

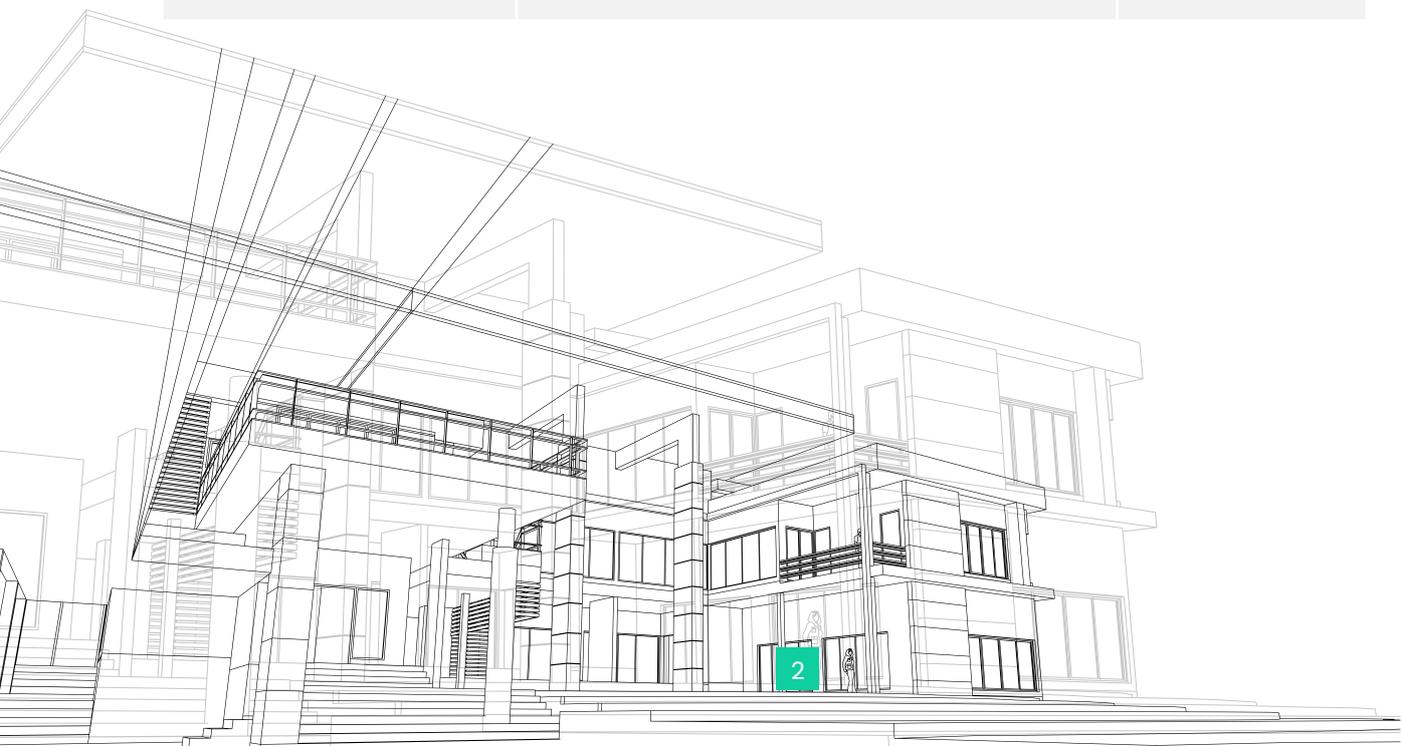
# How to design a house for a **7-star energy rating**



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# Introduction

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Australia's building industry has faced the perfect storm. Increasing prices, plus materials and labour shortages – largely due to the after-effects of the COVID-19 pandemic as well as trade sections and tariffs against Russia – have placed undue pressure on businesses. No one is immune from the mounting financial pressure, not even the larger players.

Understandably, many within the construction industry feel now is not the ideal time to move towards a new 7-star energy standard. Between 2023 to 2025, new homes in Australia will have to meet the increased energy efficiency standard under the Nationwide House Energy Rating Scheme. Refer to PG:04 for information regarding the transition for each state and territory.

It is hoped that the move from six to seven stars will place renewed focus on heating, cooling, lighting, water and solar energy to reduce carbon emissions and energy bills.

There are two vital components to consider when designing to a 7-star standard – climate data and site conditions. Relevant energy rating software will provide localised climate data to ensure corresponding design principles are met. For example, if a particular suburb or region registers a hot climate, design will favour shading.

The site conditions identify orientation of a property, which will play a role in design layout. include where north orientation is and how a design layout factors that in. You may, for example, need to consider neighbouring dwellings and the impact on shading and cooling your home.

The National Construction Code is Australia's primary set of technical design and construction provisions for buildings. The code determines heating and cooling energy limits, and it is important to note that it's not uncommon for a dwelling to reach its star rating but fail compliance in those two areas.

Now more than ever, it is vital to connect with your energy rating consultant prior to your project start date. This way a preliminary energy rating analysis can be prepared on the initial sketches. These results will provide valuable information on how well the dwelling is performing and what improvements can be made.

Throughout this book we show you exactly how the software works, the numbers behind the science and what improvements can be made to improve the energy performance of your design.



# Transition Period

State	Variation to NCC 2022	NCC 2022 Implementation	Useful Links
NSW	The BASIX assessment scorecard overrides the standard NCC 2022	1 October 2023	See <a href="#">BASIX support materials</a> . Read about <a href="#">increasing BASIX standards to 7-stars</a> .
ACT	7 Stars and WOH scorecard will be implemented	15 January 2024	Read about <a href="#">the Implementation of NCC 2022 in the ACT</a> .
VIC	7 Stars and WOH scorecard will be implemented	1 May 2024	Learn about <a href="#">NCC 2022 updates in Victoria in this industry alert</a> .
QLD	A 1 star credit applies for outdoor living areas (12m <sup>2</sup> , ceiling fan, R1.5)	1 May 2024	Read about <a href="#">NCC 2022 implementation in QLD</a>
SA	7 Stars and WOH scorecard will be implemented	1 October 2024 Voluntary adoption from 1 October 2023 – 30 September 2024	See <a href="#">statement from the Government of SA</a> regarding the use of older software.
WA	7 Stars and WOH scorecard will be implemented	Partial adoption from 1 May 2024 – 30 April 2025. Full adoption from 1 May 2025	Read <a href="#">about NCC 2022 updates and advice in this Newsletter</a>
NT	5 Stars will remain implemented	Voluntary adoption from 1 October 2023	See NT <a href="#">EE requirements for residential buildings</a>
TAS	7 Stars and WOH scorecard will be implemented	Requirements deferred until the adoption of NCC 2025	Read about <a href="#">Energy efficiency for new homes</a> in Tasmania.

# The PROCESS

The focus needs to shift from organising an energy rating right towards the building permit process to working alongside an energy assessor during the design stage.

## Start the conversation early

- If you are preparing a design quote for a potential client or you are in the preliminary discussions of the design brief, attention needs to be drawn of the cost implications associated with not following solar passive design principles. 10's of thousands can be saved when incorporating these design principles.

## Ensure the concept designs incorporate solar passive design principles.

- The more these design principles are implemented, the higher the star rating will be before costly glazing and insulation upgrades are selected.

## The energy rating program needs to be used as a design tool, not a compliance tool

- Once concept designs have been completed, send them to your energy assessor to perform preliminary assessments. This way you will understand how the dwelling is performing, where the weak points are and what improvements can be made.
- The majority of energy ratings we prepare are based on construction drawings and structural drawings, often when planning permits have been issued. Very difficult to make changes to fix energy efficiency issues at this stage of the design process.

## Discuss with preliminary energy rating results with the client

- The preliminary energy rating will provide valuable information on how each room performs, and the improvements we can suggest, based on the heating and cooling loads.
- It would be ideal to also send the energy rating and the window schedule to a few window manufacturers to see what the pricing comes back with the different scenarios.

## Not all dwelling's will achieve a 7 star energy rating

- Not incorporating any solar passive design principles can result in a failed attempt at reaching the minimum 7 stars. We have been involved in many projects that were very difficult to hit 6 stars, no matter how much upgrades were implemented. So it is possible that some designs will not get close to achieving 7 stars

# The Deemed-To-Satisfy Pathways

There are two DTS pathways to demonstrate compliance with the energy efficiency performance requirements in NCC 2022 Part H6.

**Option 1 – Energy Rating:** Using approved energy rating software (FirstRate 5, HERO, BersPro or Accurate) to model the dwelling to achieve:

- Minimum 7 stars
- Heating loads below the allowable limits based on the NatHERS region
- Cooling loads below the allowable limits based on the NatHERS region

**Option 2 – Elemental Provisions:** Using Section 13 of the ABCB Housing provisioning to meet compliance with building fabric, building sealing, ceiling fans and services.

- The NCC 2022 has spreadsheet calculators to determine the glazing specifications and
- Total R-value requirements for single storey and multi storey dwellings based on the NCC climate region.

Each option has its pros and cons and we can determine the best suitable option based on the dwelling's design and site conditions.

## Option 2: Elemental Provisions

This option is often referred to as the DTS option. The Australian Building Codes Board (ABCB) provides glazing calculators in spreadsheet format which allow us to input the glazing data into a spreadsheet and increase the performance of the glazing (U-Value and SHGC) value until a green tick appears.

The calculator from NCC 2019 has been available for the better part of a decade and was not a very good calculator to produce cost effective results. The input parameters were very limited, so unless you had a majority of north facing windows, and your glazing to floor area ratio was low, we would never be able to achieve favourable results for our clients.

The NCC 2022 glazing calculator has been revamped with additional parameters, including allocating a zoning profile (same as we would be with energy rating software) so the results now align with energy rating results.

Most of the information in the E-Book is centred around achieving 7 star energy rating using software, however, there could be some benefit to utilising option 2: Elemental Provisions pathway





# Option 1: The software (FirstRate5)

Our team members have a combined experience in building design, construction and sustainable building methodology. This gives us a deep understanding of how to optimise house designs to offer the most cost-effective solutions. It also means we know and understand that sound solar passive design principles make your dwelling more comfortable to live in. We do this by using the FirstRate5 house energy rating software.

The software is an sophisticated tool that enables our assessors to generate comprehensive energy ratings. The software integrates the AccuRate calculation engine to estimate the annual heating and cooling energy loads. It can also be used to rate an existing design, or as a tool to plan for design beyond minimum compliance. In other words, the energy rating software does not work simply by modelling the dwelling into the software and then clicking buttons labelled '6 stars' or '7 stars'.

There are two ways to increase the star rating of a dwelling.

- By designing a floor plan that has good solar passive design principles (read more on this on page: ##) and utilises the sun and wind to keep the home comfortable year-round.
- By working to increase the specifications of the windows and insulation until the 7-star rating is achieved.

Focusing on the first point will help you keep your construction bill moderate. The second will blow out costs.

The FirstRate5 software predicts how much heating and air conditioning will be used in any design project and then nominates times for each zone type to provide a relevant operating temperature. The energy rating system also works on a scaling system of one to 10. The more the dwelling can be heated naturally by the sun, the higher the star rating will be. In the summer months, if the house naturally cools well via openable windows, glazing and shading, the star rating will also increase.

The energy rating program will penalise the star rating if the design itself cannot capture free sun heat and relies on electricity to heat or cool.



# Zones



Type of zone	Details of occupancy	Colour in FirstRate5
Kitchen/living	Conditioned from 7am to midnight. Daytime occupancy. Cooking heat gains included. Minimum of one per dwelling must be included.	
Living	Conditioned from 7am to midnight. Daytime occupancy. No cooking heat gains.	
Bedroom	Conditioned from 4pm to 9am. Night-time occupancy.	
Night-time	Conditioned from 4pm to 9am. No occupancy heat gains.	
Daytime	Conditioned from 7am to midnight. No occupancy heat gains.	
Unconditioned	No heating or cooling. No occupancy heat gains.	
Garage	No occupancy heat gains.	
Garage conditioned	Garage conditioned. Conditioned from 7am to midnight. No occupancy heat gains.	





## Conditioned

This term refers to when a room or zone must sit within a set temperature range to ensure comfort. This temperature range is dependent on the local climate, as well as the nominated zone.

## Internal heat generation

According to the Nationwide House Energy Rating Scheme (NatHERS) heat loads exist within buildings as a result of latent heat energy. This is when heat is released from human activity (people are a source of heat energy), moisture in the air and energy not related to thermal comfort. Base heat loads include heat generated from cooking, lighting, electrical appliances and people. The energy rating software predicts how a dwelling's building energy efficiency will perform. It does this by assigning a set of occupancy and conditioning rules to each of the selected zone types.

## Kitchen/living zone

Only one kitchen zone can be allocated. This is a great zone as it incorporates heat generated by cooking, as well as the occupants. The bonus? There is a significant drop in temperature rating through the evenings because heat is already being generated. This means you are less likely to have the heater on for the duration of the night. If you can combine this room with an open-plan living and dining room, you will boost up your rating by a few points.

*Summary.* This is the best zone to nominate - utilising a big kitchen/living area will help shoot that star rating higher.

## Living zone

Living areas are separate living and rumpus rooms and they also calculate occupancy heat. The downside is you can only select two of these zones so if you have a house that includes three or more separate living areas, you won't be able to model them under this category. Instead, they will be nominated as daytime zones. The downfall here is that these zones are the worst performing as they have no associated occupancy heat. No occupancy heat means more time with the heater on.

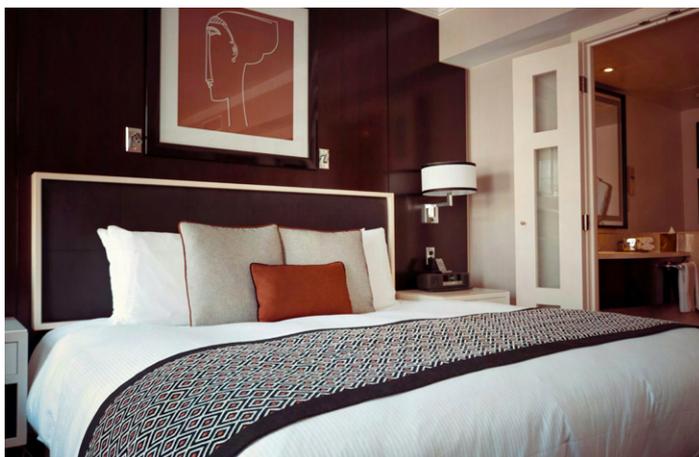
*Summary.* An average performing zone. We recommend keeping living rooms modest in size and incorporating a maximum of two additional spaces outside the kitchen/living space.



## Bedroom zone

Bedrooms are conditioned during the night and the heating and cooling loads for these rooms are not energy intensive.

*Summary.* A great zone to nominate as they have lower energy demands. We find boarding homes that feature a higher number of bedrooms have a higher star rating.



## Daytime zone

Entry and hallways, studies (without robes), bathrooms without openable windows, and any other room not specified above fall into the daytime category. Unfortunately, these have the worst associated profiles and therefore are the worst-performing zones.

*Summary.* Trying to minimise the number of daytime zones will go a long way in boosting the star rating. Keep entryways and hallways to a minimum and design bathrooms, water closets and laundries to have external openable windows or doors. This will allow these spaces to be nominated as unconditional in lieu of the daytime zone.

## Unconditioned zone

Unconditioned zones have no energy requirements to them. In simple terms, it is an area that is not considered to be heated or cooled at all – for example, your garage. A laundry, bathroom or powder room that has an operable door or window to the outdoors, can also be deemed unconditioned.

*Summary.* As mentioned in the daytime zone summary, designing bathrooms, water closets and laundries to have external openable windows or doors will allow them to be zoned unconditioned instead of as a daytime zone.

## Night-time zone

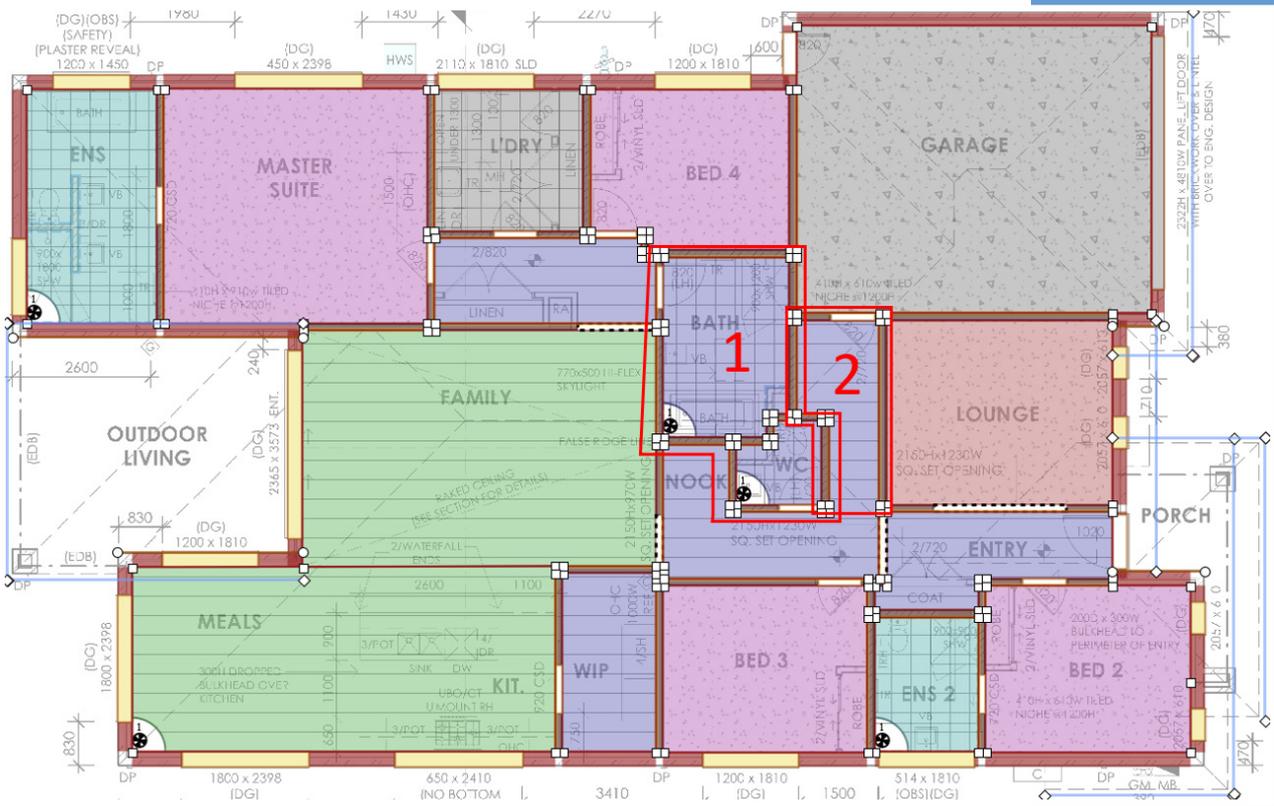
This category is allocated to rooms that can only be accessed from a bedroom, for example, a walk-in robe or ensuite. These rooms are small and have low-energy demands.

## Zone example that will drop the star rating

In this example, the bathroom and water closet have been located internally, which means they must be deemed as a daytime zone – the worst in terms of performance.

Redesigning the two rooms to be located to the external building footprint (like the laundry) will allow us to nominate them as unconditioned zones, which in turn will improve the star rating.

The hallway from entry to the internal garage door also creates an additional daytime zone, redesigning this to eliminate the additional hallway will allow us to model more living zone space which includes occupancy gains that daytime zones miss out on.



## Behind the numbers (Insulation and Glazing)

Understanding some building science fundamentals will help better explain why a dwelling's star rating might not be as high as expected or hoped.

The two critical specifications produced by the energy rating are the insulation and the glazing values. One measures in R-value and one in U-value.

Insulation is measured in R-value, the higher the better. Glazing is measured in U-value, the lower the better.

In order to determine the R-value of glazing, the following formula applies -  $1/U$ -value.

In order to determine the U-value of insulation, the following formula applies -  $1/R$ -Value

The following table further explains the concept and provides an insight into glass as a material when used against a stud wall with R2.5 batts.

Glazing profile	U-value	R-value	Performance vs R2.5
Single glazing	U: 6.5	R: 0.15	6%
Standard double glazing	U: 4.1	R: 0.24	9.75%
Standard thermally broken DG	U: 2.9	R: 0.34	13.6%
High performance thermally broken DG	U: 2.4	R: 0.41	16.66%
Triple glazing	U: 1.9	R: 0.52	20.8%

As you can see, the best-performing windows only have about 20 per cent of the performance of R2.5 wall batts.

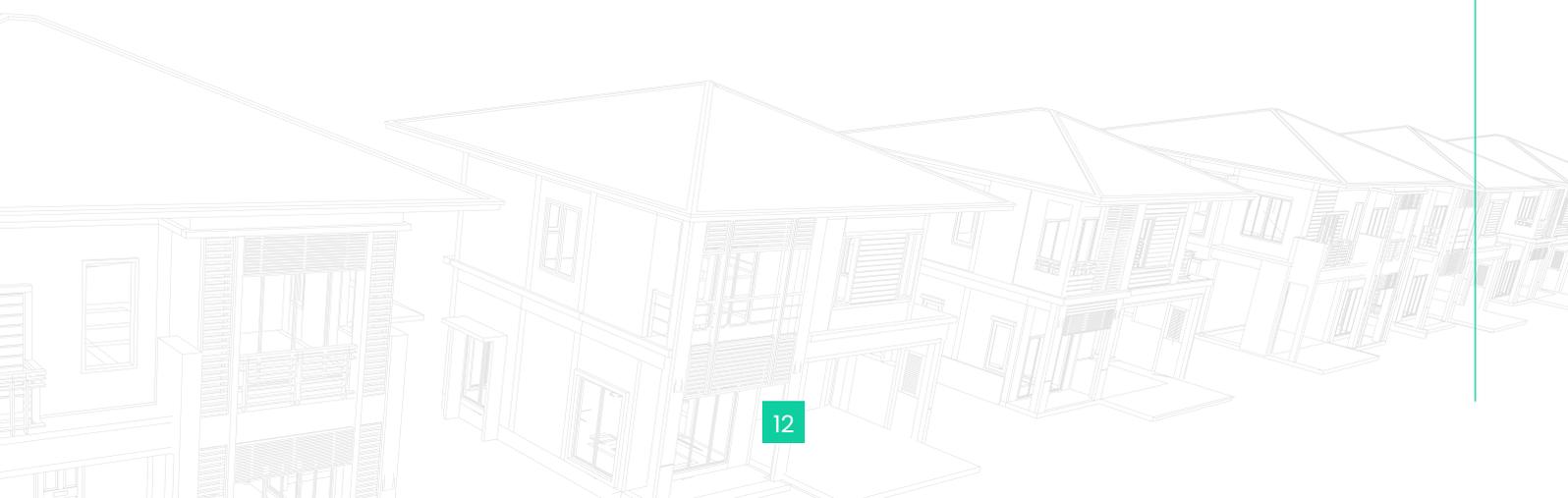
If we flip it around and wanted to find a window that had the same performance of an R2.5 insulation batt, we will need to  $1/R\text{-value}$ ,  $1/2.5 = U\text{-value } 0.4$

The lowest U-value available in the software is a triple-glazed fixed window from Paarhammer that is U-value 0.83 (R1.2), any guess what that might cost?

Open-plan living areas that feature a high level of glazing do not perform well as the opportunity to install insulation batts is limited. This is why glazing must be kept to a minimum, and the glazing-to-floor area percentage within the 15–25 bracket.

Windows are required as they allow natural light and the National Construction Code stipulates that the minimum glazing to floor area needs to be 10 per cent. This is where windows can play a big role – not only do they allow natural light in, but they play a role in heating the zone, which in turn increases the performance of the energy rating. One could argue that designing a maximum amount of windows to the north will heat the home for free and provide a huge boost in the star rating performance. However, as shown in the table, in the evening – or even on a cloudy day – an R2.5 insulation batt would perform much better than glass

If your design incorporates a sensible layout that factors climate, orientation and the site conditions, the star rating will increase. This means that the need for upgrades in insulation and glazing will reduce saving you a lot of time.



# Behind the numbers (Heating and Cooling Loads)

The recommendations we offer are based on the data provided by the energy rating software.

Each room (or zone) has a heating and cooling load that we analyse to determine if it is too high or working well.

Targeting these zones first can have a big impact on the improvement of the energy efficiency of the dwelling.

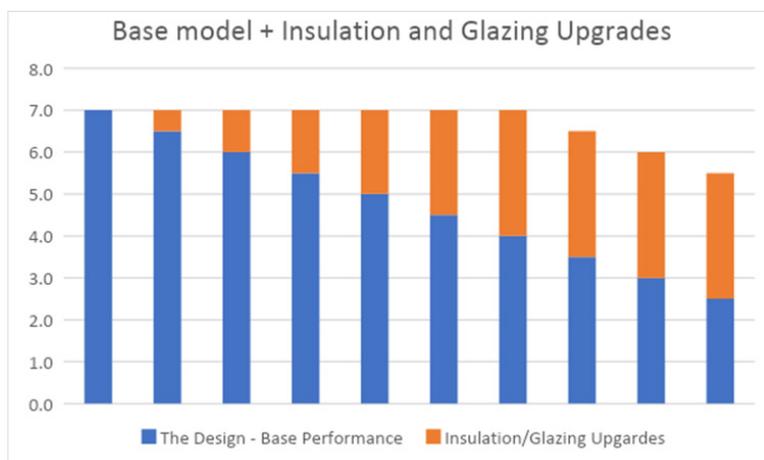
Providing upgrades to a small bedroom that already has low heating and cooling loads, will increase construction costs but provide little improvement, so it's important that the numbers are reviewed to see where high impact modifications can occur first.

Zone Energy Loads				
Zone	Heating (MJ/m2)	Total Heating (MJ)	Cooling (MJ/m2)	Total Cooling (MJ)
Bed 3 (Z024)	66.1	782.0	7.5	88.7
Indoor Lap Pool (Z015)	143.0	2407.1	93.4	1573.4
WIP (Z016)	118.6	708.6	10.2	61.1
Bed 4 (Z025)	38.0	451.0	6.3	75.4
Lounge/Entry/Stairs (Z002)	76.8	2243.7	32.7	956.9
WIR (Z018)	59.7	434.1	8.8	63.8
Master Bed (Z019)	107.4	2863.4	22.7	605.5
Hallway/Stairs (Z021)	242.4	3761.6	124.7	1935.6
Bed 2 (Z022)	58.6	808.3	30.4	418.5
Powder 2 (Z014)	126.9	150.7	46.2	54.9
Master Ensuite (Z020)	43.5	597.9	15.4	211.1
Ensuite 3 (Z007)	23.1	138.0	5.4	32.5
Powder 1 (Z011)	72.4	188.1	0.0	0.0
Hallway (Z003)	86.6	1093.5	0.0	0.0
Home Theatre (Z004)	42.6	1188.7	1.0	26.8
Stairs (Z012)	119.0	560.3	0.0	0.0
Ensuite 2 (Z026)	44.1	180.4	13.7	56.0
Wine Cellar (Z001)	124.3	1494.7	0.0	0.0
Bed 5 (Z006)	19.2	230.6	8.3	99.9
Study (Z005)	193.3	1811.8	92.7	868.7
Office (Z013)	152.1	1008.2	0.0	0.0
Kitchen/Living/Dining/Stairs (Z009)	46.8	3339.7	22.0	1571.8

## Sliding scale system

Keeping costs to a minimum is always a winner. But how can you do this and still achieve a terrific star rating? One way is to adopt a design that has a good energy star rating base with standard specifications. Keep in mind that the lower the base, the more you will need to spend on insulation and glazing upgrades to secure that 7-star rating. It's also important to note that there is a limit to how much insulation and glazing upgrades will improve the star rating, so if you start too low, you won't hit the 7-star rating regardless of how many upgrades you have.

**Graph explanation:** The blue lines represent the design and how it performs against standard insulation and standard double-glazed windows. The orange lines represent the actual amount of insulation and glazing that is required. This is a great tool for designers to use with clients as it visually represents the implications a design brief can have, and what additional costs will be required.



## Scenario A

In this example, we have a design that features a simple build form that is orientated to capture northern sunlight. It is designed with straw bale, which grants a high R-value to the walls, floor and ceilings. All bathrooms and laundries are designed to feature external openings, which means they can be nominated as unconditioned zones.

This design achieves 6.2-star energy rating with single glazing.

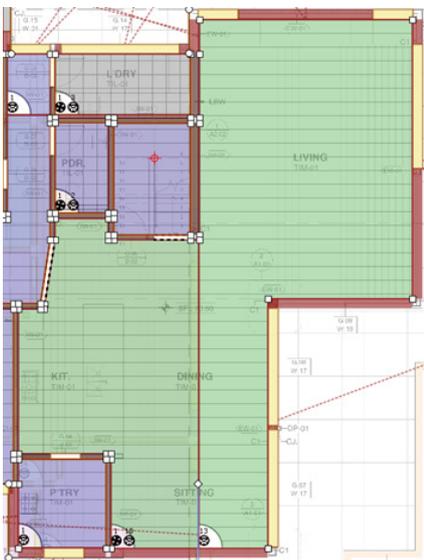
Nominating standard double-glazing will result in a projected 7.4-star rating.



## Scenario B

This example design features a large amount of glazing in the open-kitchen/living area (the green zone). The zone has an internal area of 93.63m<sup>2</sup>. The glazing area is 61.83m<sup>2</sup>.

This equates to a glazed-to-floor area ratio of 66 per cent, which is very high. This design with R2.5 wall batts, R5.0 ceiling batts plus single-glazed windows and sliding doors achieves 2.8 stars. Nominating standard double-glazing will only increase the rating to 4.2 stars.



Alternatively, deleting three of the glazed units from that green zone and replacing with R2.5 insulation will increase the original 2.8-star rating to 3.2 stars. Removing 28.89m<sup>2</sup> of glazing reduces the glazing-to-floor area of this zone to 35.1%. While the figure is high, it is a definite improvement. With the above glazing units deleted and re-nominating standard double-glazing bumps, the result will be 4.5 stars.

This example demonstrates how adjusting the glazing-to-floor area of just one zone can result in a marked improvement. The design can be further improved by adjusting the ratio in the front guest room, study and upper floor.

# Insulation

It is no secret that insulation is less expensive than upgrading the glazing on a property. Therefore, our first point of call should always be to fill all available cavities to the maximum allowable thickness. Insulation rating is based on thickness, which means you can't squeeze an R4.0 batt into an R2.5-sized cavity.

The key is to identify the sweet spot - adding insulation beyond the recommended amount will only marginally approve a star rating. We choose to increase insulation beyond the recommendation only when the additional boost is paramount.

The FirstRate5 software that we use only calculates the R-value, not the material. This means that we specify the added R-value required to meet 7-star compliance. Any product can be nominated as long as the R-value matches what is specified in the energy rating report. Generally, your builder will have their preferred suppliers.



**Please note:** some companies specify the total R-value with the materials. This means that the walls system as a whole (not just the product) has been included in the provided R-value. This is misleading as it will result in a higher number than what the insulation product will actually achieve.

Recommended Insulation Values	Rec. R-value	R-value increase (possible star rating increase)
Ceiling	R5.0-R6.0	R7.0 (0.1-0.2 stars) R8.0 (0.1 stars)
External walls	R2.5	R2.7 (0.1 stars)
Internal walls (garage and unconditioned laundry, powder and bathroom areas)	R2.0	R2.5 (0.1 stars)
Timber sub-floor	R2.5	R4.0
Posi insulation over garage, porch and alfresco	R2.0-R2.5	R3.0 (0.1 stars) R4.0 (0.1 stars) Posi insulation to remainder of dwelling (0.1-0.2 stars)
Concrete raft slab (CSOG)	R0.0	R1.1-R2.5 (0.4-0.6 stars*)

\*Adding under-slab insulation to a standard raft slab will dramatically improve the star rating at an average of 0.5. The flow-on effect of this is that it will increase the cooling load, often past the maximum limits. If you have a design that features a substantial amount of fixed glazing, this will push your cooling limits beyond the maximum allowable range.

\* NCC 2022 now requires standard raft slabs to be insulated around the perimeter and under with R0.64 insulation for NCC climate zones 6 and 7, and R1.0 for NCC climate zone 8.

## External Cladding



It is worth noting that almost all external cladding has a low R-value. This means that using the product will not particularly benefit the star rating.

External Cladding	R-Value	Possible star rating increase
FC sheet (6mm)	R0.03	Negligible
Brick (110mm)	R0.18	Negligible
Hebel panel (75mm)	R0.52	0.1 stars
EPS cladding (50mm-100mm)	R1.39-R2.78	0.1-0.2 stars

# Shading

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## OUTDOOR AREA

Australians love outdoor living, and rightly so. That said, consideration must be given to the location and design principles of any external space.

For example, if you have a living room that features a north-facing sliding door and you design an outdoor living area within that space, you will lose 0.5 stars in performance, as it will block the winter sun from heating the home for free. The repercussions of this are not so severe with 6-star compliance, but as the industry moves towards the 7-star rating, it will be a different story. An incorrectly designed outdoor living area could cost the client double or triple the amount if you need to upgrade insulation and glazing to meet the standard.

Keep in mind that designing an outdoor area that blocks out the sun through the hotter months will reduce the need for air conditioning thus improving the star rating significantly.

For warmer climates, this is the opposite. Designing shading so that it blocks out the sun from coming through completely will help keeping the cooling loads down and

## EAVES

We find that a parapet eave wall will perform about 0.1 stars better than a standard 450-millimetre eave and gutter. This is based on the law of averages that there are colder months requiring the sun to heat the home than warmer months. Pay consideration to those hot months between December and February as they will not be pleasant for the homeowners.

Adjustable eaves, while not common, work best as they allow for optimal shading in both extremes.



# Summary of design tips

Here is a handy guide of our top tips to ensure you maximise your designs to have the highest star rating possible before requiring further upgrades.

1. Design the layout with the software zones in mind
  - I. Maximise kitchen/living zone area
  - II. Keep living zones to a maximum of two and moderate size
  - III. Minimise hallways and entries to reduce daytime zone
  - IV. Locate laundry, powder and bathroom areas externally with openable windows or doors
2. Design the layout per the orientation of the site
  - I. Kitchen/living area located to the north
  - II. Bedrooms can be east and west, or north
  - III. Laundry, bathroom, garages should be located to the south.
3. Site the dwelling correctly to avoid overshadowing
  - I. Designing too close to the fence or a neighbour's two-storey dwelling can create over-shadowing that prevents the winter sun from entering a living space.
4. Keep the size of the dwelling modest
  - I. Large dwellings will have a huge amount of internal air that needs to be kept within a specific temperature range. Specifications will continue to be upgraded until 7 stars is achieved.
5. Keep the glazing-to-floor area within the range of 15 to 25 per cent
  - I. Optimise to capture north-facing sun
  - II. Reduce on south-facing elevation that receives no sun
  - III. Glazing seriously reduces the R-value of the external wall which drops the star rating.
6. Provide appropriate shading for both summer and winter
  - I. Maximise winter sun exposure
  - II. Block out summer sun
  - III. Be mindful of covered outdoor areas blocking the winter sun from warming outdoor spaces.

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**Have questions about this E-Book? Or want to workshop a design you have been working on?**

Book a free 15 minute Zoom consultation and let us workshop your designs for a 7 star result.

**Calendly Link: [Book your free 15 min consultation](#)**

Or scan the QR Code



We look forward to chatting with you.

