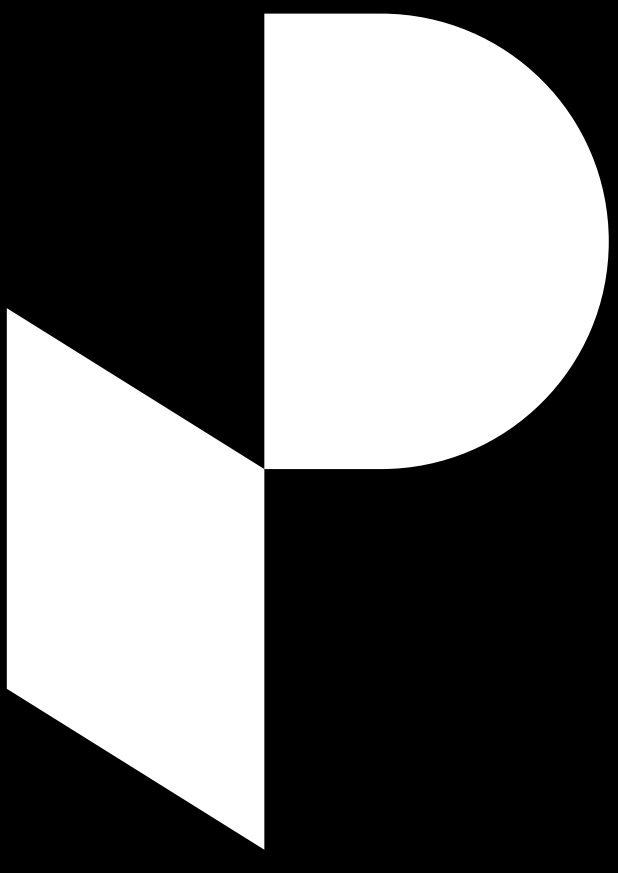
Powerhaus
Engineering

A quick guide to: Reaching 7 stars and zero carbon in **Australian homes**

Submitted for the 2023 Australian Architecture Conference



30.10.23

Zero carbon is the goal

Zero carbon means 100% renewable power, i.e. no fossil fuels, are used to power a home.

Energy is produced and used on a 24 hr cycle. At Powerhaus, we measure the energy a house will use and compare it against what their solar system will produce, for an average day for each month of the year. We call this **average daily net zero.**

Daily net zero measures the real potential to eliminate fossil fuels from a home's operational energy.

Design ratios drive outcomes

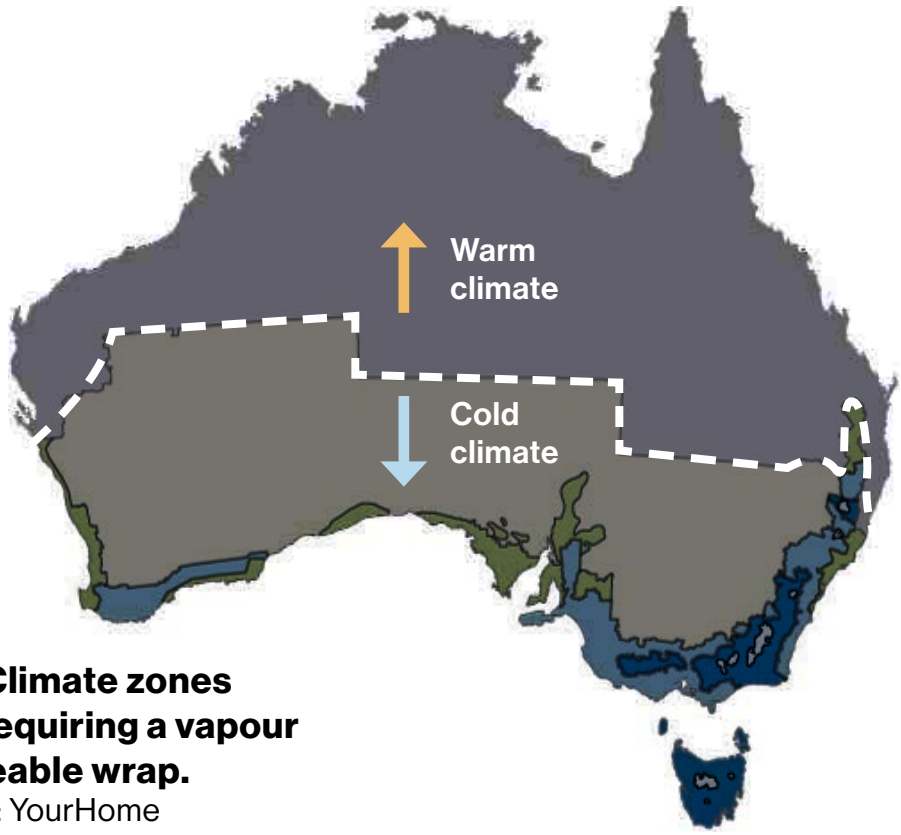
At the foundation of a sustainable home is clever design. Become the master of your star rating and reach daily net zero by adjusting these design levers.

1. Form factor
2. Window to floor ratio
3. Percentage of north-facing glass
4. Balance of shading
5. Window specification

Combine design ratios with optimal building specifications for the best outcomes.

+ Window values cheatsheet
+ Optimised standard construction insulation values

Climate-driven design



NCC Climate zones 4–8, requiring a vapour permeable wrap.
Source: YourHome

NCC climate zones 4–8 require a Class 3 or 4 vapour-permeable wrap. The need to specify a wrap can be used as a proxy for heating load. Those zones requiring a wrap have a significant heating requirement.

The majority of the advice given in this document is relevant no matter where you build in Australia. Increasing the thermal performance and energy resilience of your build will increase comfort, disaster tolerance, health and reduce energy bills and carbon everywhere.

Cold climates: Follow all the advice in this guide. The advice in this presentation is tailored to these areas, which covers most of NSW, VIC, TAS, ACT, SA and southern WA.

Warm climates: Remove the need for north-facing glass, and increase shading around the whole house.

1. Form factor

What it is: The ratio of a building's external surface area to its floor area.

Impact: A high form factor means the building has a higher ratio of external surface to floor area. This means the building fabric has to work harder to maintain a comfortable temperature and it will be more challenging to achieve higher ratings.

Design levers: Optimising other design ratios such as reduced glazed areas and high north-facing window amounts, can help offset a higher form factor.

Figure: Example form factor of various building layouts

2. Windows:
Window to floor ratio

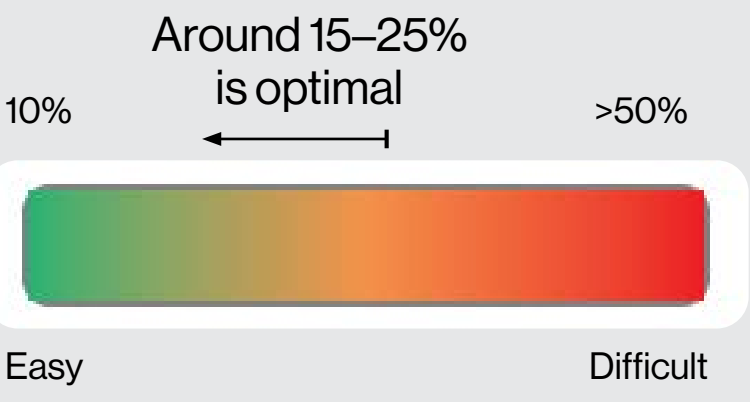
What it is: The amount of windows (m^2) relative to the floor area of the house (m^2)

Impact: Windows are the weakest thermal element of a building. A triple-glazed window has the same insulative value as an uninsulated brick veneer wall.

The more windows a building has, the harder time it will have staying comfortable and the higher performing glazing will be required.

Design levers: To increase the total amount of windows, increase the percentage of windows facing north and increase the glazing performance.

Figure: Understanding window to floor ratios



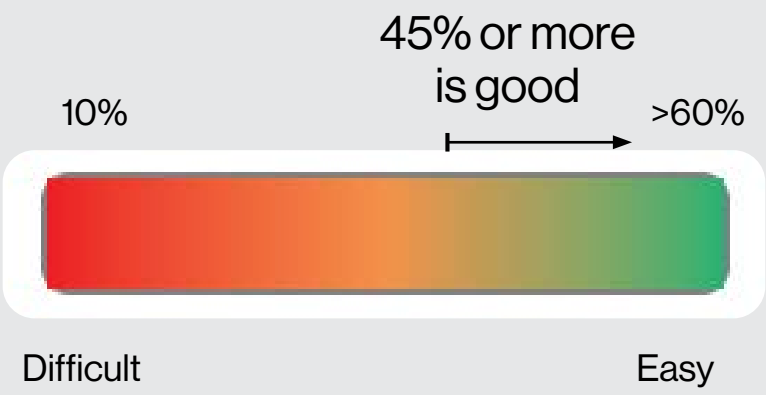
3. Windows:
Amount of north-facing glass

What it is: The amount of north-facing windows (m^2) compared to total window area (m^2)

Impact: North-facing windows, especially when located in living areas have a hugely beneficial impact on the winter comfort of any home. This is particular to heating climates, but selective use will also help climates as far north as Brisbane.

Design levers: Using the sun to heat your home for free is one of the most sustainble design choices you can make.

Figure: The more North-facing glass, the better the star rating & lower the winter energy demand



4. Shading:
Fixed and seasonal

What it is: Fixed shading includes eave depth and verandas. Seasonal shading is considered anything that is adjustable or changes with the year, including louvered pergolas, shutters, external roller blinds and deciduous planting.

Impact: Shading is an important part of controlling the heat gain over summer periods in our homes. Ensuring that fixed eave depths are balanced for summer shade and winter sunlight is crucial to a high energy rating, and a comfortable home.

Design levers: Balance cold winters with heatwave preparation by using seasonal adjustable shading. Think creatively about shading as an adaptive measure that can be modified in response to climate conditions - the way a sailing boat catches prevailing winds.

Adjustable louvres on Glenn Murcott's White House.
Source: Flickr | Lucas Torresi

5. Consider window ratios together with frame & glass

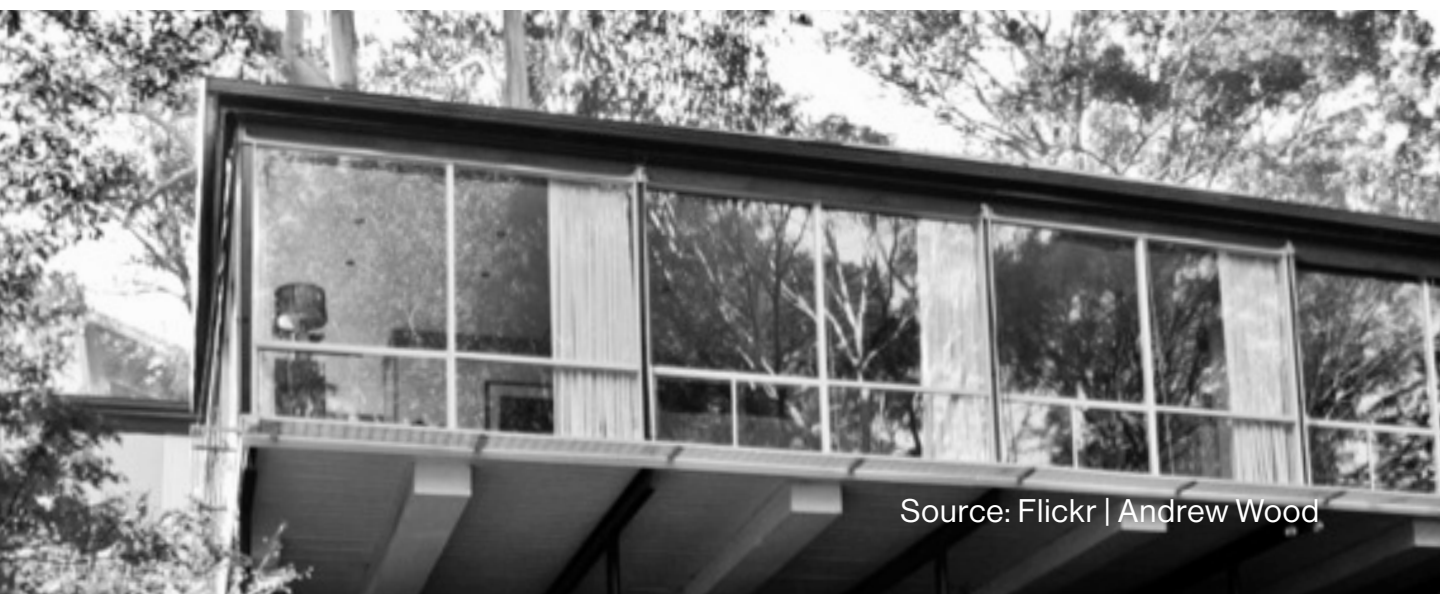
Ratios		Specification	
Window to floor ratio	Percent of windows north-facing	Shading: fixed and seasonal	Type of glass and frame (U value and SHGC)

Optimise all of these for higher ratings

Impact: Balancing window ratios with the quality of the windows specified will help you achieve better outcomes.

Design levers: Push design ratios such as complex form factor and large areas of glass by offsetting with high-performance windows, such as double-glazed uPVC or triple-glazed thermally-broken aluminium.

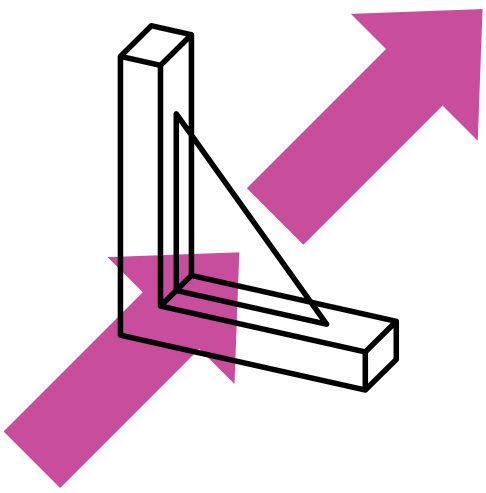
Alternatively, go for a very high star rating by optimising all of these ratios together!



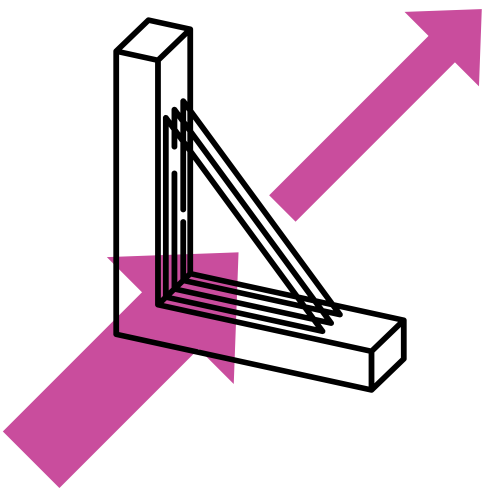
Source: Flickr | Andrew Wood

Intro to window specification

U-value measures how much heat a window loses (it's like an insulation rating – only the inverse of R-values). It measures the glass and frame combined.



High U value = high heat loss and gain



Low U value = low heat loss and gain

Solar heat gain co-efficient, or SHGC, is a measurement of the amount of solar radiation (heat) that is allowed to pass through a window into a building *when hit by direct sun*.

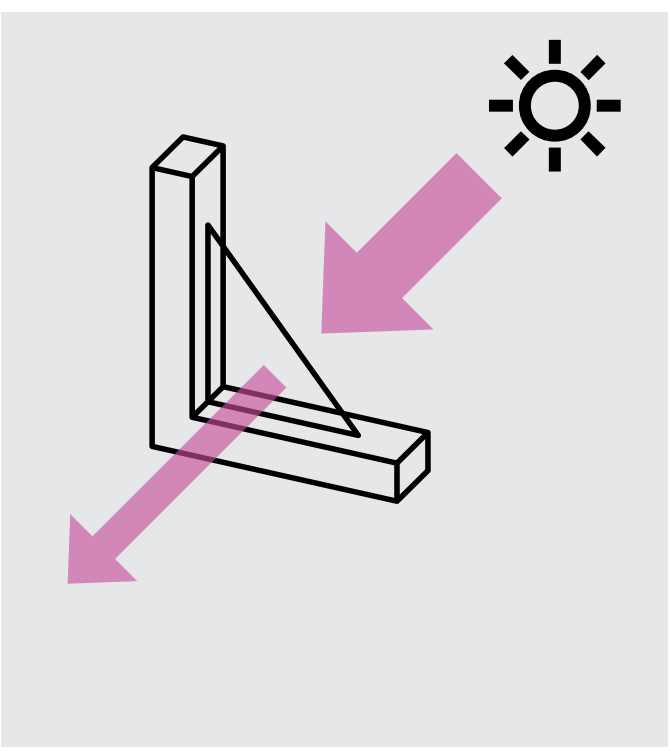
SHGC can be used to:

> increase the amount of passive heating in winter

> balance unwanted heat from west or east facades in summer

Cold climates: high SHGC (0.5–0.7)

Hot climates: low SHGC (0.2–0.4)



U-value and SHGC cheatsheet

These values represent the middle 68% of all residential window values from all manufacturers Australia wide for all frame types.

These are system values: they represent the combination of frame and glass. These values are also influenced by the operability, i.e. sliding doors, fixed windows and awning windows with the same frame and glass will have slightly different values.

Frame type	Glass type	U-value range	SHGC value range
Aluminium	Single	4.9 – 6.5	0.40 - 0.65
	Double	2.9 – 4.1	0.30 – 0.53
	Double - Low E	2.8 – 3.9	0.30 – 0.48
Aluminium, thermally broken	Double	2.2 – 3.2	0.25 – 0.49
	Double - Low E	2.0 – 2.7	0.27 – 0.50
Composite (ie Timber and aluminium) Composite	Double	2.1 – 3.1	0.37 – 0.59
	Double - Low E	1.8 – 2.6	0.28 – 0.53
	Triple	1.1 – 1.3	0.24 – 0.21
Timber	Double	2.0 – 2.8	0.31 – 0.53
	Double - Low E	1.9 – 2.3	0.30 – 0.49
	Triple	1.1 – 1.4	0.17 – 0.42
UPVC	Double	1.6 – 2.3	0.23 – 0.45
	Double - Low E	16 – 1.9	0.22 – 0.39
	Triple	1.3 – 1.8	0.22 – 0.43

Source: WERS database. Search for values here: https://werslink.com.au/wers/search.html#residential-simulation-search

Optimal standard construction insulation specifications

These values generally represent the most cost-effective insulation choices for new homes, that work with standard construction practices in cooler climates.

Ceiling:	R5–R6
Wall:	R2.5 plus a vapour-permeable airtight wrap with battened cavity for drainage
Floor	Suspended Timber; R2.5 to R4 underneath Slab on ground, thermally-broken (R1 to R1.8), i.e. insulative voids or XPS and slab-edge insulation (R1.8)
Windows	uPVC or composite, double-glazed with SHGC over 0.45 Thermally-broken alumnium, double-glazed with SHGC over 0.5

Do you want to design comfortable, healthy, energy-efficient homes that power themselves?

Contact us

Email: team@powerhausengineering.com.au
Web: www.powerhausengineering.com.au
Instagram: @powerhausengineering