WINDOWS PLACEMENT AND SIZING

This fact sheet contains information and recommendations on the sizing and placement of windows to maximise winter sun penetration, while minimising excessive summer heat gain and winter heat loss.

Benefits of good window design

Windows are a vital part of any home—they allow natural light into the home providing views and fresh air. Well-planned and protected windows improve comfort year-round and reduce the need for heating in winter and cooling in summer.

Window size, orientation, glazing treatment, shading and internal coverings can have a significant impact on energy efficiency and comfort. Designing north windows for maximum solar access can reduce winter heating bills by up to 25%. External shading can block up to 80% of summer heat gain through windows. Internal window coverings and double glazing can reduce winter heat losses by around 40%.

Window design and shading principles

The three main principles of energy smart window design are listed below.

1. Maximise winter heat gain by orientating windows to the north and sizing windows to suit the amount of thermal mass in the dwelling.
2. Minimise winter heat loss through appropriate window sizing, together with double glazing and/or close-fitting internal coverings such as drapes with pelmets.
3. Minimise summer heat gain by protecting windows with external shading devices, and through appropriate sizing and positioning of windows.

The same principles apply to other types of glazing, such as glass doors, roof windows and skylights. Wherever the term ‘window’ is used in this fact sheet, it encompasses all forms of glazing.

Heat flow through glass

The main heat gain through windows is due to solar radiation. Windows receive this as both diffuse radiation reflected from the sky and ground, and direct radiation when the sun shines on the window. On average, between 30–40% of total radiation to north windows is diffuse, depending on weather conditions.

A greenhouse effect occurs when radiation from the sun enters the home through the glass. As this term is now commonly used to refer to the global warming caused by the increase of certain gases in the atmosphere, the term ‘glasshouse effect’ will be used here to avoid confusion.

Figure 5.1 shows how the glasshouse effect occurs. Radiation from the sun (shortwave radiation) passes through glass to the interior virtually unimpeded. This radiant heat is absorbed by furniture and building elements, which then heat up and re-radiate heat to the room air. This re-radiated heat (longwave radiation) does not pass through glass as readily, resulting in convective heat build-up within the room.

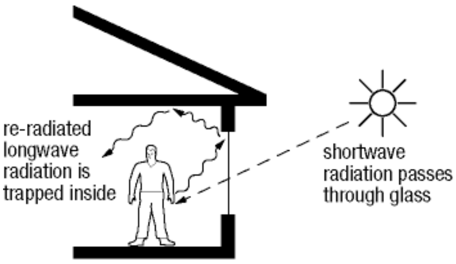


Figure 5.1: The glasshouse effect

The glasshouse effect can be used to advantage in winter to keep a home warm. In summer, however, it should be avoided by shading glass from the direct rays of the sun.

Heat also passes through glass by conduction, caused by heat flowing through glass from areas of higher to lower air temperatures. A bare window with a sheet of three-millimetre glass can gain (or lose) up to ten times more heat than through an insulated wall of the same size. On a winter night, large amounts of heat can be lost through unprotected glazing in a home. Glass is therefore the potential weak link in building design.

The amount of heat transmitted through the glass depends on a number of factors including window orientation, size, amount of external shading, and glass treatments such as tinting or reflective films. Net heat gains depend on the balance between the amount of direct and diffuse radiation received and the amount of heat lost. It is vital to have a net heat gain through windows in winter, and a net heat loss in summer.

Window orientation

The amount of radiation received by a window varies according to orientation and time of year. During summer, all windows receive net heat gains, but especially those facing east and west. Figure 5.2 compares the summer radiation received by windows of different orientations with the heat given out by a two-bar radiator operating three hours per day. As can be seen, most unshaded windows receive substantial heat gains.

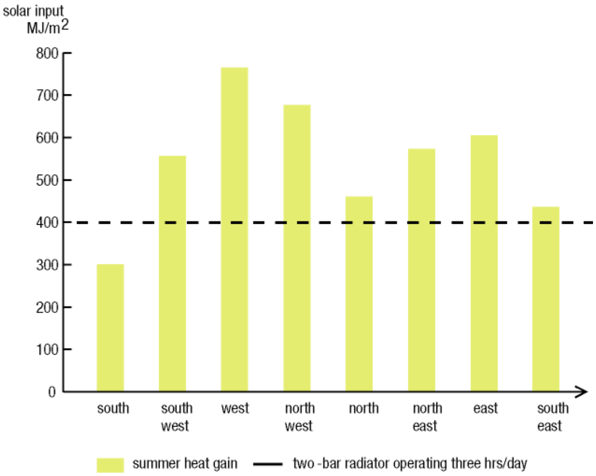


Figure 5.2: Window orientation and summer radiation (unshaded glass)

In winter, the situation is different. Only windows facing north, north-west and north-east have a net heat gain over winter, with heat gains outweighing heat losses (see figure 5.4). Although east and west windows receive substantial solar radiation in the morning and afternoon, respectively, the overall heat losses outweigh the gains over a 24-hour period. Windows orientated to the south also have net heat loss.

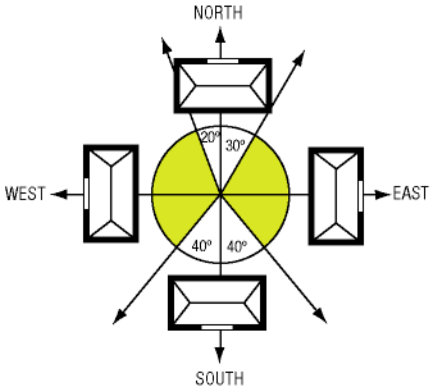


Figure 5.3: Window orientations considered to be north, east, west and south

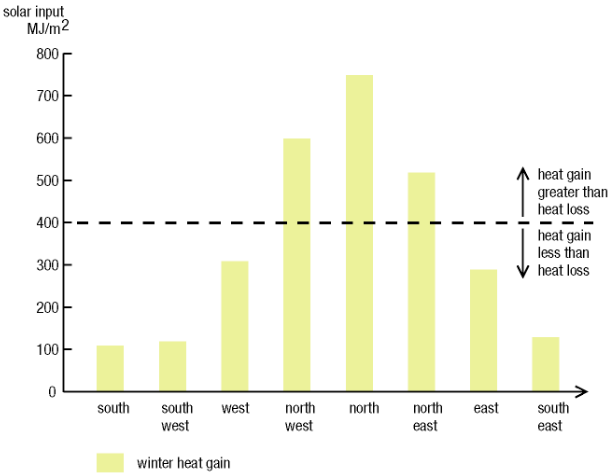


Figure 5.4: Window orientation and winter radiation (unshaded glass)

Figure 5.3 shows the range of orientations for Victoria within which a window is regarded as facing north, east, west, or south. These orientations are used for all tables and calculations in this fact sheet.

North-facing windows receive winter sun, allowing light and warmth into the home. They can be easily shaded in summer to help keep the home cool. If north-facing windows are too large, they will suffer excessive heat loss in winter and heat gain in summer. The optimum size of north-facing windows will depend on solar access and the building materials used.

East and west-facing windows receive little winter, autumn and spring sunlight, but excessive summer sunlight. They should therefore be kept small, especially those facing west, and be well shaded.

South-facing windows receive no direct sunlight in winter and only receive early morning and late afternoon sunlight in summer. They should be kept small, however, with cooling breezes in summer usually coming from the south, they are useful for cross-ventilation.

Optimum window size

The most appropriate size of windows for energy smart design depends on building orientation and the amount of thermal mass in the internal building materials. The total glass area is best kept between 20–25% of the total floor area for brick veneer houses and 22–30% for double-brick houses.

Three factors to consider in sizing windows are listed below.

1. Window area must be kept within acceptable limits.
2. Balancing different orientations of north, south, east and west glass should be used.
3. Glass in individual rooms should be correctly sized.

In addition, Victorian building regulations require a minimum glass area of 10% of the room's floor area for each habitable room.

The *FirstRate* House Energy Rating can be used to assess the effect of variations to glass areas, window orientations, shading, internal coverings or double glazing on energy efficiency.

Thermal mass (refer to *Thermal mass* fact sheet) can be used to moderate temperature and balance the area of glass.

Total window area

Table 5.1 gives recommended **total** window areas expressed as a percentage of total floor area. Larger areas of glass are better suited to homes with higher levels of thermal mass and larger north-facing windows.

CONSTRUCTION TYPE	TOTAL AREA % WHEN NORTH GLASS IS LESS THAN 5% OF TOTAL FLOOR AREA	TOTAL AREA % WHEN NORTH GLASS IS MORE THAN 5% OF TOTAL FLOOR AREA
Timber Floor		
Brick veneer and weatherboard walls	20.0	22.5
Brick cavity walls	22.5	27.5
Concrete slab floor		
Brick veneer and weatherboard walls	22.5	25.0
Brick cavity walls	25.0	30.0

Table 5.1: Maximum total glass area as percentage of total floor area

Balancing different orientations

It is recommended that the majority of glass be orientated towards the north. This provides maximum winter benefits, and can be easily shaded in summer. Smaller amounts should face east and south, with even smaller amounts facing west.

North-facing windows

Between 30° east of true north and 20° west of true north (see figure 5.5).

Ideal sizes of north-facing windows depend on solar access and the building materials used. Additional thermal mass such as internal brick walls can improve energy efficiency and allow the use of more north-facing glass.

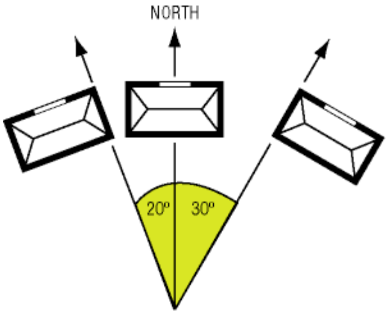


Figure 5.5: Range of acceptable orientations for north-facing windows

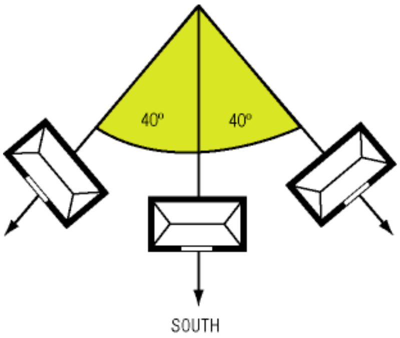


Figure 5.6: Orientation of windows considered to be south-facing

If solar access is good and the **floors are concrete slab**:

> the area of north-facing windows should be large: between 10–15% of the home's total floor area; and
> the area of north-facing windows in individual rooms can be up to 25% of the room's floor area.

If solar access is good and the **floors are timber**:

> the area of north-facing windows should be large: around 10% of the home's total floor area; and
> the area of north-facing windows in individual rooms can be up to 20% of the room's floor area.

If solar access is **poor**:

> the area of north-facing windows should be kept reasonably small: less than 8% of the home's total floor area; and
> keep the window area in individual rooms less than 15% of the room's floor area.

South-facing windows

Between 40° east of south and 40° west of south (see figure 5.6).

> Keep south-facing windows reasonably small: total window area should be less than 5% of the home's total floor area.
> Keep the window area in individual rooms less than 15% of the room's floor area.
> Place south-facing rooms and windows so that cooling summer breezes can pass through the rooms easily.

East-facing windows

Between 30° east of true north and 40° east of south (see figure 5.7).

> Keep east-facing windows reasonably small: total window area should be less than 5% of the home's total floor area.
> Keep the window area in individual rooms less than 15% of the room's floor area.
Shade east-facing windows in summer.

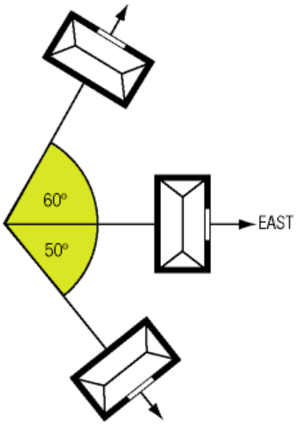


Figure 5.7: Orientation of windows considered to be east-facing

West-facing windows

Between 20° west of true north and 40° west of south (see figure 5.8).

> Keep west-facing windows small: total window area should be less than 3% of the home's total floor area.

> Keep the window area in individual rooms less than 10% of the room's floor area.

> Shade west-facing windows in summer.

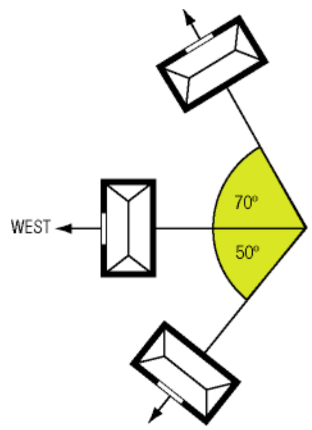


Figure 5.8: Orientation of windows considered to be west-facing

Roof windows and skylights

Roof windows and skylights should:

> be kept as small as possible;

> be avoided in living and bedroom areas;

> provide summer shading and protection from winter heat loss; and

> be doubled-glazed or have a ceiling diffuser fitted.

Windows facing more than one direction

The maximum window sizes apply to rooms that have windows facing only one direction. If rooms with east or west windows have windows facing other directions as well, maximum sizes should be adjusted as follows:

> reduce east glass by 1% for every 1.5% of north window area and 2.8% of south window area; and

> reduce west glass by 1% for every 2% of north window area and 3.5% of south window area.

Sites with poor solar access

Innovative design can overcome problems of poor solar access and overshadowing. This is often a problem for renovations, infill development, higher density and small lot developments. In situations with little or no direct solar access (e.g. homes with mainly south-facing windows or heavily shaded sites), appropriate levels of insulation, window protection and draught proofing are vital. Conversely, thermal mass is of less importance.

To compensate for poor solar access, the total window area of the home should be kept below 20% of the total floor area. Also, the following window design strategies should be considered.

Raise sill heights

Raising sill heights can avoid 'wasted' areas of glass which are permanently in shadow (see figure 5.9). They allow high solar gains to be achieved for north windows with as little as four metres separation between single-storey buildings.

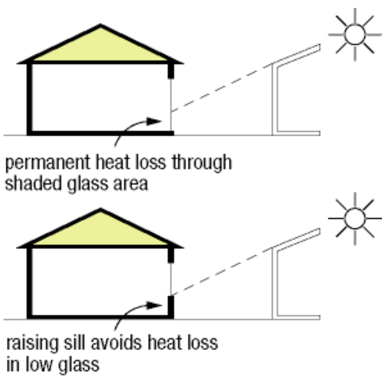


Figure 5.9: Raise sill height to maximise winter heat gain

Table 5.2 shows the recommended sill heights and distance required from a northern obstruction to maintain 90% of winter solar access.

SILL HEIGHT	DISTANCE (METRES) NEEDED TO MAINTAIN 90% SOLAR ACCESS		
	ONE STOREY	TWO STOREY	THREE STOREY
Eave width (600 mm)			
Floor level	5.8	11.0	16.5
0.3 mm	5.3	10.0	15.2
0.6 mm	5.0	9.4	14.4
Eave width (300 mm)			
0.9 mm	4.3	8.0	13.5

Table 5.2: Distance between buildings needed to maintain 90% solar access

Clerestory windows

North-facing clerestory windows should be considered as they can be particularly useful where there is a building obstructing solar access to the north (see figure 5.10). A simple eave overhang for a northern orientation can shade clerestory windows. For east and west-facing clerestory windows, internally-operated adjustable louvres or blinds installed internally or externally, or sandwiched between two panes of glazing, can be used. Tinted glass could also be considered, although this will reduce winter light and affect heat gain.

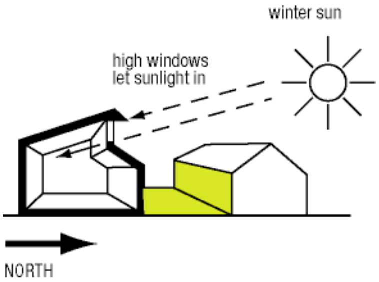


Figure 5.10: North-facing clerestory windows can provide solar access

Courtyards

A north-facing courtyard can be created with an L-shaped or U-shaped house plan. Courtyard windows need to be small in size, as overshadowing by the side walls of the building itself and adjacent structures will occur, reducing solar access (see figures 5.11 and 5.12).

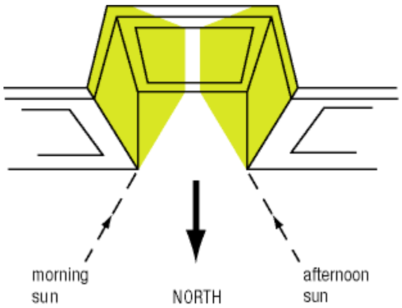


Figure 5.11: Side walls overshadow large windows in deep courtyards in winter

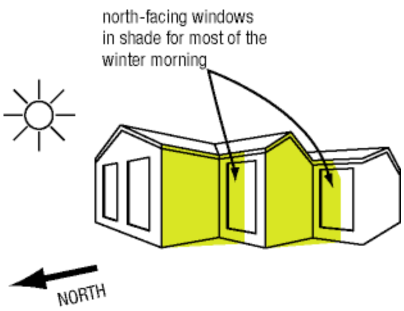


Figure 5.12: East and west-facing walls can shade adjacent north-facing windows in winter

More overshadowing will occur on the lower part of the wall than the upper, so minimise the use of full-height windows adjacent to side walls. Table 5.3 sets out a formula for identifying the preferred glazing zone. This table allows the optimum area of glazing both above and below 1200 mm in height to be gauged.

Depending on the dimensions of the courtyard and the height of adjacent obstructions, courtyard windows may need summer shading (see table 5.3).

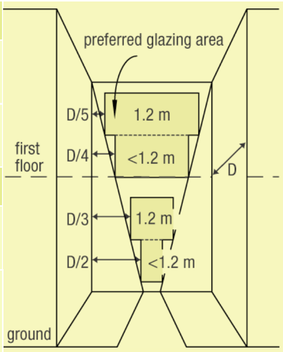
WINDOW LOCATION AND HEIGHT	DISTANCE TO INSET WINDOW FROM SIDE WALL (D = DEPTH OF WALL)	PREFERRED GLAZING ZONE
First floor		
> Windows with any glazing below 1200 mm	D/4 (max 1.5 m)	
> Windows with all glazing below 1200 mm	D/5 (max 1 m)	
Ground floor		
> Windows with any glazing below 1200 mm	D/2 (max 3 m)	
> Windows with all glazing below 1200 mm	D/3 (max 2.2 m)	

Table 5.3: Preferred glazing zone for recessed northern walls

Solar gain from east or west windows

In the absence of northern solar access, windows to the east and west can provide some winter heat gains. As winter heat losses and summer heat gains are greater for east and west windows than for north windows, appropriate shading and protection from heat loss is essential. Keep window areas within the limits suggested.