes/

Better Apartment Design Standards
www.planning.vic.gov.au/policy-and-strategy/better-apartments/better-apartments-design-standards

Green Building Council of Australia, Design and As-Built Submission Guidelines
new.gbca.org.au/

Sustainability VIC, Energy Smart Housing Manual
https://bit.ly/3dWJ36N

Moreland Apartment Design Code
https://bit.ly/3nyyfz8

Other existing CASBE Sustainable Design Fact Sheets
www.casbe.org.au/what-we-do/sustainability-in-planning

Environment Design Guide papers
Lyons, P. 2004. Properties and rating systems for glazings, windows and skylights (including atria). Environment design guide, PRO 32. Australian Institute of Architects, Melbourne.

acumen.architecture.com.au/environment

Other Fact Sheets in this series are available to provide guidance on Indoor Environment Quality and Energy Efficiency. Those Fact Sheets are entitled:

1.0 Indoor Environment Quality

1.1 Daylight

2.0 Energy Efficiency

2.2 Building Envelope Performance

ACKNOWLEDGEMENT: The MAV acknowledges the five IMAP (Inner Melbourne Action Plan) councils – the Cities of Yarra, Port Phillip, Melbourne, Stonnington and Maribyrnong – for their leadership in producing this suite of Fact Sheets to enable a more liveable and sustainable built environment.