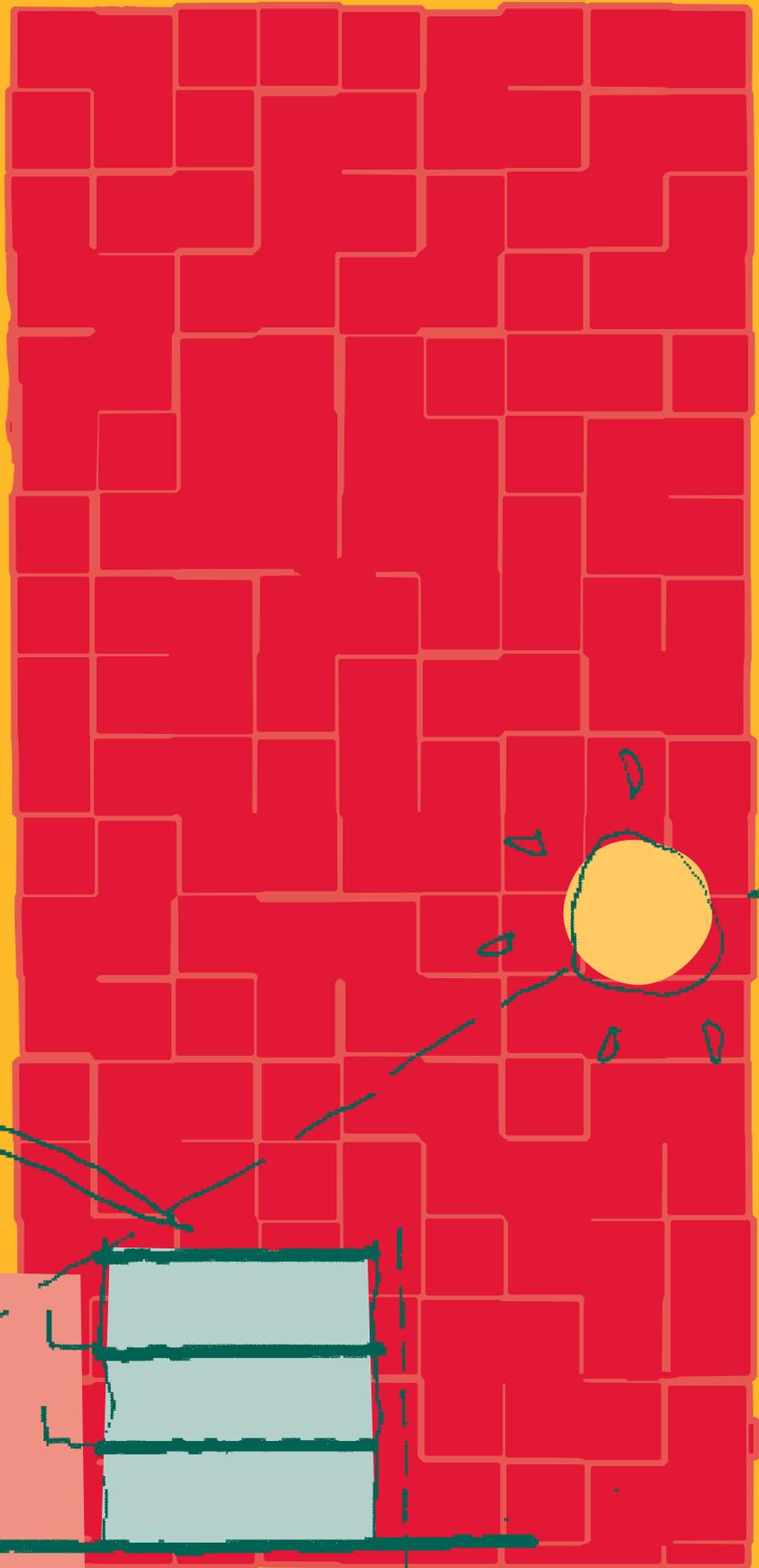
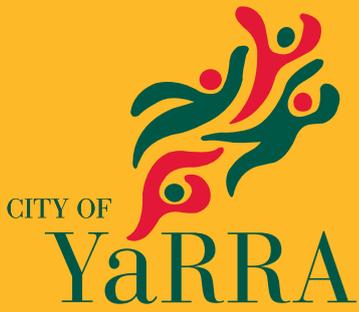


Sustainable Design Guidelines



Apartment development

Mayor's message

Yarra City Council is working towards a more sustainable inner city environment as well as making our planning and building information easily accessible. These Sustainable Design Guidelines aim to achieve both these goals.

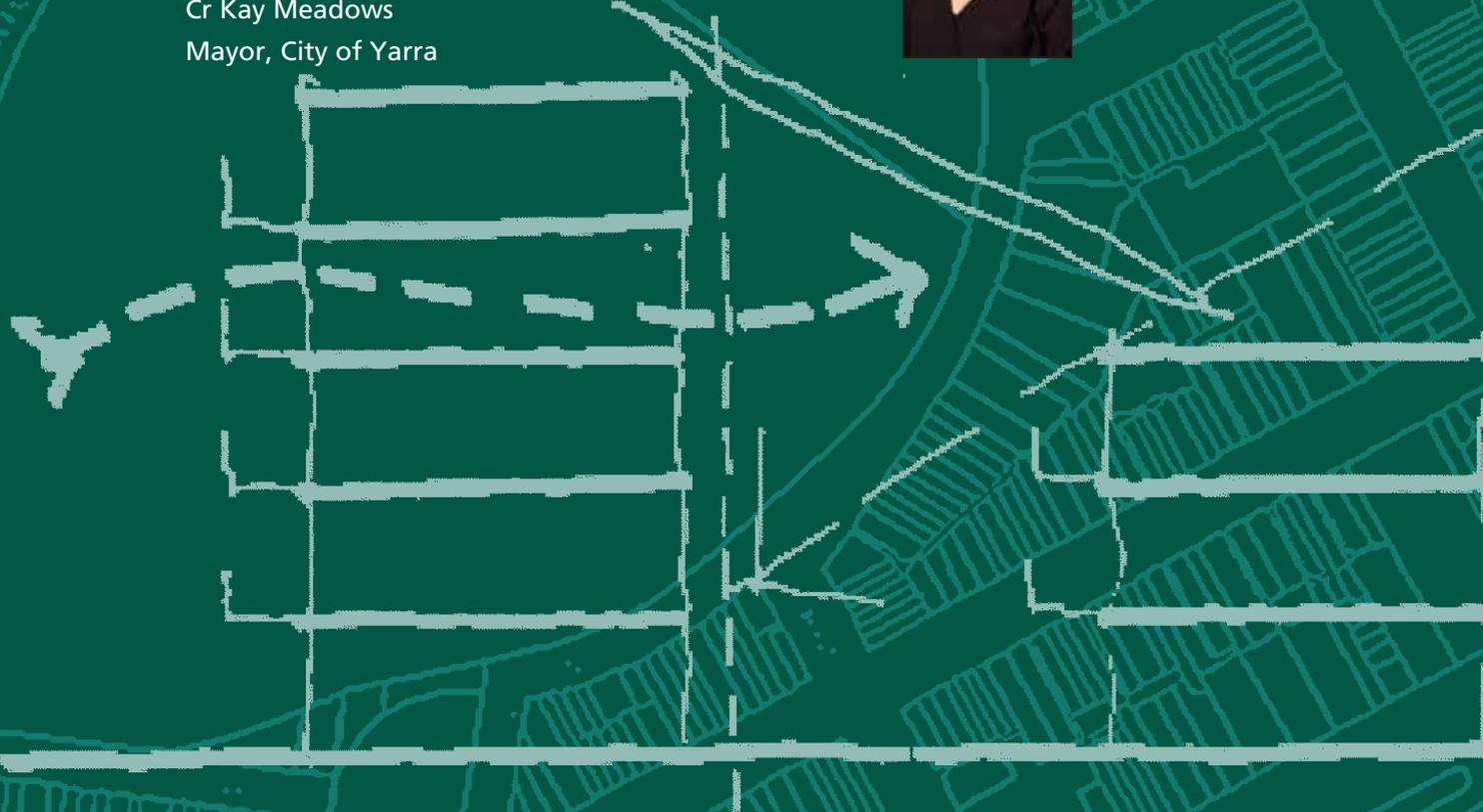
The Guidelines are part of the City's Greenhouse Action Plan, which includes the goal of reducing greenhouse emissions in the Yarra community by 20% from 1996 levels, or 300,000 tonnes, by 2010. It is estimated that 85% of greenhouse emissions from the Yarra community are from electricity and gas consumption. One way to achieve the reduction goal is to build more energy and water efficient new buildings and to incorporate sustainable design principles into existing buildings when renovating.

The Guidelines are for residents, planners, builders and architects. Using the Guidelines will make buildings more comfortable, improve energy and water efficiency, and save you money in the long term.

I encourage you to find out how you can contribute to the health of our environment and make your building perform better by using the Sustainable Design Guidelines.



Cr Kay Meadows
Mayor, City of Yarra



Sustainable Design Guidelines

Apartment developments

- Site apartments for maximum solar access.
- Provide cross-flow ventilation.
- Access natural daylight.
- Re-use existing building fabric.

What's important in designing a sustainable apartment development?

A sustainable development depends on creative design to reduce the environmental 'footprint' of its construction and operation.

To be truly sustainable, the design of apartments should:

- make clever use of space to provide comfort and function so that the total floor area is minimised
- be adaptable to changing patterns of use so that the development can continue to be occupied for many years without being extensively renovated or demolished.

This booklet is part of a series of sustainable design guidelines, produced in the interests of good sustainable development.

Each booklet in the series explains strategies to take advantage of key sustainable design opportunities for different types of developments:

- single dwellings or extensions
- townhouse developments
- apartment developments
- warehouse conversions
- commercial developments.

Booklets are available on Council's website at www.yarracity.vic.gov.au or from Council offices at:

- Richmond Town Hall, 333 Bridge Rd, Richmond
- Collingwood Town Hall, 140 Hoddle St, Abbotsford

or by telephone:

- Yarra Access on (03) 9205 5555

Passive solar design

Passive solar design

Standard Plan

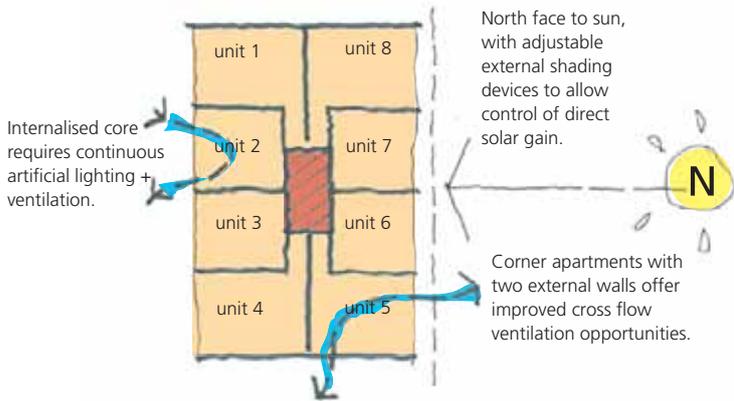


Fig. 1a Conventional central core plan – best orientation

Long faces are orientated to the north so that all units have either northerly sun, or a southerly aspect.

Good passive solar design uses the heat of the sun and natural night time cooling to keep apartments at a comfortable temperature all year. This will reduce or eliminate mechanical heating and cooling, save on energy costs and reduce greenhouse emissions over the lifetime of the building.

The greatest opportunity for influencing sustainable design outcomes arise at the sketch design stage (when the building mass and form is first being considered). Sound sustainable design principles should inform the building design from the outset, including:

- providing direct solar access to all apartments in winter to provide passive winter heating while controlling summer heat gain
- designing for effective cross ventilation for summer cooling
- maximising day lighting while controlling glare.

Sustainable Design Plan

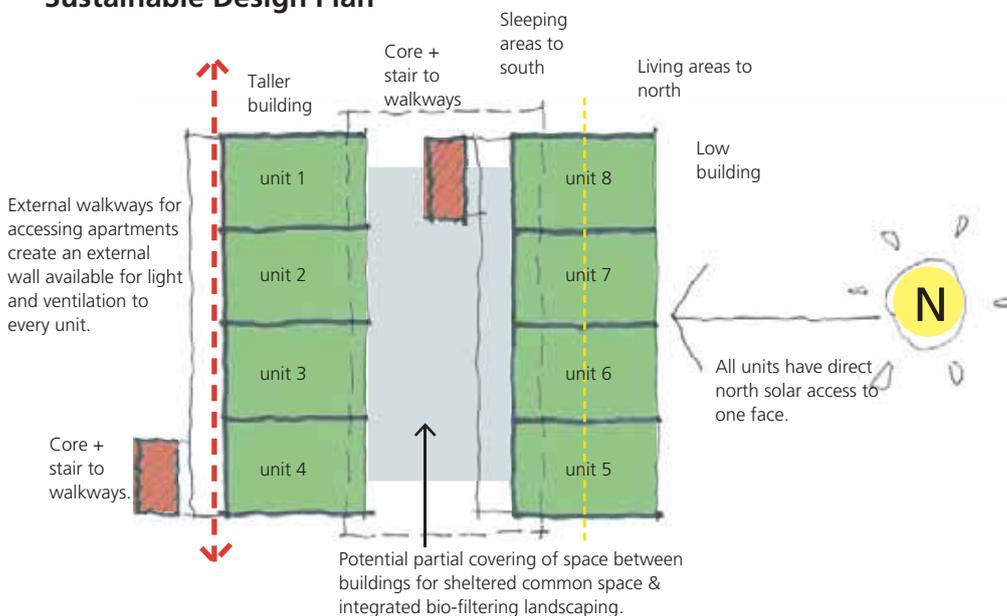


Fig. 1b Split core, external walkway – sustainable design solution

Separating the conventional single corridor plan into blocks with one sided external access means that all units have dual exterior walls providing good light and cross flow ventilation.

Sustainable Design Guidelines

Passive solar design

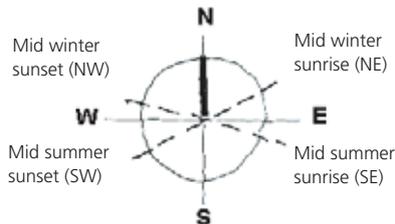


Fig. 2a Principal sunlight directions

As winter sets in, the sun crosses the sky at a much lower angle. To maximise solar access it is important to consider the sun's path, and the direction of north in relation to your building site.

Passive solar design

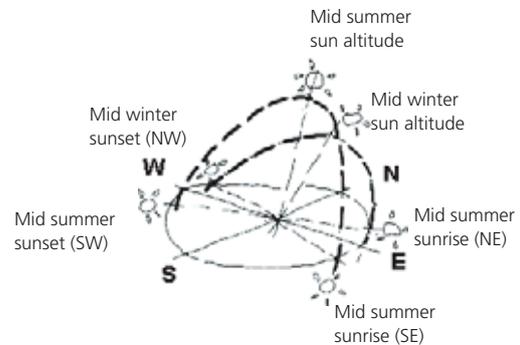


Fig. 2b Sun's path through the sky

This view of the sun's path shows the higher angle of the sun in relation to the earth's ground plane in summer as compared to winter.

Daylight and sun control

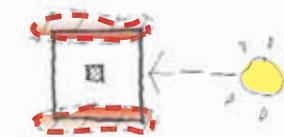
Windows are vital elements in affecting winter heat loss, summer heat gain and the level of internal light in the apartments.

The size and position of windows should be carefully planned according to the direction they face. Protect east, north and west facing windows from summer overheating by using external shading devices such as overhangs, adjustable awnings, shutters, deciduous trees and vines.

Unprotected single glazed windows lose 10 times more heat in winter compared to the same area of insulated wall. Winter heat loss can be reduced by fitting double glazed windows and/or close fitting drapes or blinds which trap a layer of insulating air between them and the glass.

Tinted or toned windows should only be used where other shading solutions are impractical because they reduce beneficial winter heat and daylight transmission.

'Square' type form - one face oriented to north. West and east facades suffer from low angle sun. Requires extensive external shading to avoid overheating and glare.



'L-shape' type form - one face oriented to north. West facade suffers from low angle sun. Requires extensive external shading to avoid overheating and glare.



Linear type form - building width oriented to north. West & east facades suffer from low angle sun. Requires extensive external shading to avoid overheating and glare.

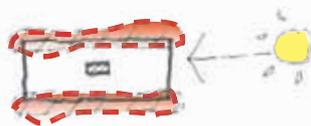


Fig. 3 Other apartment models

Orientation is the most critical factor in determining the energy use of an apartment building. External shading devices and reduction of glazing should be employed if orientation cannot be changed.

Passive solar design

Conventional vs. Sustainable design approaches

Apartments which are not designed with sustainability as a starting point may not benefit from the full range of opportunities. For example, Figure 4a shows a typical model of development which can lead to poor natural ventilation and high heat loads to unprotected westerly and easterly faces.

An alternative approach informed by sustainable design principles is illustrated by Figure 4b. This building form allows the integration of cross flow ventilation, high levels of natural daylighting, with additional opportunities for sustainable landscaping.

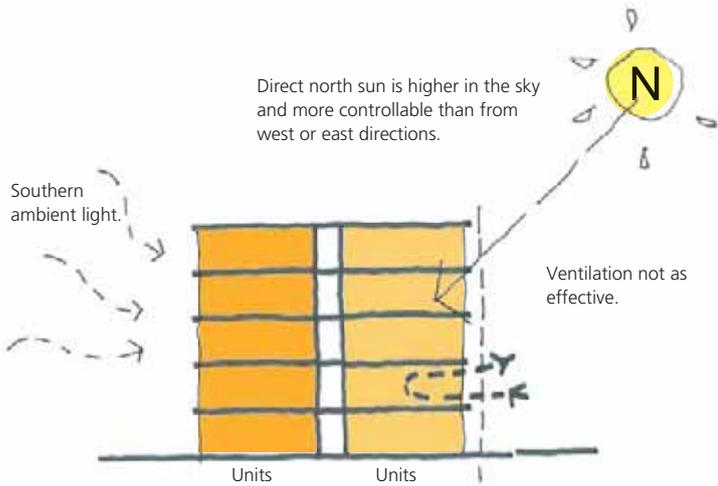


Fig. 4a Conventional design

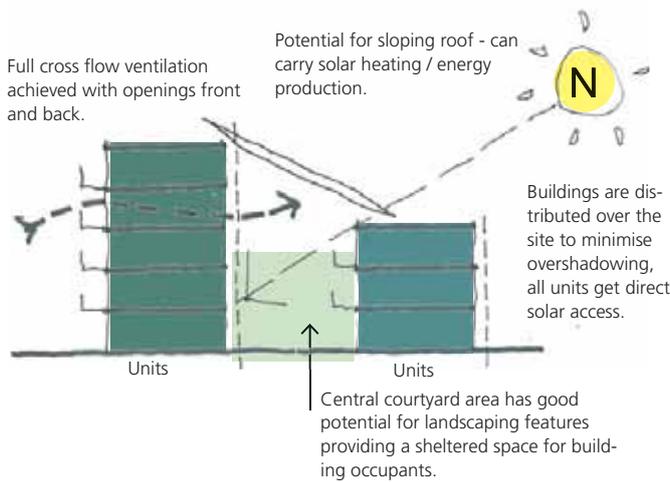


Fig. 4b Split core, external walkway – sustainable design solution

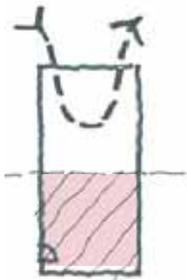
Separating the conventional single corridor plan into blocks with one sided external access means that all units have a back and front.

Sustainable Design Guidelines

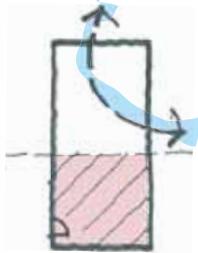
Passive solar design

Inadequate natural ventilation.

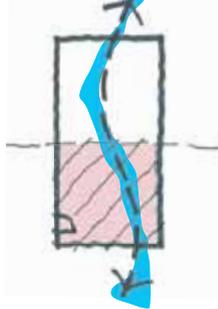
living areas



Ventilation through two adjacent walls, satisfactory.



Superior ventilation is achieved with full front to back openings.



sleeping areas

Fig. 5 Zoning and ventilation

The ability to effectively ventilate trapped hot air is vital for comfortable year round living.

Ventilation

Ventilation is a free means of removing heat from apartments on hot summer days. Design strategies include:

- siting windows and doors to promote cross flow ventilation from prevailing winds
- taking advantage of the 'stack effect' to vent hot air from upper storey windows, skylights or other openings
- using landscaping and water features to provide evaporative precooling.

Insulation and thermal mass

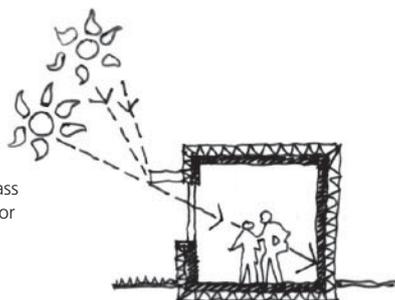
Insulation provides a barrier to heat flow throughout the year, keeping rooms more comfortable and saving energy. As a guide, ceiling insulation should be R2.5-3.5, walls R1.5 -2, and floors R1-2.5. The 'R' values indicate the resistance of the insulation to heat movement.

Insulated thermal mass absorbs heat for later re-radiation. Concrete floors, internal masonry walls and 'reverse' brick veneer walls can absorb winter warmth from direct sun, then release it back into rooms when the sun has gone.

Cavity brick walls retained from a previous structure can add to heating demand because of poor thermal performance (for example, a double brick wall has a thermal value of approximately R0.6).

To minimise the adverse effects, consider:

- using existing walls as feature internal walls to provide thermal mass
- designing units to minimise portion of external façade from existing walls
- adding insulation to internal faces to minimise heat transfer.



Insulated thermal mass absorbs direct heat for later re-radiation.

Fig. 6 Thermal mass

Heavy, well insulated walls (e.g. concrete and brick), work by absorbing and storing excess heat and re-radiating this supply during cooler periods (e.g. from day to night).

Insulation and thermal mass

Wall areas shared between units, and floors between levels, do not require thermal insulation if rooms on both sides are to be heated. However, if unheated utility areas (such as laundries or garages) are adjacent to habitable rooms, the walls should be insulated.

Heat transfer through suspended floors over garages can be avoided by insulating timber floors with bulk insulation between joists or to the underside of suspended slab floors.

Effectively draught-proofing the building by sealing all gaps and cracks during construction (e.g. between window frames and walls) is vital to get all the benefits of insulation and passive design.

Exhaust fans should have automatic shutters.

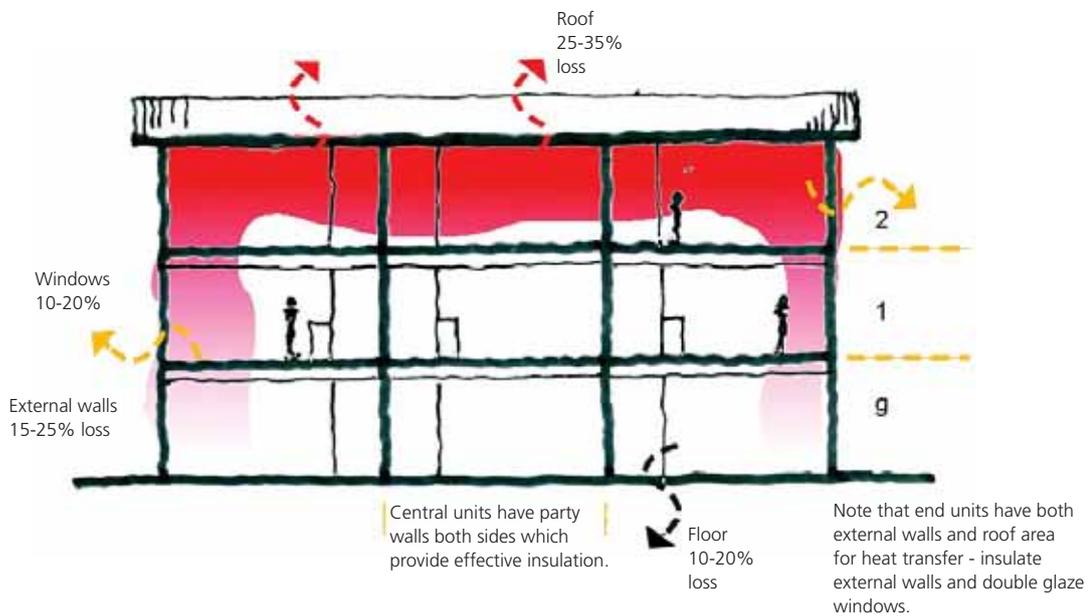


Fig. 7 Typical heat gains/losses

Insulation and sealing of the interior are vital to reduce heat loss during winter, and heat gains during summer.

Sustainable Design Guidelines

Passive solar design

Internal layout

The principles to apply to the layout of internal spaces are:

- place day use areas such as living rooms to the north
- locate utility areas such as laundry and bathrooms to the south and west and/or away from external walls
- avoid ceilings higher than 2.7 metres
- separate heated and unheated zones (such as stairways and laundries) by doors
- provide outdoor spaces that are sheltered and sunny in winter but cool in summer.

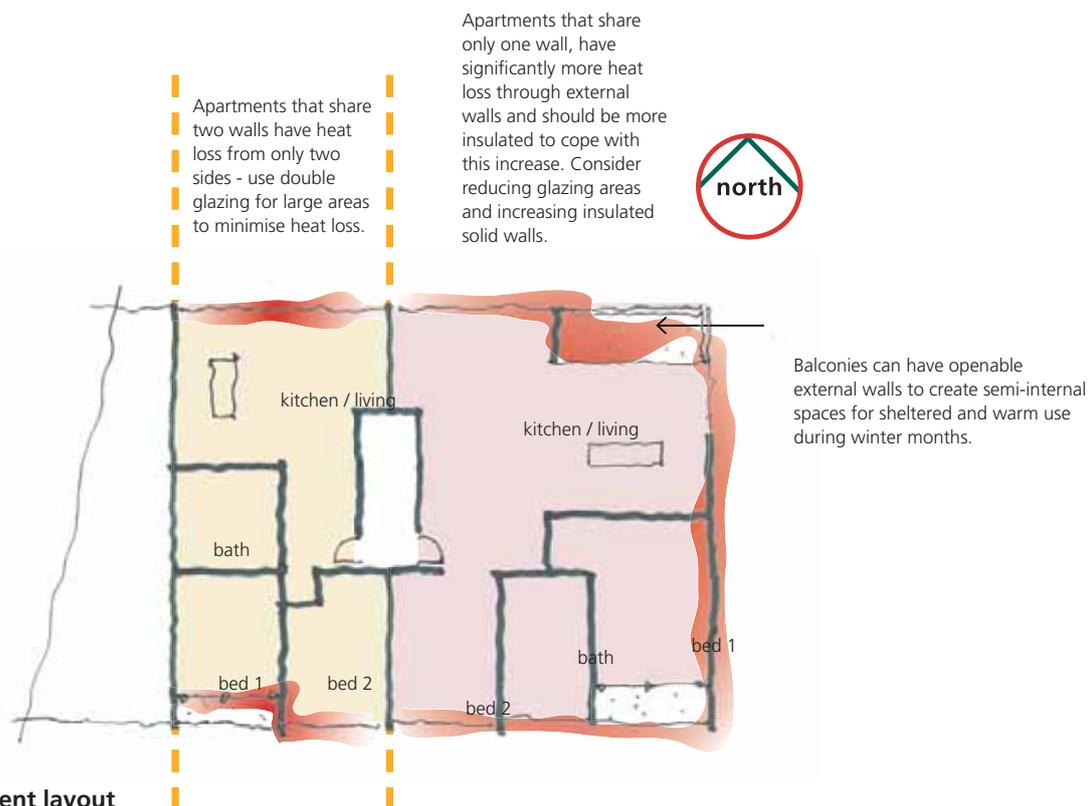


Fig. 8 Apartment layout

Living areas, as a general rule, should be closest to direct northern solar access. Sleeping and utility rooms should be to the south, and laundries and bathrooms ideally to the west or east.

Energy services

Heating and cooling options

Maximising the passive solar performance of the building design is the most important strategy in reducing the environmental impact of heating and cooling. A passive solar design will have a significantly reduced requirement for mechanical heating and may also stay cool enough in summer to avoid the need to install refrigerative cooling.

When selecting heating or cooling systems, individual systems are generally preferable to centralised building systems because:

- centralised systems can have high running costs due to the energy lost from heating and cooling distribution piping and the 'parasitic' energy use of central pumps, fans, etc.
- unlike individual systems, most central plants run continuously
- it is easier to adjust decentralized air conditioners to the individual requirements of residents. Individual systems also avoid a significant management and financial burden on the body corporate.

When installing systems:

- specify appropriately sized units. Explain to the supplier that the dwelling will have a superior energy rating to save on capital and running costs, or (preferably) have an engineer select equipment based on calculated requirements. This will be cheaper than selections made according to industry 'rules of thumb'
- install units with the highest energy star rating available
- zone the dwellings by installing heating and cooling only where it is needed. Remember that rooms without external walls often require little heating due to minimal heat losses. Many energy efficient residences do not require heating in bedrooms.

If providing heating:

- it is generally preferable to install a high efficiency natural gas space heater to heat a large room, rather than central heating
- central heating systems should be high efficiency natural gas and zoned to reflect the use of different rooms.

If you choose to provide cooling:

- remember that ceiling fans coupled with cross ventilation will usually provide adequate comfort (requires adequate headroom, 2.4m min.)
- be aware that a reverse-cycle airconditioner with a heating star rating of at least 2.5 stars is also an efficient space heating solution.

Sustainable Design Guidelines

Energy services

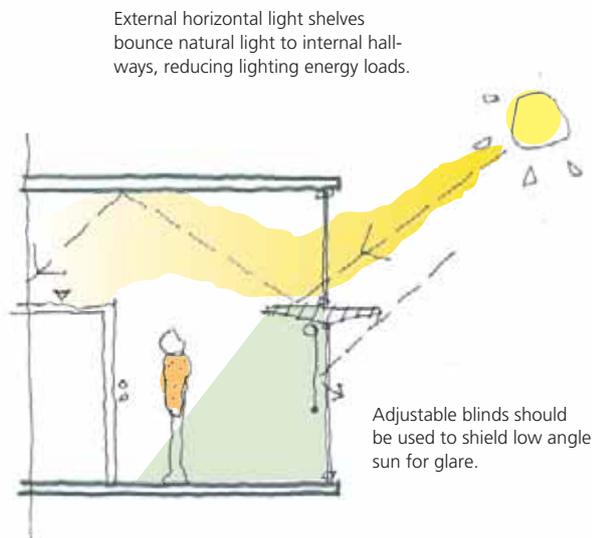


Fig. 9 External light shelves

Reducing lighting loads in infrequently used areas such as lobbies by introducing natural light.



Fig. 10 Energy efficient light fittings

Compact fluorescent light bulbs and triphosphor tubes (top) last longer and use about a quarter of the energy of incandescent light bulbs (bottom).

Lighting

Daylight is not only a free source of light, but it is widely acknowledged that homes with good levels of daylight are also more liveable. The challenge is to provide daylight while controlling glare and summer heat. Ideally, day light should be provided to all rooms by:

- carefully locating windows to capture north light
- providing appropriate shading for windows
- minimising plan depths
- using light wells, light shelves or skylights to send daylight to rooms without external walls
- using light coloured external and internal finishes to reflect available light
- ensuring that kitchen, living and sleeping areas have external windows
- daylighting of common area corridors by extending corridors to perimeter of the building, using voids, light shelves and light wells (see figure 9).

When designing the lighting layout, consider the following:

- attractive compact fluorescent light fittings are now available in a range of styles. These require about one quarter the electricity of incandescent (standard bulbs) and last about 6 – 10 times longer
- activities which are likely in each room, and provide lights for those activities. For example, a kitchen requires general light for the whole room and task lighting over benches and the stove
- provide separate switches for each lighting group
- low voltage lights are not cheap to run and have a much shorter life than compact fluorescent lights. As a rule they should not be specified for general lighting and are best suited to a few specific tasks, such as over a kitchen bench
- control outside lights with combined automatic movement and daylight switches.

Carpark ventilation and lighting

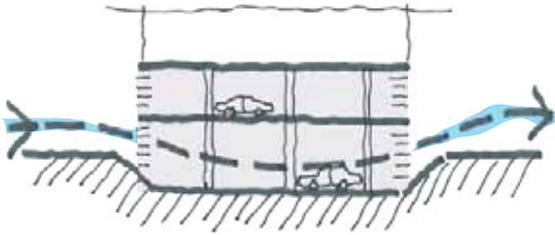


Fig. 11 Natural carpark ventilation

Open sides to basement carparks can provide good ventilation.

Ventilation

If the car park is above ground level, natural ventilation can be used instead of fans.

Ventilation in a below ground car park can be improved by:

- minimising the resistance of the air entry (e.g. ventilated roller doors and exhaust ducts)
- installing air quality sensors and a variable speed fan, to automatically vary air flow according to requirements.

Lighting

Minimise car park lighting requirements by:

- using day-light (this is possible even in basement car parks by using translucent sections in the podium)
- painting the ceilings white and the walls a light colour
- controlling all lighting in daylight areas according to daylight
- providing a main lighting circuit and a skeleton circuit in each area of the car park
- controlling the main lighting circuit according to occupancy sensors which can detect people and cars.

Sustainable Design Guidelines

Energy services

Floor area (each house represents a doubling of size).

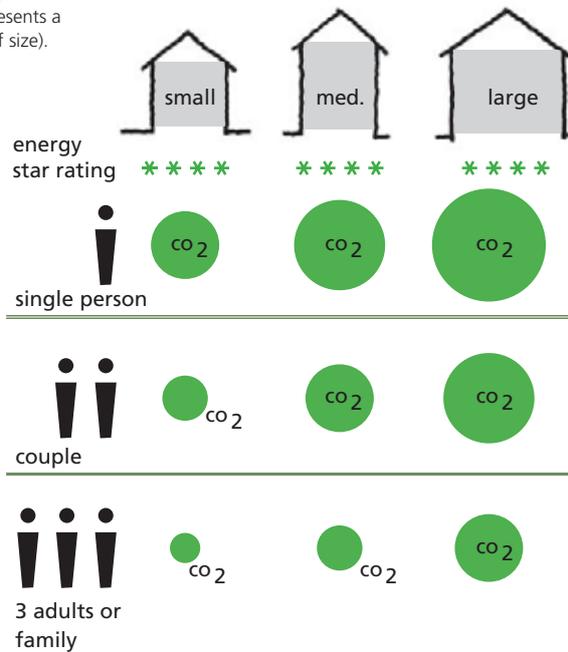


Fig. 12 CO₂ 'footprint'

A sustainable home aims to reduce environmental 'footprints' including per capita greenhouse emissions.



Fig 13 Appliance ratings

Check your appliance for an accredited rating scheme to see how energy efficient it will be.

Energy supply

Generating your own electricity from the sun with photovoltaic (PV) panels is feasible, but you should be aware that in terms of environmental benefits, it requires a much higher capital investment than other environmental design initiatives such as passive design (free) or insulation (low cost). Nevertheless a PV system is certainly a visible action and is perhaps easier to justify if its education value is taken into account. To maximise electricity output, it is essential that PV panels receive uninterrupted solar access on a north facing roof, wall or shading element.

In a development with common area lighting and other services, the system may be sized to provide energy to annual common area usage so that all residents share the benefit through the body corporate.

Energy ratings provide a measure of building envelope energy on a square metre basis. It is best to review the success of your design strategies by undertaking energy ratings early in the design cycle when modifications can readily be made.

Clothes drying

Electric clothes dryers can be a significant energy user in apartment developments.

To minimise energy use:

- use solar power by providing external clothes lines which are screened from the street and receive direct sunlight
- provide a positively ventilated internal drying space with a hanging rack to dry clothes at room temperature. This can be as simple as providing a hanging rack in the laundry coupled with a low power fan that circulates air through the space.

Roof catchment area	50m ²	100m ²
Rainfall (kilolitres)	36 kl/year	72 kl/year
Tank size (l)	500	81%
	1000	83%
	2500	99%
	5000	100%

Fig. 14 Percentage of water demand met

The table shows approximately how much water storage is required to meet a given percentage of demand for toilet flushing (average household water use in Melbourne).

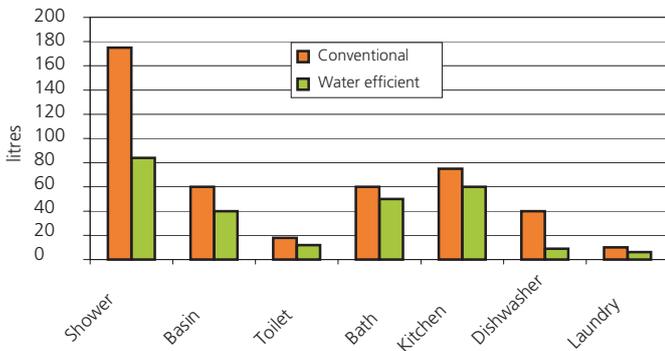


Fig. 15 Comparative water consumption

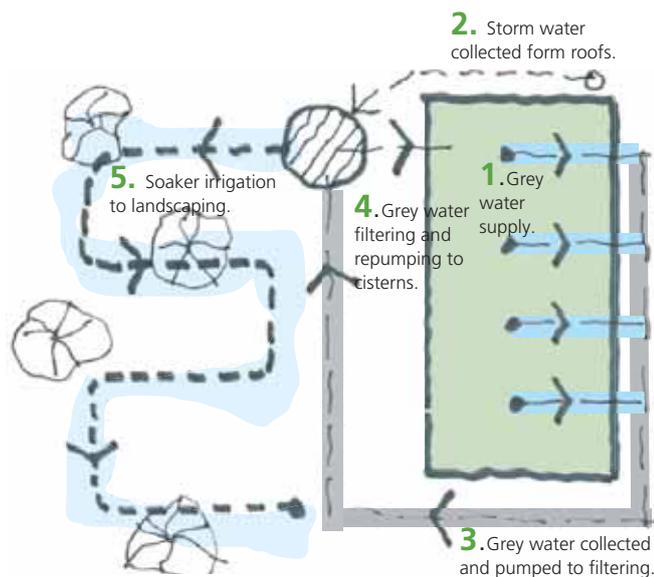


Fig. 16 Water recycling

Water can be reused for a number of applications before entering the sewerage system.

Household water use

There are two important environmental objectives to household water use:

- reducing the demand for water so that it doesn't have to be 'imported' from other catchments
- ensuring stormwater runoff does not adversely affect local waterways (which run into the Yarra River and ultimately flow into Port Phillip Bay).

Water sensitive urban design

Water sensitive urban design will enhance the amenity and aesthetics of the building and improve water quality.

Key water strategies to consider during design and construction of apartments are:

- selecting minimum flow (AAA rated) taps, showerheads and appliances
- planting local indigenous and drought resistant plants (For more information regarding species selection, refer to the booklet *Gardening with Native Plants in Yarra* which is available from Council.)
- installing an efficient drip irrigation system to balcony planter boxes
- installing rainwater tanks and reusing the water for toilet flushing and watering gardens (it's easier to collect rainwater if the roof drains to a single point)
- allowing rainwater to infiltrate the soil rather than drain off site by choosing pervious ground coverage for outdoor areas in preference to impervious hard surfaces.

Sustainable Design Guidelines

Waste and Materials

Construction

Building materials have environmental impacts throughout their life cycle (from the sourcing of the raw material to their post use disposal). While the scientific issues are complex, listed below are some simple principles to reduce the impacts of construction material.

- Design rooms to be used for multiple functions (to reduce overall building size and reduce the likelihood of premature demolition/modification.)
- Select dimensions to suit standard material sizes to reduce wastage during construction.
- Favour construction systems that allow for off-site prefabrication.
- Avoid expensive building materials to reduce embodied energy - higher cost materials usually require more energy to produce.
- Select materials that require minimal finishes and maintenance.
- Prefer recycled and environmentally benign materials.

To reduce the energy of a typical steel and concrete structure, specify:

- steel produced from post-consumer waste
- concrete blends to include maximum use of a cement extender (such as fly ash or blast furnace slag)
- concrete incorporating recycled aggregate wherever practicable.

For information on reducing construction and demolition waste, see the *Builders' Code of Practice and Waste Management Guidelines* published by the City of Yarra and available at Council offices.

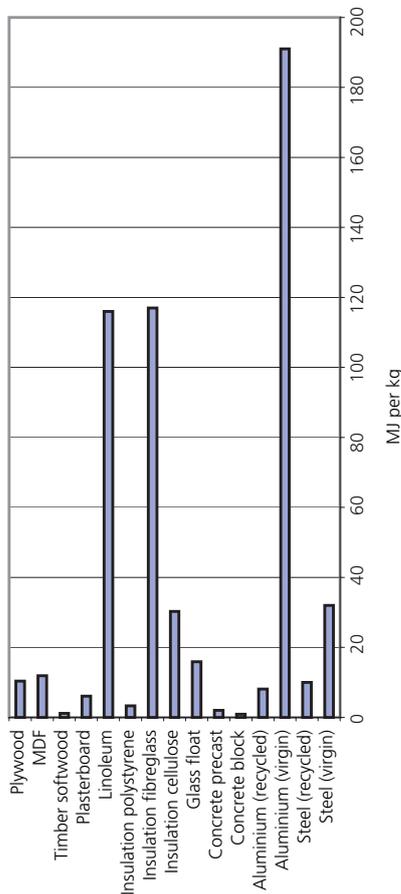


Fig. 17 Embodied energy (MJ/kg)

Embodied energy is the total energy expenditure for a particular material from mineral extraction through to site delivery.



Fig. 18 Material research

ecospecifier is a not-for-profit subscription database detailing a number of aspects of a material: embodied energy, volatile organic compound release, recycled content and many more.

Materials

Indoor air quality

The use of synthetic building materials, finishes and furnishings which release (or 'off-gas') pollutants can contribute to poor indoor air quality and the well-being of residents. While pollutant levels from individual sources may not pose a significant health risk by themselves, most homes have multiple sources of indoor air pollution which may interact. Avoid key problem sources and materials by:

- only applying finishes to structural materials where necessary. For example, selecting off-form concrete finishes rather than additional paint or render
 - asking to see material safety data sheets to compare products
 - generally preferring natural materials to synthetics
 - using sustainably grown solid wood or plywood as an alternative to Medium Density Fibreboard (MDF) or particleboard. If manufactured wood products are used, cover all surfaces and edges with laminates or seal them with low emitting paint or varnish to reduce emissions of formaldehyde.
- painting walls, ceilings and other surfaces with low Volatile Organic Compounds (VOCs) conventional water-based paints or mineral based paints instead of petrochemical paints and varnishes
 - generally finishing timber with plant based hard oils or waxes instead of polyurethane finishes
 - using linoleum, cork or ceramic floor tiles instead of vinyl flooring
 - generally using water based or quick drying adhesives and fillers
 - considering rugs or other flooring materials such as sisal or coir as an alternative to carpet
 - when selecting new carpet, request information about the emissions of the carpet (even woollen carpet is usually treated with a range of chemicals to prevent staining) and underlay.

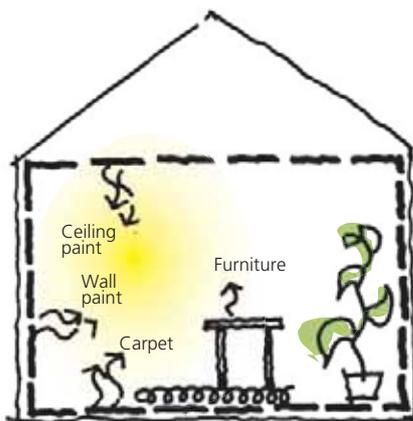


Fig. 19 Internal VOC release

Internal environment quality is affected by release of Volatile Organic Compounds (VOCs).

Volatile Organic Compounds

Volatile Organic Compounds (VOCs), are a range of chemical substances that become volatile at room temperature. They are given off by most paints, wood preservatives and glues commonly used during construction. Formaldehyde is a common VOC which is contained in most manufactured wood products such as plywood and MDF.

Exposure to VOCs can be a health risk depending on the specific composition of the VOCs present, its concentration and the length of exposure. VOCs have been linked to a range of health problems such as eye, nose, and throat irritations, headache, fatigue, coughing, sneezing and dizziness. Some VOCs are suspected or known to cause cancer in humans. The build up of VOCs in indoor environments have been associated with 'sick building syndrome'.

Sustainable Design Guidelines

Landscaping and Transport

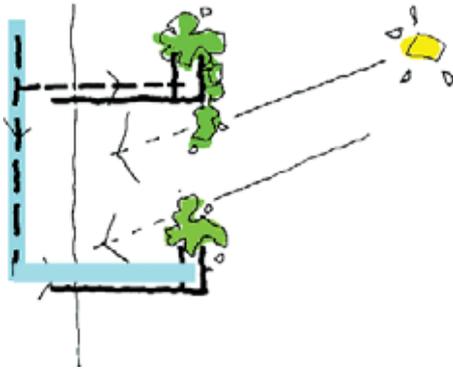


Fig. 20 Landscaping

Lightweight structures which hold deciduous vegetation make exterior spaces livable all year round.

Landscaping

Integrated landscaping can contribute to sustainable outcomes by providing shading, insulation, improved air quality and contributing to biodiversity. Design strategies to consider include:

- using deciduous plants to shade windows from summer sun
- using native vines to green building facades
- integrating planting into screening elements
- providing built-in planter boxes on balconies or rooftops
- including a rooftop garden for the building, to be accessible from upper level units.



Fig. 21 Bicycle hoop

Minimising car use

Residents of the City of Yarra have the advantage of living close to many facilities and services readily accessible by a short walk, bicycle trip or public transport.

Ensuring that the design of the development allows for secure, under cover bicycle storage which is easily accessible from the street, will make it more likely that residents will use bicycles.

In large developments, bicycle hoops should be provided in a well lit, highly visible location, within communal areas such as underground car parks. Secure weatherproof bike storage should also be provided for visitors near the entrance to the building.

General References

Practical information on sustainable design and construction issues can be found on the following websites.

Appliance Energy Labelling Scheme

www.energyrating.gov.au

Bicycle Victoria

www.bv.com.au

Building Commission

www.buildingcommission.com.au

Commonwealth Department of Health and Ageing

Copy of 'Healthy Homes – A guide to indoor air quality in the home for buyers, builders and renovators'

www.nphp.gov.au/enhealth/council/pubs/pdf/healthyhomes.pdf

Domestic Refuse Collection: Multi-Unit Developments

City of Yarra Infosheet

Ecorecycle Victoria

www.ecorecycle.vic.gov.au

Ecospecifier

www.ecospecifier.org

Commonwealth Department of Environment and Heritage, Air Toxic Web Site

www.deh.gov.au/atmosphere/airtoxics

Sustainable Energy Authority

www.seav.vic.gov.au

Your Home Guide, Australian Greenhouse Office

www.greenhouse.gov.au/yourhome

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