CHAPTER 5

WINDOWS

This chapter contains information and recommendations on the sizing and placement of windows, together with details on how to maximise winter sun penetration, while minimising excessive summer heat gain and winter heat loss.

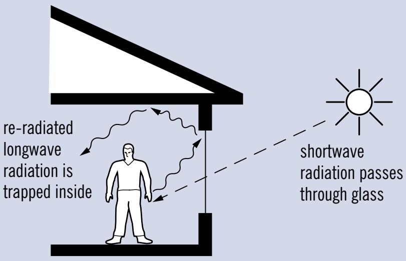


Figure 5.1: The glasshouse effect

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 chapter, 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.

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.

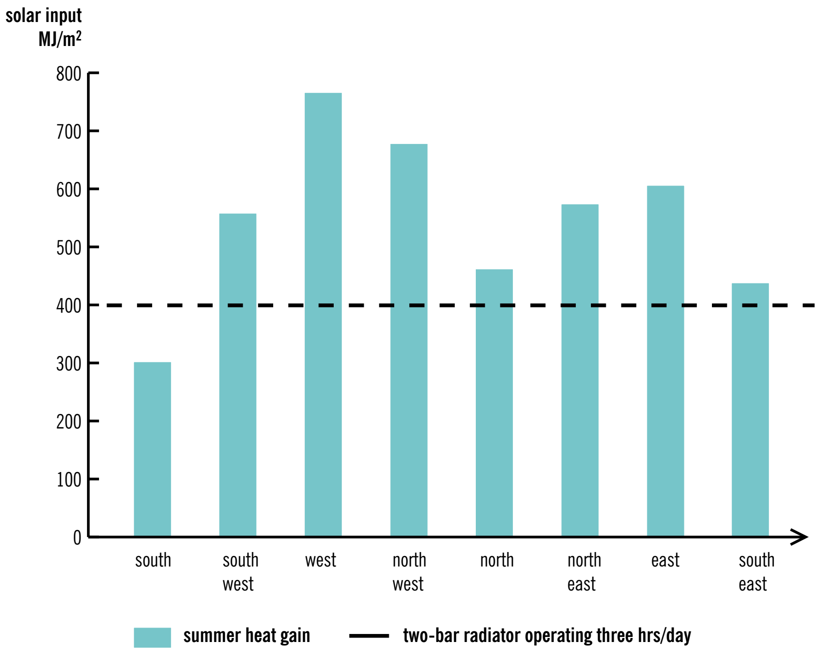


Figure 5.2: Window orientation and summer radiation (unshaded glass)

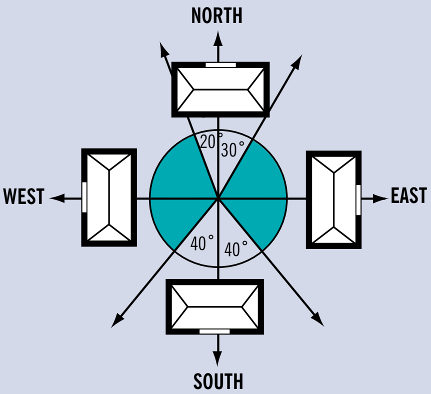


Figure 5.3: Window orientations considered to be north, east, west and south

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.

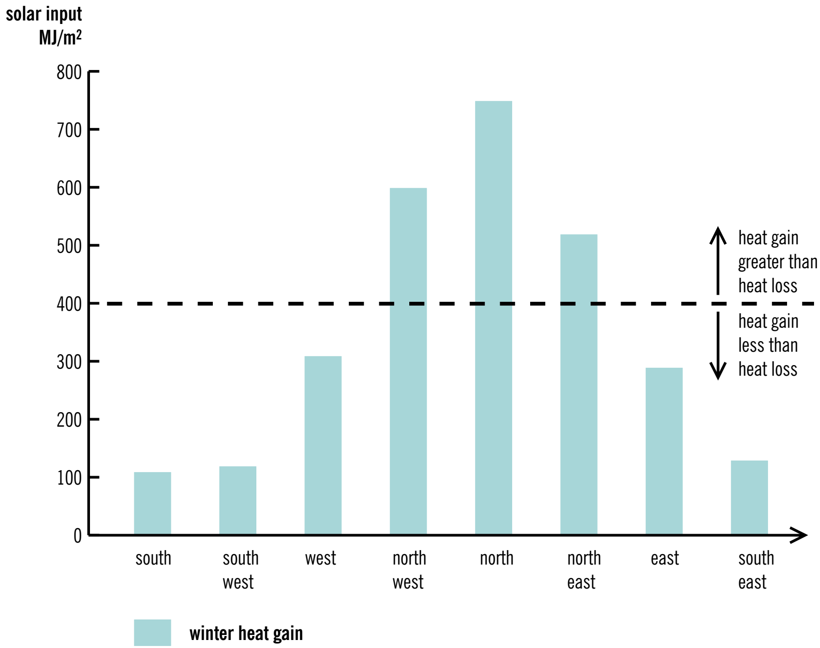


Figure 5.4: Window orientation and winter radiation (unshaded glass)

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 chapter.

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 software (refer to Chapter 11) 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 Chapter 6) 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.

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

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

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.

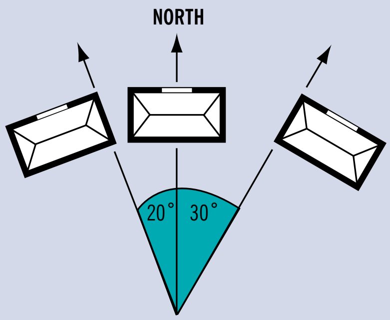


Figure 5.5: Range of acceptable orientations for north-facing windows

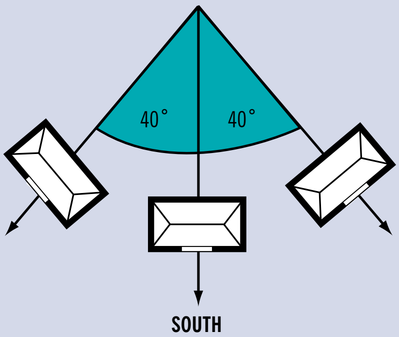


Figure 5.6: Orientation of windows considered to be south-facing

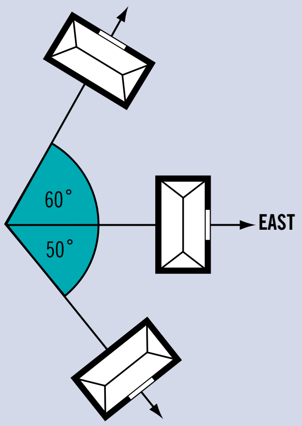


Figure 5.7: Orientation of windows considered to be east-facing

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.

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.

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.

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.

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

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

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

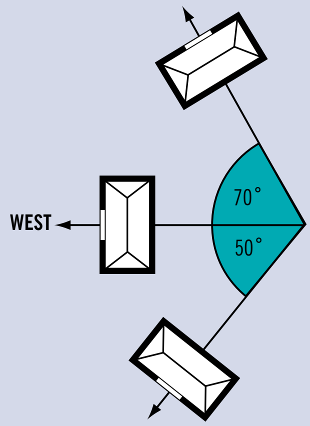


Figure 5.8: Orientation of windows considered to be west-facing

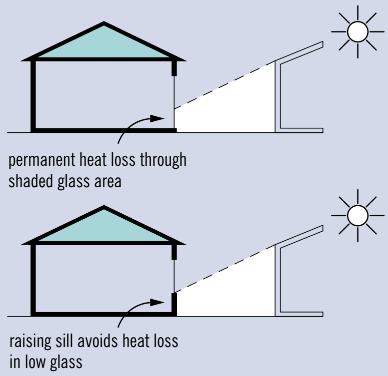


Figure 5.9: Raise sill height to maximise winter heat gain

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.

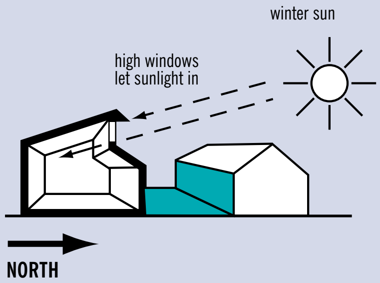


Figure 5.10: North-facing clerestory windows can provide solar access

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).

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).

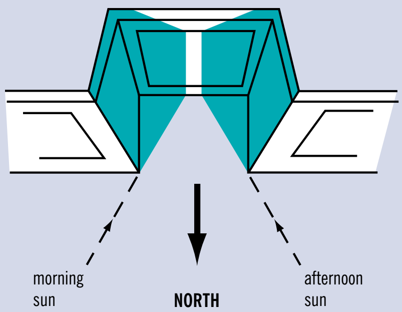
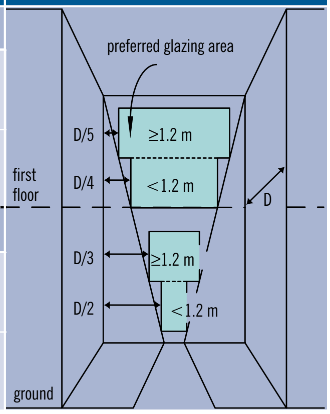


Figure 5.11: Side walls overshadow large windows in deep courtyards in winter

Table 5.3: Preferred glazing zone for recessed northern walls

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 above 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 above 1200 mm	D/3 (max 2.2 m)	

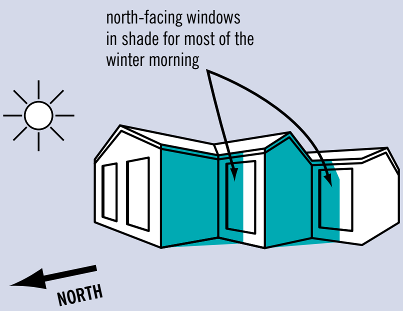


Figure 5.12: East and west-facing walls can shade adjacent north-facing windows in winter

SOLAR GAIN FROM EAST OR WEST WINDOWS

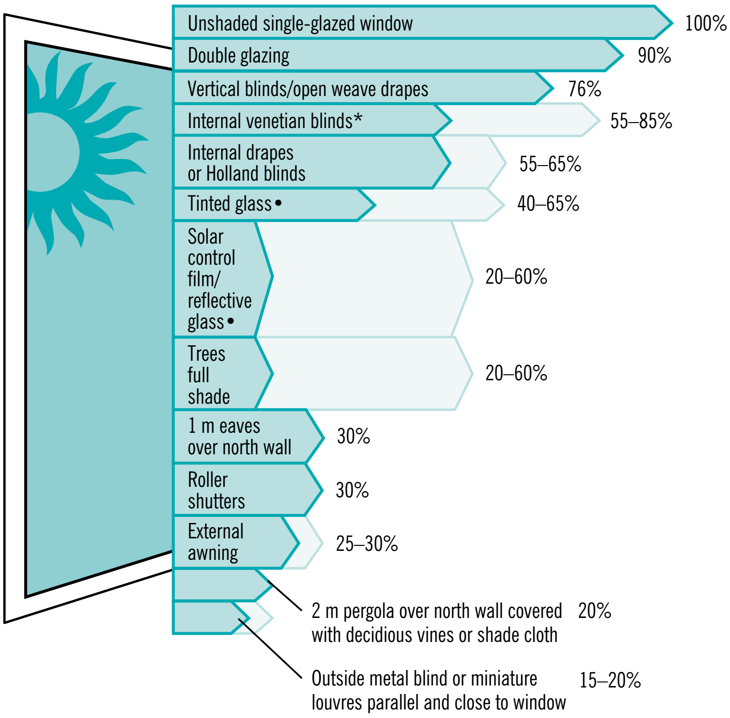
In the absence of northern solar access, windows to the east and west can provide some winter heat gains. As winter heat losses and summer heat gains are greater for east and west windows than for north windows, appropriate shading and protection from heat loss is essential.
Keep window areas within the limits suggested on page 24.

Reducing summer heat gain

External shading devices are an effective way to reduce heat gain through windows in summer and keep a home cool. They provide much better protection from heat gain than internal window coverings. External shading reduces heat gains by 70–85%, whereas internal coverings can reduce heat gains by as little as 15% (see figure 5.13).

Shading devices should allow for ventilation on the outside of the window. If shading is fitted too closely to the window, warm air can be trapped and heat conducted into the room.

If external shading is not feasible, internal shading devices such as close-fitting blinds, lined curtains or internal shutters are preferable to no shading at all.



* Effectiveness is reduced as the colour darkens
• Solar film, tinted glass and reflective glass of varying effectiveness is available. They significantly reduce light levels all year round.

Figure 5.13: Comparison of heat gains through different window treatments in summer

FIXED OR ADJUSTABLE SHADING

Fixed shading includes structures such as eaves, pergolas or verandahs—i.e. usually a part of the building structure (see figure 5.14). They are only appropriate for use over north-facing windows. Although fixed devices provide effective protection from heat gain, they lack flexibility in situations where shading may be needed one day but not the next. However, fixed shading is durable and does not require ongoing adjustment. It is important to allow an adequate distance between the top of the window and the underside of the shading device. This avoids partial shading of the window in winter. This should be about one sixth or 16% of the height of the window (see figure 5.17).

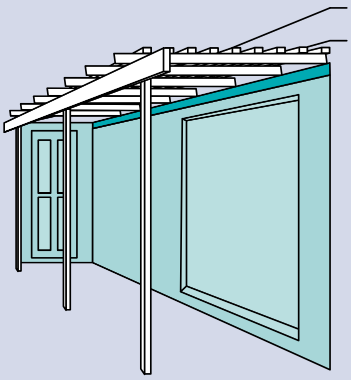


Figure 5.14: Fixed shading

Adjustable shading devices can also be used. These include canvas blinds, conventional or roller shutters, angled metal slats and shadecloth over pergolas. Such devices permit greater flexibility to make adjustments on a day-by-day, or even hour-by-hour, basis, in response to changing weather conditions and individual comfort levels. They can be completely retracted to maximise winter solar access. However, the user is required to respond to climatic conditions (see figure 5.15).

In general, it is a wise idea to choose adjustable shading wherever possible and convenient.

Choosing shading devices to suit window orientation

NORTH WINDOWS

- Use adjustable shading devices such as external blinds or shutters, or removable shading over pergolas. These allow full winter sun access, in addition to full summer sun protection.
- As an alternative, horizontal overhangs such as eaves or shade battens on pergolas can be used. The depth of such overhangs can be calculated using the methods described in the following section.
- Shade battens on pergolas are a commonly used horizontal shading device. The amount of shading they provide depends on the spacing between them. This spacing should be no greater than one-third of the battens' width (see figure 5.18).
- Avoid the use of deciduous trees and vines, as these block large amounts of autumn and spring sun from entering a home.
- Avoid using fixed, angled louvres on pergolas. Although these can be designed to allow midday sun penetration in winter, earlier morning or later afternoon sun is lost.

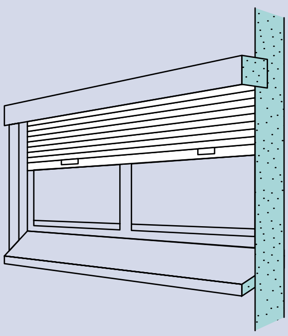


Figure 5.15: Adjustable external shading devices

EAST AND WEST WINDOWS

- Use adjustable external shading. For horizontal shading to be effective at blocking low angled morning and afternoon summer sun, it needs to have a depth of around twice the window height. This will significantly reduce solar gain and daylight in winter.
- Windows that face north-east or north-west are also best shaded by adjustable vertical shading devices such as awnings or blinds.

Calculating the size of north-facing shading devices

There are two methods for calculating the required overhang for north windows.

METHOD 1: RULE OF THUMB

To provide full shade from late October to late February in Victoria, the depth of the horizontal overhang should be approximately 45% of the vertical height to be shaded, measured from the sill of the window to the underside of the shading device (see figure 5.17). This depth represents an acceptable compromise between shading in late summer and direct solar gain in late spring, while providing full penetration of winter sun.

Note that, if possible, the window should not extend fully to the underside of the overhang, as this will create an area of glass in perpetual shadow (and thus permanent heat loss).

METHOD 2: RATIO CHART

Figure 5.16 shows the impact of shading on summer and winter sun. The chart can be used to determine how much summer and winter sun a particular overhang will require.

WIDTH OF SHADING DEVICE

For horizontal shading to be effective, it should extend past the edges of the window for at least the same distance as its depth (see figure 5.19).

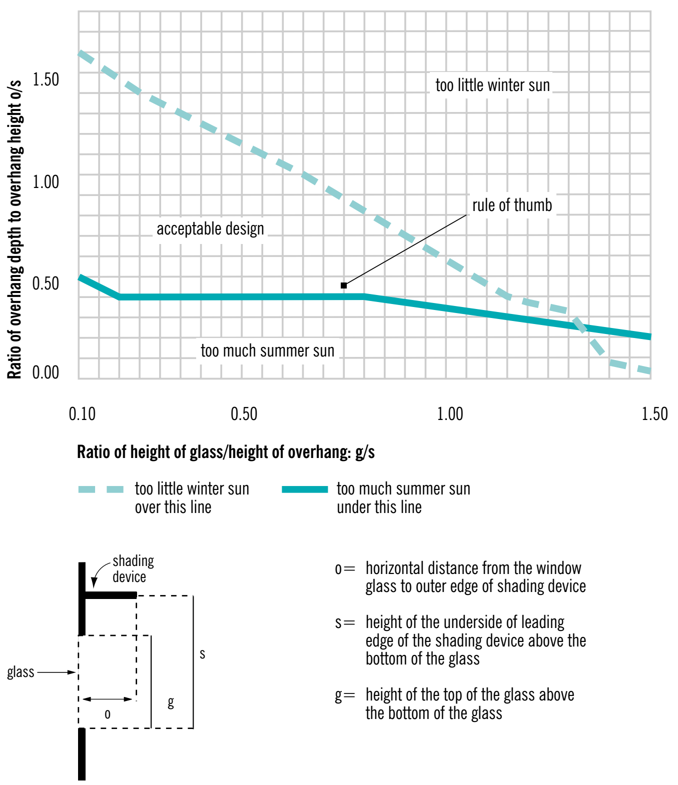


Figure 5.16: Ratio chart for north window overhang

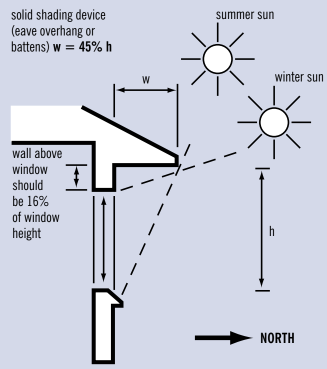


Figure 5.17: Rule of thumb for sizing north window overhang

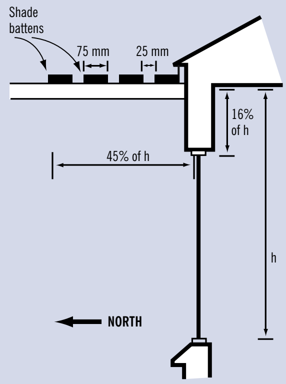


Figure 5.18: Use of shade battens on pergolas

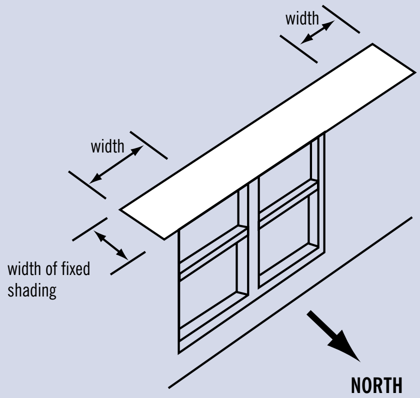


Figure 5.19: Extend shading beyond the window edges

Toned glass and reflective films

Glass can be treated to reduce the amount of solar energy transmitted through it. This can be an alternative method of preventing summer heat gain where external shading devices are inappropriate, such as for windows which are inaccessible, or have views which must be maintained. However, treated glass must be used with caution, as it reduces heat gain and light in winter as well as summer.

TONED GLASS

Toned glass has a tint applied to the glass during manufacture, to reduce the amount of heat transmitted through it. There are two main types of toned glass available:

1. Basic tones, usually bronze, grey and green; and
2. Super tones which offer a higher level of performance, such as EverGreen™, SuperGrey™, SolarGreen® and Azurlite®.

REFLECTIVE COATINGS

Reflective coatings can be applied to new and existing windows. They tend to stop greater amounts of heat gain than some toned glass, and increase privacy by stopping vision into a home. To ensure optimum performance, films should be applied professionally.

LOW EMITTANCE GLASS

Low emittance (Low-E) glass is sometimes used for summer sun control. Emittance is a measure of how much radiant heat a material absorbs and emits. As Low-E glass reduces solar gain in winter as well as summer, it is not recommended for sun control in Victoria. It is more appropriate at complementing double glazing to reduce winter heat loss through windows.

ADVANCED TECHNOLOGY GLAZING SYSTEMS

New glazing technologies can change the physical characteristics of glazing in response to external conditions. They include:

- **photochromics**: which cause glass to darken on exposure to sunlight;
- **thermochromics**: which reduce solar energy transmission through glass in response to increasing temperature; and
- **electrochromics**: which cause glass to become opaque in response to an electrical charge across the coating.

In general, these technologies are relatively expensive, and as yet, have not made a significant impact on the residential construction market.

Reducing winter heat loss

Glazing is often the weakest link in a dwelling when it comes to winter heat loss. In fact, a single-glazed, three-millimetre-deep pane of glass can lose from ten to 15 times more heat than an insulated wall of the same area. In winter, all windows require protection from heat loss.

To reduce winter heat loss, it is necessary to trap a layer of insulating still air between the window and the room. Savings of up to 40% can be achieved with heavy, lined curtains and pelmets, while double glazing can provide savings of around 35%.

Thickened and/or laminated glass has a negligible effect on stopping heat loss. This is because around 98% of the window's resistance to heat flow comes not from the glass itself, but by naturally occurring air films on either side of it (see figure 5.21).

GLASS EFFECT ON WINTER COMFORT

Warm room air cools as it contacts the cold glass surface and falls to the floor as a cool draught. This lowers the room temperature and produces draughts near unprotected glass. Further discomfort is experienced as a person near a window loses body heat to the cooler surface of the glass (see figure 5.22).

The relative effectiveness of various window treatments in reducing winter heat loss is shown in figure 5.20.

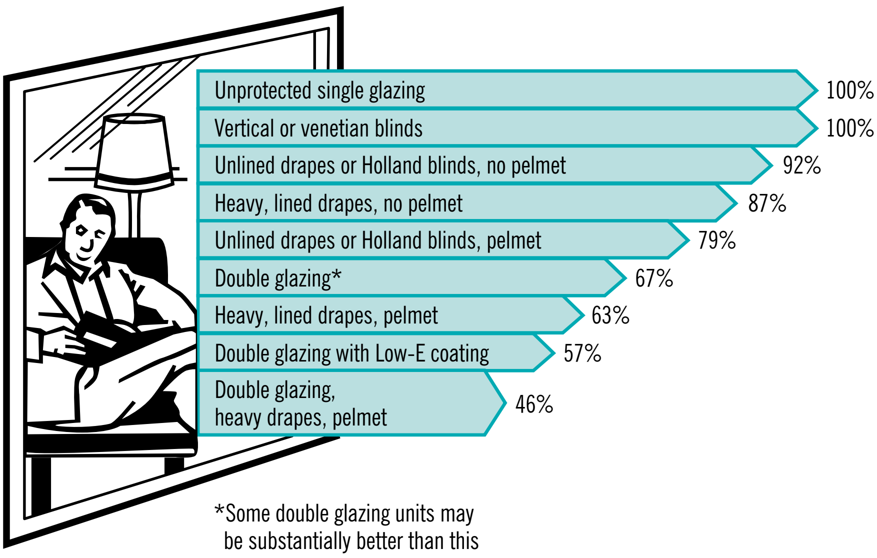


Figure 5.20: The effect of window treatments on winter heat loss

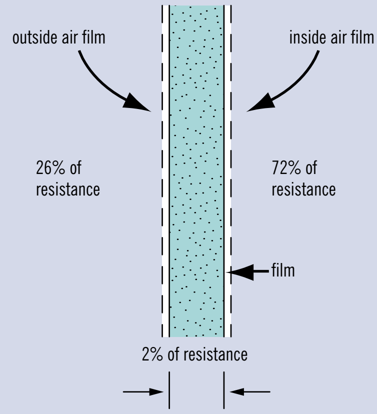


Figure 5.21: Resistance of air films and glass to heat flow

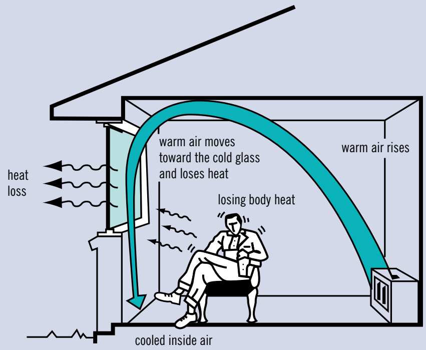


Figure 5.22: Unprotected glass and winter discomfort

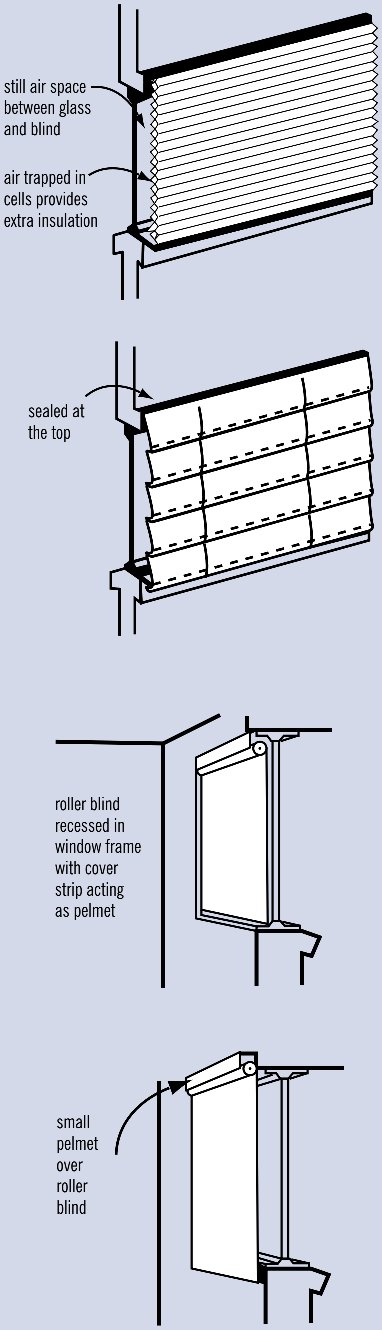


Figure 5.23: Features of effective window coverings

INTERNAL WINDOW COVERINGS

Internal window coverings are used to trap a layer of still air between the glass surface and the covering, reducing heat flow through the glass (see figure 5.24). To maintain the still air layer, coverings must be opaque and closely woven, be fitted completely over the window and have a barrier at the top, such as a boxed pelmet. Alternatively, they should be recessed into the window reveal (see figure 5.23).

Appropriate coverings include drapes, Holland blinds, Roman blinds and Austrian blinds. Avoid vertical blinds, conventional or timber venetians which do not give a good air seal. Thin or lace curtains should be used in conjunction with appropriate coverings.

DOUBLE GLAZING

Double glazing is a second alternative to stop heat loss through windows. Although useful for any window, it is vital that it be used if internal coverings are not desired or are inappropriate, such as the kitchen, highlight or clerestory windows, or simply those where unobstructed views are desired.

Double glazing does not impede solar heat gain. Therefore, it will still allow winter sun penetration. Unprotected double-glazed windows will still require appropriate summer shading.

Double glazing can incorporate most types of glass and is available with toned, laminated and toughened glazing.

For optimum performance, the space between the two panes should be at least nine millimetres. However, increasing it above 15 millimetres will not provide any extra significant thermal benefits.

Double glazing can be used in most situations, but is particularly appropriate:

- in cold or alpine climates;
- in skylights, clerestory windows and roof glazing;
- for large areas of glazing;
- where curtains or other window coverings are not used; and
- where energy costs are high.

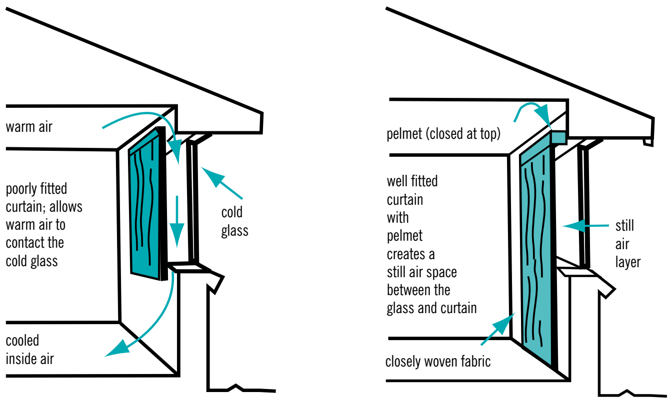


Figure 5.24: Features of effective window coverings

Types of double glazing

Double glazing is most commonly produced as a factory-sealed unit where two panes of glass are separated by a still air layer of between six to 20 mm. These are then fitted into window frames, which are usually made wider to accommodate the double-glazed unit. Factory made units contain dry air between the layers of glass, a desiccant (silica gel) to absorb any moisture likely to cause condensation and are usually double sealed (see figure 5.26). These are usually manufactured to order.

Some manufacturers offer alternative gases for filling double-glazed units, with the most common being argon and SS6 gas. Argon increases the performance of units by around 20% due to its lower conductivity than air while SS6 gas is used to help reduce noise transmission.

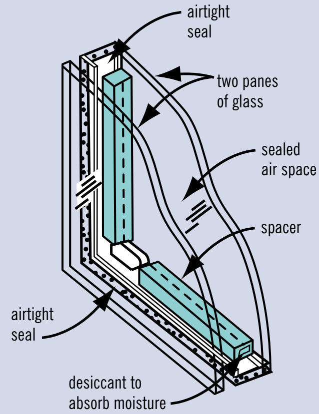


Figure 5.26: Typical double-glazing system

LOW EMITTANCE GLASS

Another method of reducing heat loss through glazing is to use low emittance (Low-E) glass. This glass has a special coating which reflects radiant heat back into the room. The coating is located on the glass inside the air space, and reduces transmission of radiant heat from the warmer glass to the colder glass. Low-E glass is generally only used in conjunction with double glazing.

Depending on the direction the coating is facing, Low-E glass can be used to reduce either heat loss from inside a building or heat gain from outside (in hot climates). The use of Low-E glass to control heat gain is not recommended for Victorian conditions as it also reduces the amount of solar gain in winter.

WINDOW FRAME MATERIAL

The material of the window frame can affect overall window performance. Materials with high heat conductance cause more rapid heat loss from the heated interior in winter and higher heat gain in summer. PVC and timber frames generally perform better than metal frames, unless metal frames have thermal breaks to decrease conductance across them (see table 5.4). Figure 5.25 compares the percentage in energy savings of different window frames and glazing when compared to single-glazed aluminium frames.

Table 5.4: Total heat transfer through windows

FRAME MATERIAL	U VALUE OF GLAZING TYPE ($W/m^2/°C$)		
	SINGLE GLAZING	DOUBLE GLAZING	DOUBLE AND LOW-E COATING
PVC/timber	4.5	3.0	2.4
Aluminium	5.5	4.0	3.3
Aluminium—with thermal break	4.6	3.1	2.5

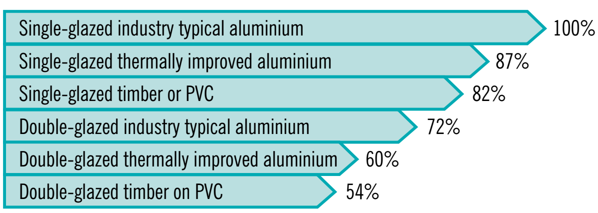


Figure 5.25: Comparison of heat loss through different window frames

WINDOWS TO KEEP YOU COOL

NUMBER OF STARS	INDICATIVE IMPROVEMENT
NIL	0%
★	12%
★★	24%
★★★	36%
★★★★	48%
★★★★★	60%

WINDOWS TO KEEP YOU WARM

NUMBER OF STARS	INDICATIVE IMPROVEMENT
NIL	0%
★	9%
★★	18%
★★★	27%
★★★★	36%
★★★★★	45%

*Based on the amount of energy required to heat or cool a typical house, when compared with using clear, single glazed aluminium windows

Figure 5.27: Percentage improvement in heating and cooling is represented by the number of stars

Window Energy Rating Scheme

The Window Energy Rating Scheme (WERS) is a program implemented by the Australasian Window Council Inc. (AWC) with the support of the Australian Greenhouse Office. The AWC rates a window's energy performance in terms of stars. No stars means the window is a very poor performer while 5 stars indicates an excellent performer (see figure 5.27). The aim of the scheme is to help consumers evaluate the relative energy performance of different types of windows to make an informed decision suited to their needs. The window manufacturer can display a label that shows the star rating for its heating and cooling performance. The label shows an indicative percentage reduction in the home's heating and cooling needs compared with using clear single-glazed aluminium framed windows and also the AWC Certified Performance Data (see figure 5.28).

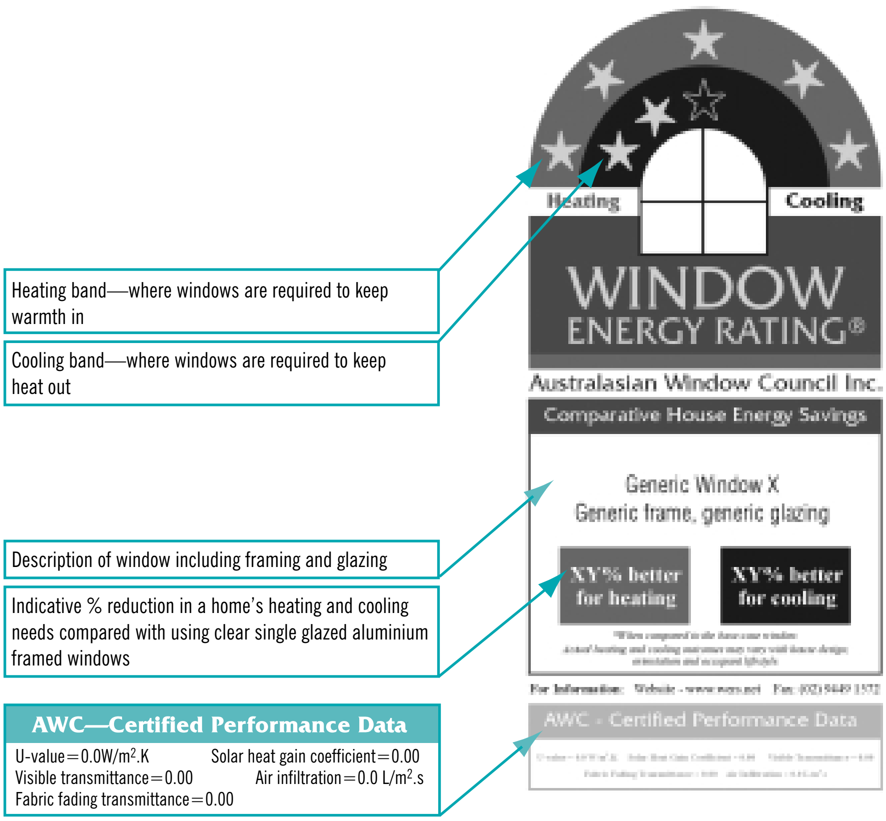


Figure 5.28: Window Energy Rating label

Skylights and roof glazing

Skylights and roof glazing can cause serious problems of heat gain in summer and heat loss in winter. The larger the glass area, the greater the potential for excessive heat loss and gain. It is vital to design and size these types of glazing correctly, as they can be difficult and expensive to correct once installed.

Roof glazing should only be installed where it is absolutely necessary and kept as small as possible. As it admits, on average, around three times as much light as the same area of vertical glazing, there is no reason for it to be excessively large. Australian Standard AS4285 provides recommended sizing guidelines for skylights, e.g. toilet, ensuite or walk-in wardrobe requires 400 mm x 400 mm shaft or one 250 mm tube type.

SUMMER HEAT GAIN

Angled or horizontal skylights and roof glazing admit significantly more radiation than vertical glazing. A typical 900 mm x 900 mm skylight can admit heat equivalent to turning on a three-bar radiator for six hours a day throughout summer. Unprotected north-facing roof glazing admits 50% more radiation in summer than the same area of unprotected west-facing vertical glazing.

Where possible, install skylights to face south, to reduce direct summer heat gain. Avoid them facing north or west unless absolutely necessary.

Skylights and roof glazing can be shaded using specialist products. However, these are not readily available. It is far better to keep roof glazing as small as possible, and avoid facing it north or west. To provide protection from summer heat gain, tinting and/or internal blinds or louvres can be used.

WINTER HEAT LOSS

Winter heat loss through high-level windows is greater than through ground-level windows, owing to stratification of the heated air inside a home. Glazing at ceiling level loses 30% more heat than glazing at eye level. All roof glazing should be double glazed or fitted with ceiling diffusers to reduce winter heat loss (see figure 5.29).

DAYLIGHT TUBES

Daylight tubes can be a more energy efficient alternative to conventional skylights. They consist of a clear, hemispherical dome, a smooth highly reflective tube and a diffuser at ceiling level (see figure 5.30). As they require a smaller area of roof glazing than a traditional skylight, heat gain in summer and heat loss in winter is significantly reduced. They are best suited for use in smaller rooms such as bathrooms, hallways and entry areas. Note that types with textured, flexible ducts can deliver significantly less light than those with smooth shiny ducts.

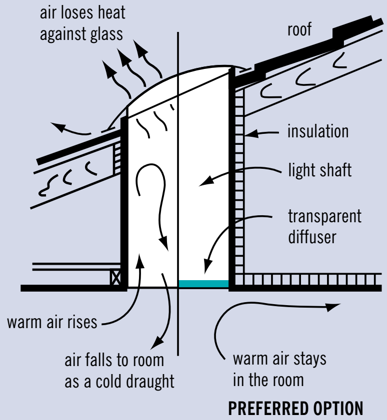


Figure 5.29: Skylight diffuser

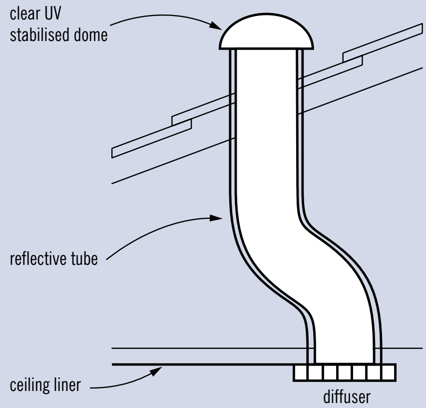


Figure 5.30: Daylight tube