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ISSUE 40 • SPRING 2017
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ISSN 1833-1416
9 771833 141000

FEATURES

Windows: In the frame

Wondering which glazing is most suitable for your house and climate? Lance Turner and Dick Clarke introduce you to the delicate art of window selection, and explain the key terms and concepts to get you started.

GLAZING OF BOTH WINDOWS AND DOORS IS WHAT ALLOWS the outside environment to interact with the interior of the house, a relationship that can be both good and bad. It's good when we open doors and windows up to allow cool summer breezes inside, but it's bad when all that glass sucks the warmth out of a room on a frosty winter evening, or lets the hot afternoon sun heat up the internal temperature to unbearable levels.

Glazing is usually the Achilles heel of a building's performance and should be one of the very first things to go under the microscope when considering a building upgrade. An otherwise well-insulated house can suffer considerable unwanted heat loss or heat gain through single-pane glass, which has almost no insulating ability – around R0.15.

The Australian Window Association (AWA) estimates that up to 40 per cent of a home's heating energy can be lost through windows and up to 87 per cent of its heat gained through them. Choosing high-performing windows and placing them appropriately can reduce energy costs significantly and improve thermal comfort. The art is in knowing how different windows will interact with the design of your home.

But where do you start to work out which glazing system or treatment is the best solution for you? It's a complex task even for a switched-on homeowner. The AWA has made things easier with the Window Energy Rating Scheme (WERS).

WINDOW PERFORMANCE MEASURES

WERS simplifies window comparison by rating the performance of residential windows using a star rating system, much like star ratings for appliances. The star ratings are based on the window's basic performance measures: U-value and solar heat gain coefficient (SHGC). Windows receive a rating for both heating and cooling performance. WERS has three climate types for the whole of Australia (and New Zealand fits one of these): heating, cooling and mixed. The zones indicate whether most energy will be dedicated to heating or cooling to maintain thermal comfort, and mixed means just that – about equal shares of both.

The whole-window U-value (Uw) measures how readily a window conducts heat. The lower the U-value, the greater a window's resistance to conductive heat flow and the better its insulating value. WERS gives comparative ratings for frames and glass combined in a functioning window or door. If we use old-school aluminium frames plus single glazing as a benchmark, modern aluminium frames, thermally broken frames and some uPVC frames plus double glazing (insulated glazing units or IGUs) can reduce internal to external thermal transfer (conductivity) by 50 to 75 per cent or even more. Timber frames (softwood) are about equivalent to thermally broken aluminium frames; steel frames are not proven high performers. More on frames later.

The other important factor influencing window performance

is its whole-window solar heat gain coefficient (SHGCw). This measures the window's ability to control heat transfer from solar radiation. This coefficient is expressed as a number between 0 and 1 – the lower the number, the less solar heat the window transmits.

Real-world U-values normally fall between about 8 (worst case) down to 1 (best case). Real-world SHGCs range from about 0.75 down to 0.15. Unlike U-value, we don't tend to label high SHGC as 'bad' and low SHGC as 'good' as the judgement depends on the climate where the building is located. In almost all cases, a low window U-value is better in all climates.

SINGLE, DOUBLE AND TRIPLE GLAZING

In general, all windows will benefit from having better insulating properties – that is, from double or triple glazing or from insulating window coverings. These technologies slow down the conductive heat flows in both directions.

Double-glazed windows are far superior to single-glazed windows for insulating your home. If you're wondering whether the added cost of improved glazing is worthwhile, consider that compared to single glazing, in cold and mixed climates a double-glazed window could cut your window heat loss by 60 per cent or more, reducing heating loads.

Some people may simply choose to replace leaky old windows with double glazing, with good outcomes. But for anyone currently in the process of assessing quotes and specifying energy-efficient windows, you will already know there's a lot more to consider than multi-pane glazing to achieve optimal results.

GLASS COATINGS AND TINTS

Coated and tinted glass can be used to improve the performance of single-pane windows or to turbocharge the performance of double- or triple-glazed units to make them even better.

Tints use a pigment in the glass to reduce solar heat gain and light transmission; coatings are applied to the surface at the factory and can be reflective ('mirror' glass) through to higher-end low-emissivity (low-e) coatings.

Low-e coatings reduce the onward transfer of radiant heat, and so can reduce heat loss or gain through the glass. The coating can be tuned to reflect most, some or very little of the radiant solar heat, depending on the needs of the climate and orientation. This approach can reduce the SHGC by more than 60 per cent compared with clear glass and is often used in warmer climates or for west-facing windows when trying to minimise heat from the sun, while still retaining daylight.

From a solar heat gain point of view, the location of a low-e coating is quite important. In hot climates or for unshaded windows facing east or west, a low-e coating should be on the inside-facing surface of the outer glass layer and should be a coating with low solar transmittance (thus, low SHGC). In climates with cold winters (most of southern Australia) where passive solar gain is needed, the coating should be on the outward-facing surface of the inner glass layer for optimal results. Getting it the wrong way around will reduce performance by about seven per cent. It may not sound like much, but to get a seven per cent boost at no extra cost simply by careful specification and correct assembly is definitely worth it!

When dealing with suppliers it is helpful to have a basic understanding of the technical aspects and what their implications are. It is possible to inadvertently select glazing for an energy-efficient building which blocks all heat flow. Sadly, we know of one instance where the passive solar design has been largely nullified by heat-blocking glass purchased on the basis of it being the 'smart' option. It was the wrong specification, because the building's shading design kept the summer sun under control, but now the winter sun's warmth is kept out too. On sunny days, the owners have to open the north-facing sliding doors to allow the sun to pump some heat directly into the slab floor – a less than ideal workaround.

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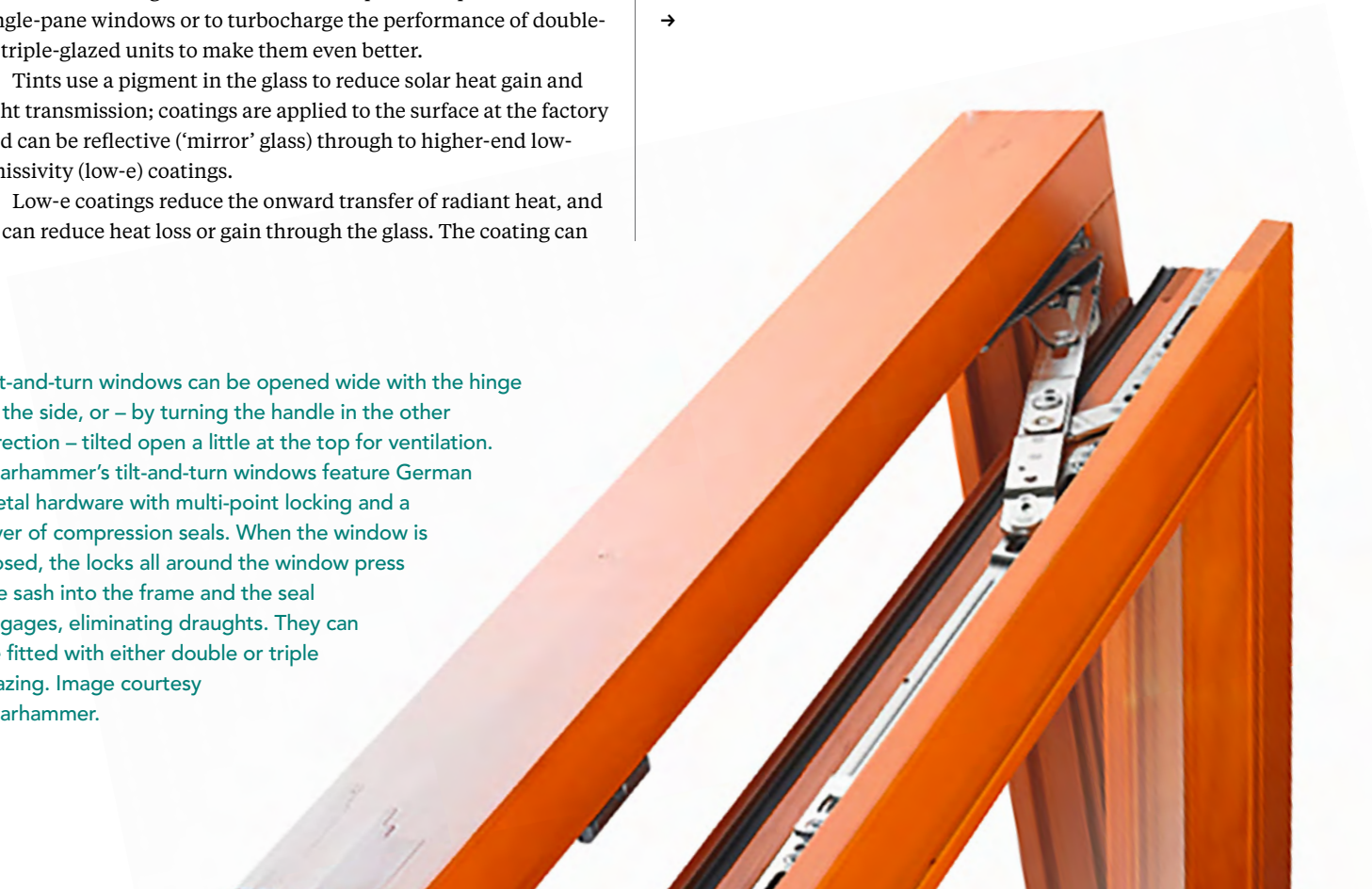

Tilt-and-turn windows can be opened wide with the hinge to the side, or – by turning the handle in the other direction – tilted open a little at the top for ventilation. Paarhammer's tilt-and-turn windows feature German metal hardware with multi-point locking and a layer of compression seals. When the window is closed, the locks all around the window press the sash into the frame and the seal engages, eliminating draughts. They can be fitted with either double or triple glazing. Image courtesy Paarhammer.

SHADING AND GLAZING SELECTION

Selection of the type of glass and coatings for your windows can be a daunting process. There are some general guidelines that apply, depending on your climate zone and the window orientation, but many factors come into play, including the design of your home and the size of the windows. Careful tuning of windows based on orientation can help maximise the result, combined with the use of good summer-only external shading and internal curtains or blinds with pelmets.

The trick is to tune how you control the flows of radiant heat. For example, in warmer climates or for westerly windows, you'll generally want a low solar heat gain, thus always reducing the amount of heat getting in. In cooler climates on northerly windows, you'll generally want a high solar heat gain, to allow the winter sun into the interior, but you may also want to reduce radiant heat transfer back through the window with a low-e coating (described above). For all window orientations, you need to take into account the window size and external shading. This is best done in conjunction with a professional designer or thermal performance assessor.

Correct shading is particularly important with double glazing. This is because incoming solar radiation is in short wavelengths, which passes through glass rather easily, heating up everything it strikes. These warm surfaces then re-radiate heat but in long wavelengths, which do not pass through glass as easily, and thus we get a net build-up of heat – which is why cars get so hot when parked in the sun. Double glazing exacerbates this accumulation of heat. Passive solar design uses this to provide free heating, and passive cooling excludes the solar radiation (by shading) to prevent it from getting inside in the first place.

FRAMES, VENTILATION AND THERMAL BREAK

Frames are an important part of the heat transfer equation, and while it is entirely possible to have energy-efficient glazing in any style at all, the performance of a frame needs to be considered in conjunction with the glass type.

The most popular type of frame is the all-aluminium frame, but aluminium is a great conductor of heat and so provides no insulation. However, aluminium frames can be made to perform better by introducing a 'thermal break' in the centreline of the frame. This consists of a structural insulator between the inner and outer frames that is made from timber or plastic (usually a polyamide such as nylon).

A number of manufacturers now make 'composite aluminium' frames – aluminium on the outside and timber on the inside, which can look attractive and effectively creates a thermal break.

You might prefer other framing materials; these include all-timber (making sure it is sustainably sourced), uPVC plastic (unplasticised polyvinyl chloride), and even fibre-reinforced plastic (fibreglass). Steel framing is making a comeback, but the old-style profiles were not good thermally, whereas some new profiles take conductance and sealing seriously – but always check the WERS rating.

When selecting a frame design it's very important to consider air movement: where do the desirable and undesirable breezes come from? What is the best arrangement of any operable sections of the window to take advantage of these? Safety and falls prevention considerations in the building codes now require a window to be designed to prevent children from falling out. Sounds reasonable, but it is often poorly implemented, by means of limiters that prevent the window from opening more than 100mm, which will not allow proper ventilation.

Careful use of louvre windows may be a good option to consider. The usual question then thrown up is about them being single glazed – but in most temperate climate zones, a mix of, say, 25 per cent of louvres combined with 75 per cent fixed IGUs provides sufficient overall insulation capacity, combined with excellent controllable secure ventilation. But make sure they are designed to fully seal when closed. Once again, good thermal modelling using simulation software can guide these design details.

When selecting a frame design it's important to consider air movement including where the desirable and undesirable breezes come from, and the best arrangement for any operable window sections to take advantage of them; bearing in mind all window designs need to account for falls. All of these factors have been executed beautifully in this POD-designed house in Cairns. Image: Nic Granleese

WEATHER SEALS

A window allowing air movement through it even when closed will be a poor insulator, no matter what its materials and construction. Windows that have moving sections should have good seals between the moving sash and the fixed frame. Most modern commercially made windows have a reasonable seal, but their effectiveness depends on how well the window is designed and manufactured. The amount of air that passes through an area of window under a given pressure is known as the infiltration rating – the lower the value, the better.

Compression seals (as seen on awning, casement and tilt-and-turn windows) usually seal better and last longer than brush seals commonly fitted to sliding or double-hung windows.

A good seal between the window frame and the wall is also very important. It is not uncommon to see windows with gaps and considerable air leakage between the frame and the wall – this means that energy saved with improved glazing can be lost through the frame.

DOUBLE GLAZING RETROFIT AND WINDOW FILM

Other than entirely new windows, there are other ways to achieve better window performance. There are several aftermarket double-glazing products, such as Thermawood which replaces the glass with a double-glazed unit, or Magnetite which is designed to improve but not replace existing single-glazed windows. This may be a consideration, especially to avoid waste if your existing frames are in good condition.

Another way to improve the performance of your existing windows is through the application of film. Film can be considered to be a lot like a factory-fitted coating on the glass, but instead it comes on a roll and should be fitted by a professional. Films come in many types, including spectrally selective and low-e, and vary in performance and what they actually do – the trick is to select a film that does what you need it to do, depending on the local climate, the orientation and location of the window, and the performance of the rest of the house.

EVEN MORE IMPROVEMENTS – INSULATE!

Renovations should always make the house better, and this should include all the windows if at all possible. But many existing houses may have other problems that cause them to be too cold or hot (usually too cold in southern Australia and New Zealand). Apart from the obvious likely culprit of poor or missing ceiling insulation, other miscreant elements include uninsulated subfloors, leaky and ill-closing windows and doors, gaps in floorboards and under skirtings, wall vents (no longer required), absent pelmets – the list goes on. Most of these problems are easily solved and should be tackled with pocket money before any serious money is spent on new windows and doors.

If double glazing and film options are not suited to your situation – for instance, if you are a renter or your budget is just too tight – then you can improve the thermal performance of windows with some simple insulation. Windows can be insulated in a number of ways: by covering them with thick curtains or double honeycomb blinds (or similar); even using roller or vertical blinds is better than nothing, but they must be tightly fitted within the window reveal or have pelmets at the top to prevent convective currents circulating, otherwise they will do very little. See *Sanctuary* 39 for our article on internal window coverings.

WELL WORTH IT

Improving the thermal performance of glazing can be expensive, but it is a very worthwhile investment (even if the walls of your existing house are not yet insulated). All new homes and renovations need to meet energy regulations, and efficient glazing is one way you can quickly upgrade a building's energy performance. High-performing windows may be up to 10 per cent or more of the total cost of renovating or building a home; it is hard to generalise, but industry studies on the homes built by one of Victoria's biggest home builders showed an average cost payback of just over five years, but it can be as many as 15 depending on your house and climate. For retrofits where windows are being replaced in order to recoup on energy costs alone (without accounting for comfort), Sustainability Victoria's "Energy efficiency upgrade potential of existing Victorian houses" report found payback periods were much longer. Even assuming a building lifespan of the woefully short Sydney average of 42 years, for many, double glazing is a sound investment, made all the better now that real estate agents are being trained through the Centre for Liveability Real Estate to recognise, value and communicate the potential to home buyers.

If you decide to replace your existing windows and go with double glazing, it is important that you get quotes from at least three suppliers and talk to them about what is right for your home. Remember, what applies in colder climates doesn't necessarily apply in warmer climes. The orientation of a home and its location on the block will help determine what types of windows are needed. *Your Home* and *WERS* are also excellent resources for this. If trying to understand windows and quotes is still making your eyes glaze, seek professional help – it is a specialised area after all.

Also, don't assume that the same window type and rating is ideal for each room – selecting a window's ratings for each room can tweak the thermal performance even further. While that may seem like a lot of effort, it can be worth it. Glazing is second only to the base structure for permanence so you may be living with those windows for a long time. Ⓢ

Dick Clarke is principal of Envirotecture, a sustainable building design firm in Sydney and Redland Bay, Queensland.
Lance Turner is the ATA's technical editor and writes for *Sanctuary*'s sister magazine, *ReNew*.

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