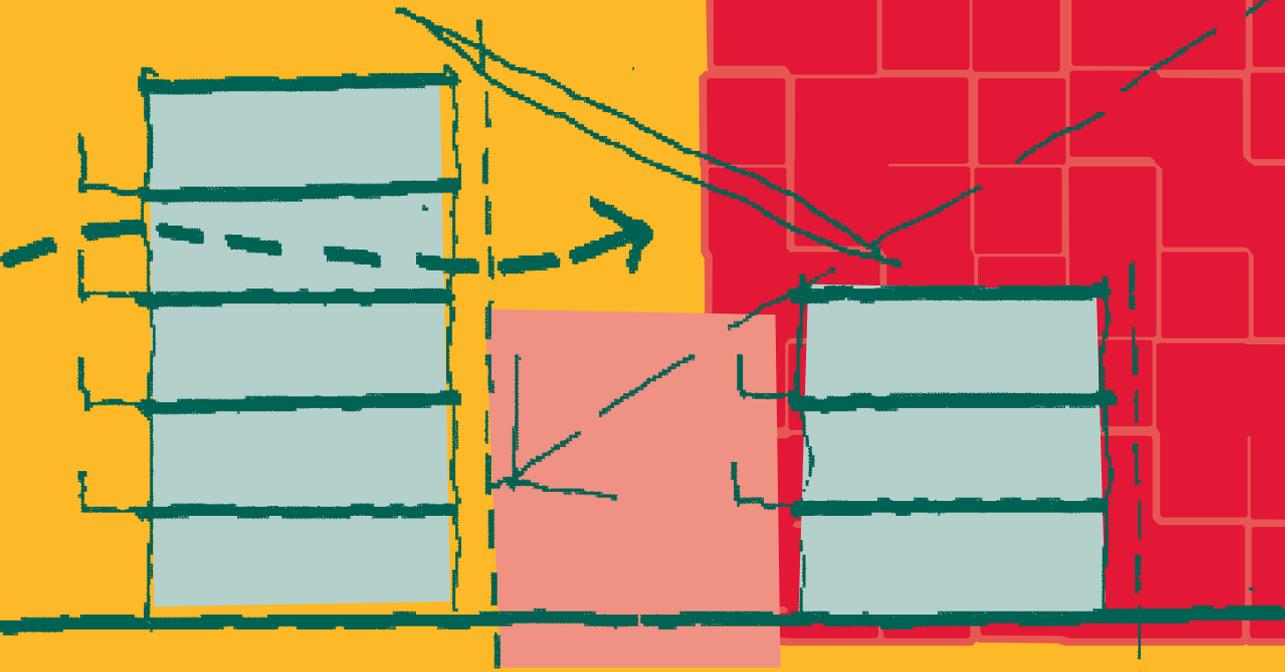
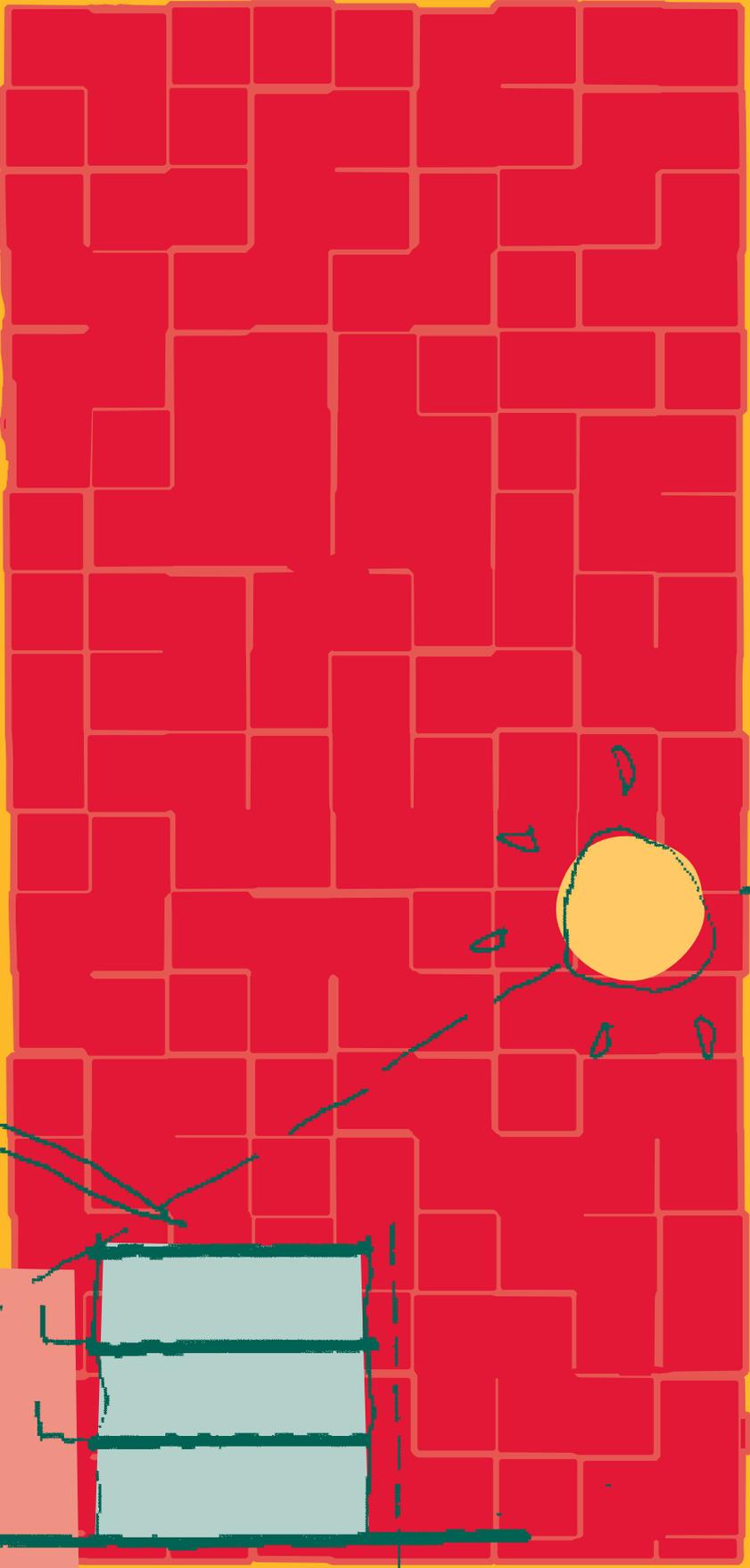


# Sustainable Design Guidelines



Townhouse 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.

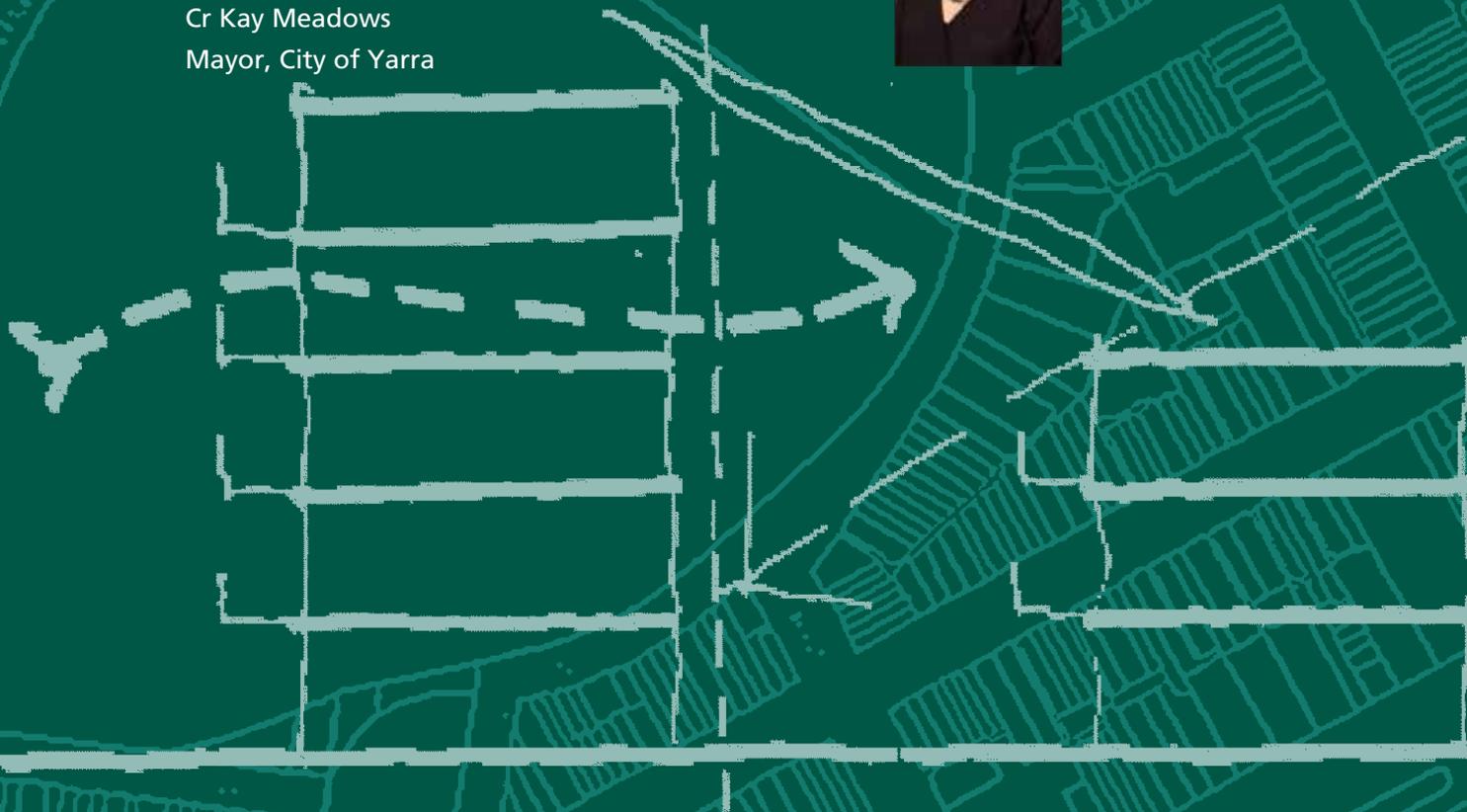
The Guidelines are part of the City's Greenhouse Action Plan, which includes the goal of reducing greenhouse emissions in the Yarra community by 20% from 1996 levels, or 300,000 tonnes, by 2010. It is estimated that 85% of greenhouse emissions from the Yarra community are from electricity and gas consumption. 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

## Townhouse development

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

### What's important in designing a sustainable townhouse?

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

To be truly sustainable, design 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 townhouse can continue to be occupied for many years without being demolished or extensively renovated.

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](http://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

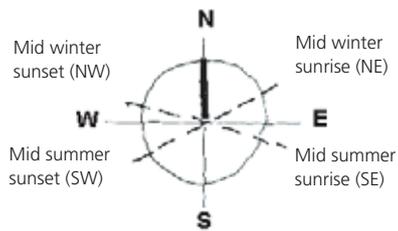
# Passive solar design

## Passive solar design

Passive solar design uses the heat of the sun and natural night-time cooling to keep dwellings at a comfortable temperature all year around.

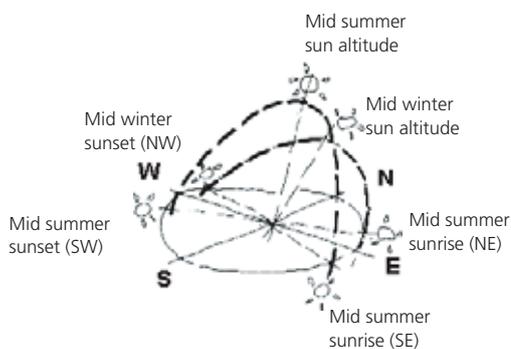
By applying passive solar design principles you can reduce or eliminate mechanical heating and cooling, save on energy costs and reduce greenhouse emissions.

Getting the most out of orientation is the key factor in designing your townhouse development.



**Fig. 1a 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.

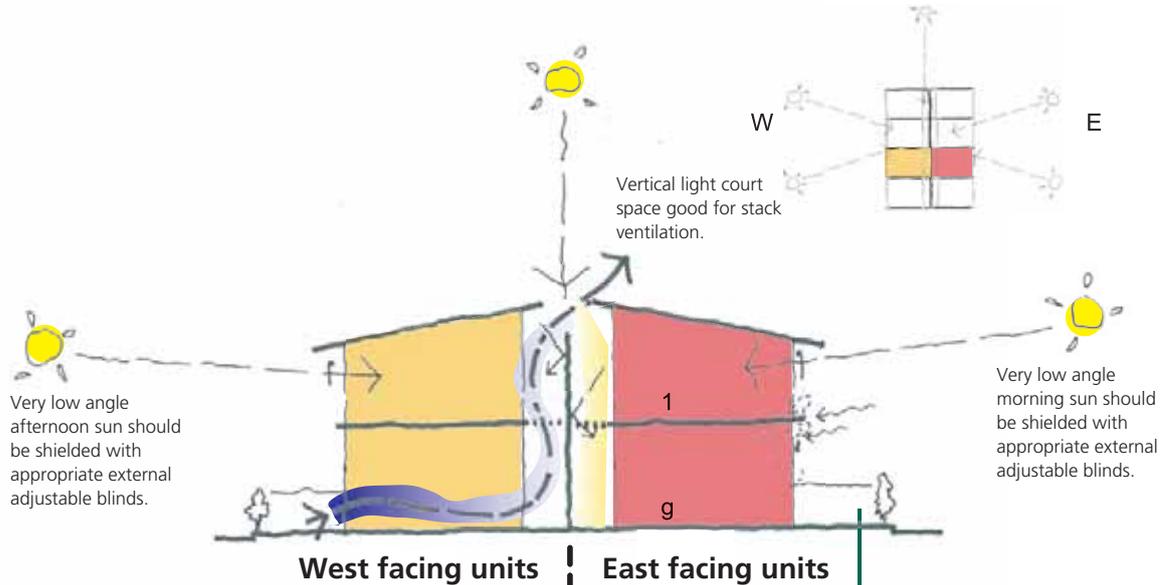


**Fig. 1b Sun's path through the sky**

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.

# Sustainable Design Guidelines

## Passive solar design

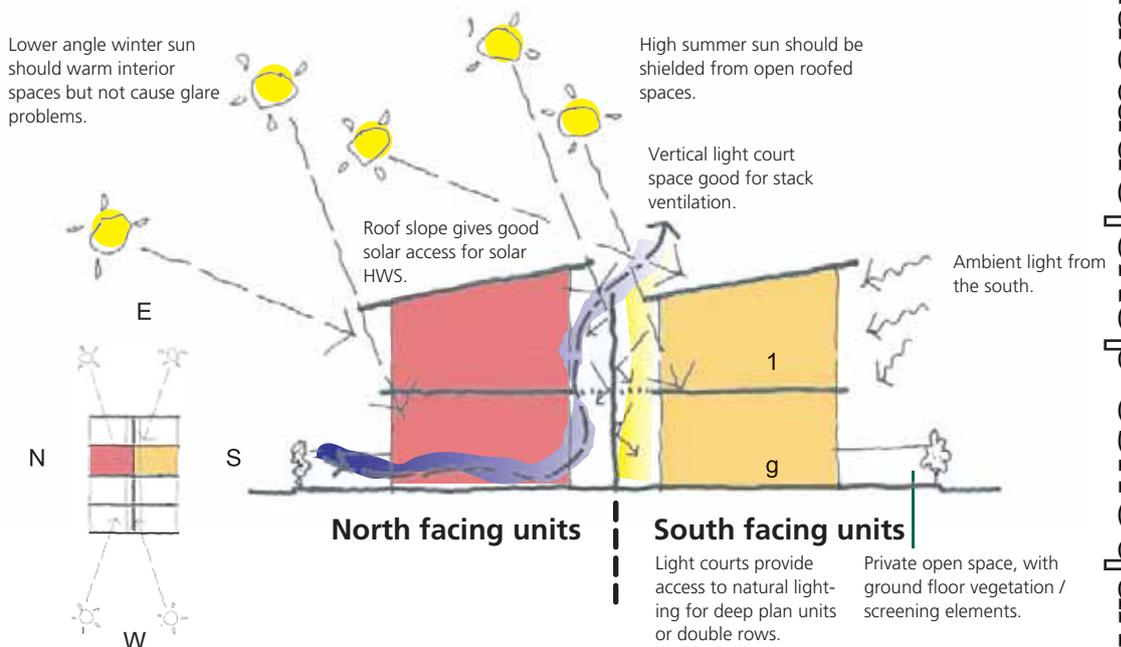


**Fig. 2a Example section, east/west orientation**

Sketch neighbouring buildings, orientation, prevailing winds and any other features that will effect solar access, ventilation or shading of the building.

Light courts provide access to natural lighting for deep plan units or double rows.

Private open space, with ground floor vegetation / screening elements.



**Fig. 2b Example section, north/south orientation**

Sketch neighbouring buildings, orientation, prevailing winds and any other features that will affect solar access, ventilation or shading of the building.

Light courts provide access to natural lighting for deep plan units or double rows.

Private open space, with ground floor vegetation / screening elements.

# Passive solar design

## Orientation and zoning

Townhouse design is inherently more energy efficient than detached housing because:

- party walls are shared and not exposed to outside temperatures
- they have a smaller footprint, minimising heat transfer from external surfaces.

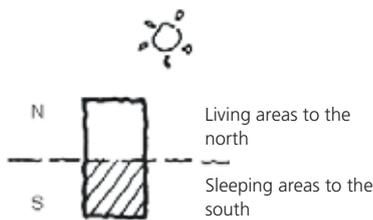


Fig. 3 Zoning

Good design strategies to apply to internal spaces include:

- placing day use areas such as living rooms and children’s bedrooms to the north
- placing utility areas such as laundry and bath rooms to the south and west
- placing kitchens and bedrooms to the east to access morning sun
- avoiding ceilings higher than 2.7 metres to minimise heating and cooling requirements
- separating heated and unheated zones by doors
- providing outdoor spaces that are sheltered and sunny in winter but cool in summer.

## Daylight and sun control

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

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.

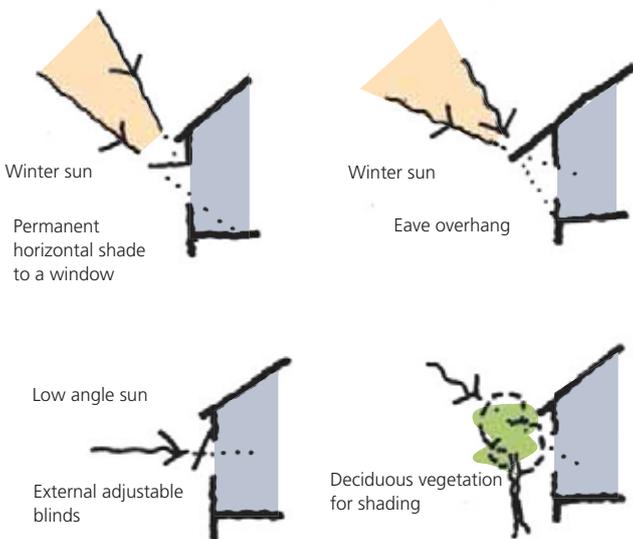


Fig. 4 Shading and sun control

A number of options for sun control are illustrated. External blinds should be easily adjustable to maintain good natural light.

# Sustainable Design Guidelines

## Passive solar design

High level clerestory windows for ventilating trapped air.



Use wind flow to remove hot air by locating windows on opposite sides of a room.



Use a fan to circulate and ventilate high level hot air from a space.



**Fig. 5 Ventilation**

Exchanging warm internal air for fresh cool night air is a very effective way to deal with summer heat.

## Ventilation

Ventilation is a free means of removing heat from a home after a hot summer day. Design strategies to improve ventilation 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.



**Fig. 6 'Stack effect'**

Stair wells and vertical connections can be good sources of 'stack' ventilation which relies on rising hot air drawing in a cooler supply through lower levels.

## Insulation and thermal mass

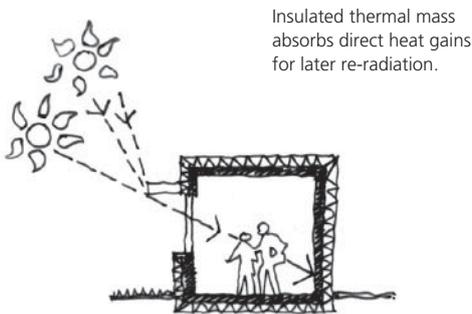
Insulation provides a barrier to heat flow, keeping rooms more comfortable and saving energy. As a guide, ceiling insulation should be R2.5 to 3.5, walls R1.5 to 2, and floors R1 to 2.5. The R values indicate the resistance of the insulation to heat movement.

Insulated thermal mass absorbs direct heat gains 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 set.

Walled areas shared between units, and floors between levels, do not require thermal insulation if the 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.

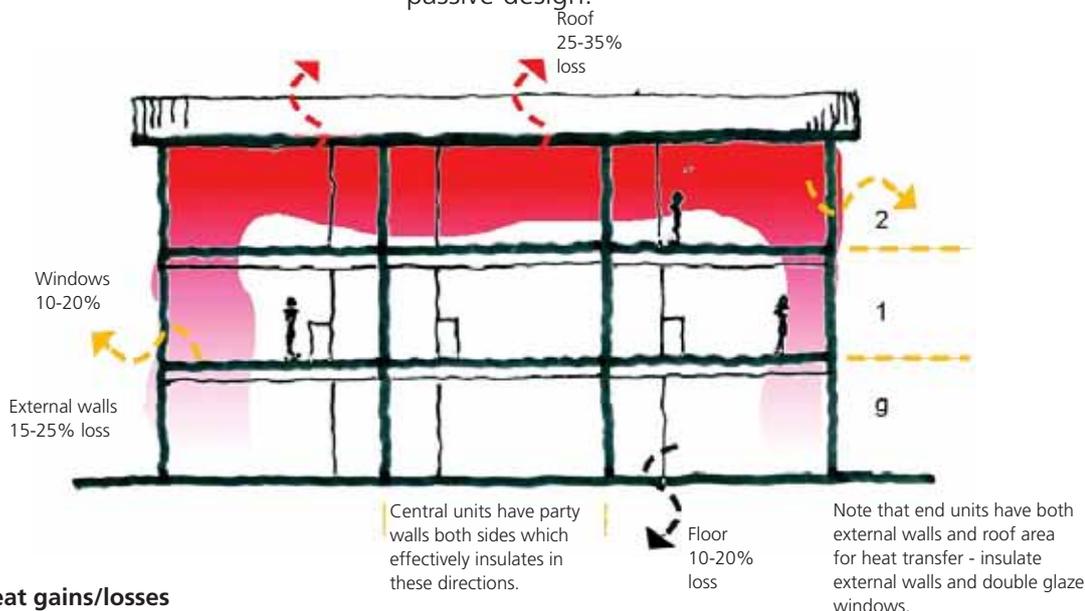
Heat transfer through suspended floors over garages can be avoided by insulating timber floors with bulk insulation between joists or to the underside of the suspended slab floor.

Draught-proofing the building by sealing all gaps and cracks during construction (e.g. between window frames and walls) is vital if you're going to achieving the benefits of insulation and passive design.



**Fig. 7 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.



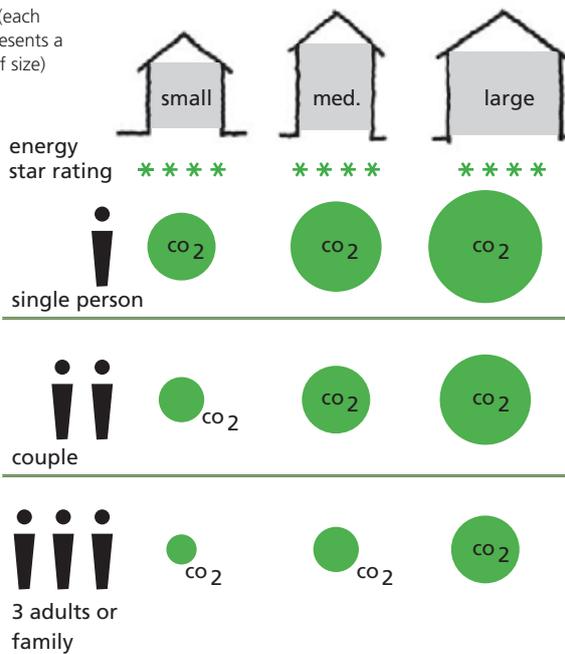
**Fig. 8 Typical heat gains/losses**

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

# Sustainable Design Guidelines

## Energy services

Floor area (each house represents a doubling of size)



**Fig. 9 CO2 'footprint'**

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



**Fig 10 'First rate' energy rating**

A computer software package can calculate your energy expenditure based on the nature of your townhouse. Variables such as amount of window area, insulation and height of ceilings will determine the energy rating you receive.

## 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 has a much reduced requirement for mechanical heating and may completely avoid the need for additional cooling.

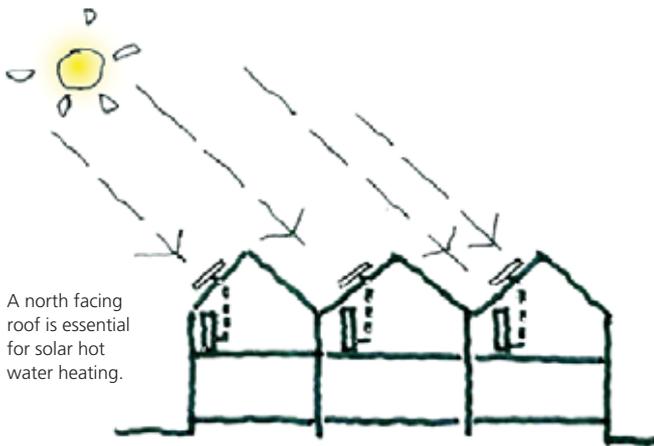
**Tips for selecting heating and cooling systems include:**

- installing units with the highest energy star rating available
- zoning the townhouse by installing heating and cooling only where it is needed
- if providing heating only:
  - note that it is generally preferable to install a high efficiency natural gas space heater to heat a large room rather than central heating
  - remember that central heating systems should be high efficiency natural gas and zoned to reflect the use of different rooms
- If providing cooling:
  - remember that ceiling fans coupled with cross ventilation will usually provide adequate comfort
  - be aware that a reverse cycle air-conditioner with a heating star rating of 2.5 stars is also an efficient space heating solution.

## Energy ratings

Energy ratings measure 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. Accredited energy raters can undertake an assessment of your design.

# Energy services



A north facing roof is essential for solar hot water heating.

**Fig. 11 Solar hot water**

Solar hot water panels which heat water directly by the sun's energy, need north facing sloped roofs to work effectively.

## Supplying hot water

The priorities for minimising hot water costs and environmental impact are:

- reducing the demand for hot water (e.g water efficient shower, washing machine taps, etc.)
- locating appliances that use hot water close together and near the water heater.

In general, the water heaters with the lowest life cycle greenhouse emissions include:

- a gas boosted solar water heater. This is the best option where a north facing roof pitch with uninterrupted solar access is available. To avoid conflict with heritage and streetscape policies, the units should be sited where they are not visible from the street
- an instantaneous gas water heater
- an electric heat pump, which is the most environmentally benign electric means of heating water using electricity.

## Clothes drying

Electric clothes dryers can be a significant energy user in medium density residential developments.

To avoid the need for clothes dryers:

- use solar energy by installing 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 to circulate air.



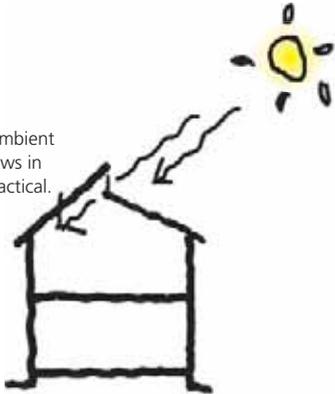
**Fig. 12 Appliance ratings**

Check your appliance for an accredited rating scheme.

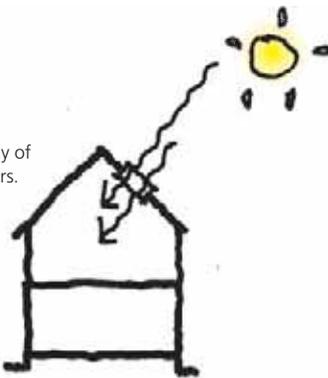
# Sustainable Design Guidelines

## Energy services

Clerestory windows take advantage of direct and ambient natural light where windows in the external wall are impractical.



Skylights are an excellent way of admitting light to upper floors.



**Fig. 13 Natural lighting**

Natural light is an important part of a quality indoor environment.



**Fig 14 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

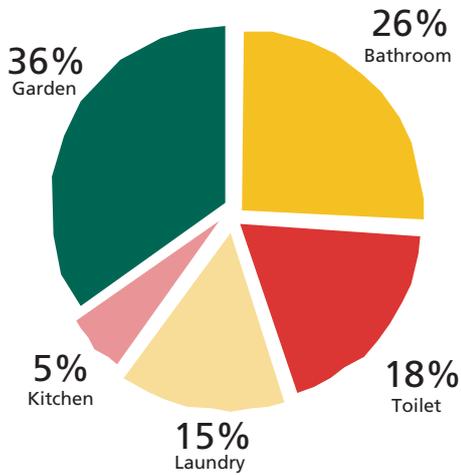
Daylight is not only a free source of light, but it is widely acknowledged that homes with good levels of daylight are also more liveable. The challenge is to provide daylight while controlling glare and summer heat.

Daylight should be provided to all rooms by:

- carefully locating windows to capture north light
- providing appropriate shading for windows
- installing double glazed or tubular skylights in rooms with no external walls
- using light coloured external and internal finishes to reflect available light.

When designing the lighting layout, consider:

- 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
- low voltage lights are not cheap to run and have a much shorter life than compact fluorescent lights
- the activities which are likely to occur 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
- providing separate switches for each lighting group
- controlling outside lights with combined automatic movement and daylight switches.



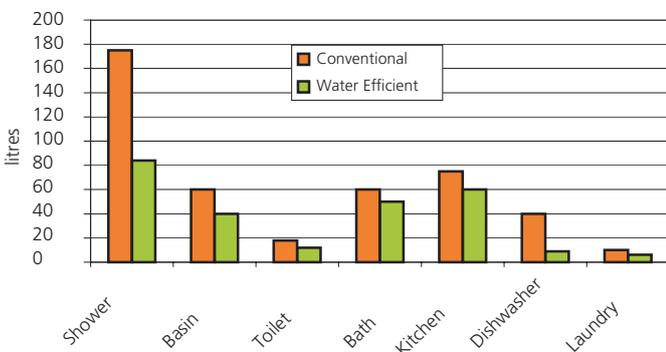
**Fig. 15 Household water use in Melbourne**

Data based on an average sized dwelling.

| Roof catchment area   | 50m <sup>2</sup> | 100m <sup>2</sup> |
|-----------------------|------------------|-------------------|
| Rainfall (kilolitres) | 36 kl/year       | 72 kl/year        |
| Tank size (l)         | 500              | 81%               |
|                       | 1000             | 83%               |
|                       | 2500             | 99%               |
|                       | 5000             | 100%              |
|                       | 10000            | 100%              |

**Fig. 16 Percentage of water demand met**

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



**Fig. 17 Comparative water consumption**

Data based on an average sized dwelling.

## 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 that stormwater runoff does not adversely affect local waterways which run into the Yarra River and ultimately flow into Port Phillip Bay.

Key sustainable water cycle strategies to consider during design and construction of townhouses are:

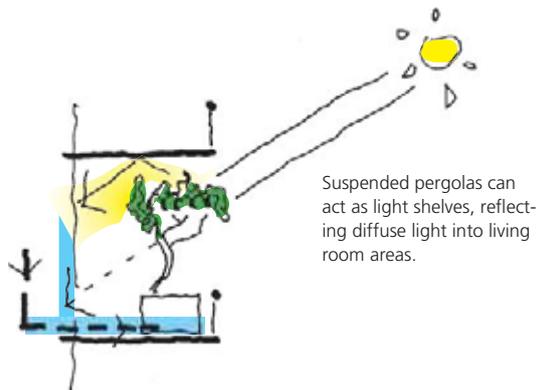
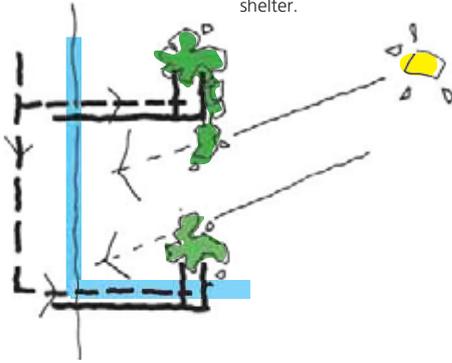
- selecting minimum flow (AAA rated) taps, showerheads and appliances such as dishwashers and washing machines
- selecting indigenous and drought resistant plants to minimise the demand for garden water (For more information regarding species selection, refer to the booklet *Gardening with Native Plants in Yarra* which is available from Council.)
- installing an efficient drip irrigation system
- installing rainwater tanks and reusing the water for toilet flushing and watering gardens. Note that it's easier to collect the rainwater if the roof drains to a single point. Many different tank options are available for small sites e.g. underground, slimline tanks, fence / wall storage or even bladders which can be placed under timber floors or decking
- allowing rainwater to infiltrate through the soil rather than drain off site by choosing pervious materials for outdoor areas in preference to hard paving
- separately collecting greywater from laundries and showers for reuse to flush toilet and/or irrigate gardens. (Note that greywater systems must be approved by the EPA. Visit [www.epa.vic.gov.au](http://www.epa.vic.gov.au) for more information.)

# Sustainable Design Guidelines

## Landscaping and Transport

Provide drip irrigation directly to base of planters to maintain growth.

Vegetation can significantly improve outdoor spaces by reducing glare and providing shelter.



Suspended pergolas can act as light shelves, reflecting diffuse light into living room areas.

**Fig. 18 Greening via balconies**

Lightweight structures supporting deciduous vegetation or adjustable blinds, make exterior spaces liveable all year round.

## Landscaping

Integrated landscaping contributes to sustainable outcomes by providing shading, insulation, improved air quality and 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.

## Minimising car use

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

Ensuring that dwellings have secure, under cover bicycle storage which is easily accessible from the street front, will make it more likely that residents will use bicycles.

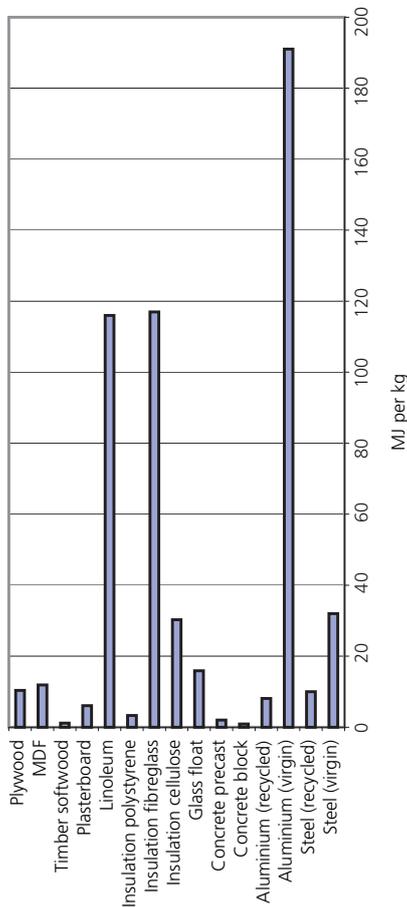
In large developments, bicycle hoops should be provided in a well lit, highly visible location.

## 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.

- Retain and reuse as much of the existing building as possible.
- Design the townhouse(s) to enable rooms to be used for multiple functions - to reduce overall building size and reduce the likelihood of future renovations.
- To reduce wastage select dimensions to suit standard material sizes.
- Favour construction systems that allow for offsite 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.
- Avoid using timbers harvested from native forests.
- Avoid materials that require long distance transporting.
- Facilitate waste management during life of building by providing adequate space for recycling receptacles.

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. 19 Embodied energy (MJ/kg)**

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



**Fig. 20 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.

# Sustainable Design Guidelines

## Materials

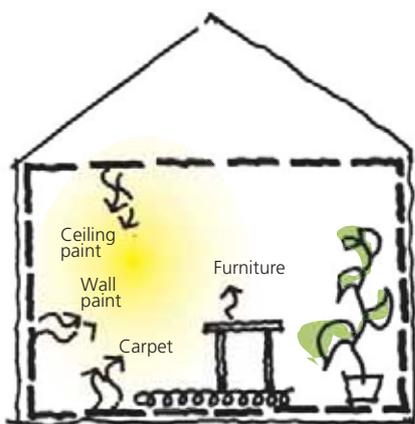
The use of synthetic building materials, finishes and furnishings which release (or 'off-gas') pollutants can contribute to poor air quality and wellbeing. While pollutant levels from individual sources may not pose a significant health risk, most homes have multiple sources of indoor air pollution which may negatively interact.

Avoid key problem sources/materials by:

- 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 MDF or particle board. (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.)

## Indoor air quality

- painting walls, ceilings and other surfaces with low VOC 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
- if 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. 21 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'.

## 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](http://www.energyrating.gov.au)

### **Australian Greenhouse Office, Your Home Guide**

[www.greenhouse.gov.au/yourhome](http://www.greenhouse.gov.au/yourhome)

### **Building Commission**

[www.buildingcommission.com.au](http://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](http://www.nphp.gov.au/enhealth/council/pubs/pdf/healthyhomes.pdf)

### **Ecorecycle Victoria**

[www.ecorecycle.vic.gov.au](http://www.ecorecycle.vic.gov.au)

### **Ecospecifier**

[www.ecospecifier.org](http://www.ecospecifier.org)

### **Commonwealth Department of Environment and Heritage, Air Toxic Web Site**

[www.deh.gov.au/atmosphere/airtoxics](http://www.deh.gov.au/atmosphere/airtoxics)

### **Smart Water Project**

[www.emegroup.com.au/urbanwater](http://www.emegroup.com.au/urbanwater)

### **Sustainable Energy Authority**

[www.seav.vic.gov.au](http://www.seav.vic.gov.au)

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