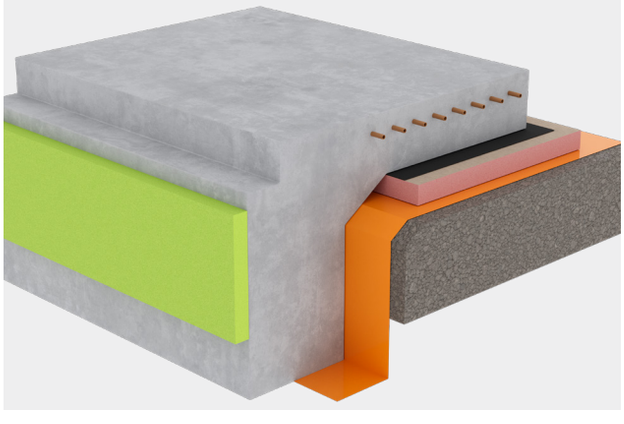
Insulation
Australia

How to achieve a 7 Star NatHERS Rating in Class 1a Buildings

A Guide for Victoria and New South Wales.



Kingspan®

7 Star Partner

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Introduction

In Australia, buildings are directly responsible for around 18%[1] of carbon emissions, largely from heating or cooling energy demands. Making our buildings more thermally efficient is one of the most important and most straightforward steps we can take to reduce carbon emissions and help mitigate climate change. A key part of achieving this aim is being driven by changes to the National Construction Code (NCC). Here we explore the requirement for new homes to meet a 7 Star NatHERS rating and how insulation can help to meet it.

What are NatHERS Ratings?

The Nationwide House Energy Rating Scheme – NatHERS – is the framework that defines the energy ratings for new dwellings.

NatHERS drives energy efficiency improvements for Australia's residential buildings by nationally standardising the energy rating assessment tools used to rate dwellings.

NatHERS' 10-Star rating system estimates a home's thermal performance – in essence, its heating and cooling needs. Information about a home's design, energy performance, construction materials and climate zone all contribute to its star rating. NatHERS' rating tools use calculations following rigorous scientific research carried out by Australia's National Science Agency, CSIRO.

Following the 2022 update to the National Construction Code (NCC), the minimum required NatHERS rating increased from 6 to 7 stars in some regions. The NCC 2022 version also includes more recent and more accurate weather data updates to the climate files used to calculate star ratings for NatHERS. The new files, which relate to 69 Australian Climate Zones, now include data from 1990 to the end of 2015, replacing data gathered from 1970 to 2005.

In New South Wales (NSW) the long established Building Sustainability Index (BASIX) tool is used to assess the sustainability of residential buildings. A BASIX compliant NatHERS assessment can not be less than 7 Stars. To achieve this, the stringency of individual heating and cooling load metrics has increased, and a Total Load metric in line with NatHERS 7 Stars has been added to the BASIX software. The total load metric is identical to the 7 Star Total Load required by NatHERS in each affected climate zone.

About this Document

Kingspan Insulation has produced this document as a guide to achieving a NatHERS 7 Star rating under the NCC 2022, which is now in use within the states of New South Wales and Victoria. It specifically concentrates on the parts that are relevant to building fabric insulation, whilst showing how compliance can be achieved by including Kingspan's insulation products for walls and floors in traditional residential buildings.

1. https://www.dcceew.gov.au/energy/energy-efficiency/buildings

How to achieve a 7 Star NatHERs Rating in Class 1a Buildings

Introduction

Class 1 Buildings are defined as residential buildings and have two sub-classifications:

- **Class 1a** – a single dwelling or one of a group of attached dwellings such as in a row of terraces.
- **Class 1b** – a boarding house, guest house or hostel with a floor area of less than 300m^2.

A 7 Star standard demonstrates a home's energy efficiency and sustainability, representing Australia's commitment to better building practices and environmental stewardship. It uses a 'Whole-of-Home' approach, meaning that a 7 Star NatHERS energy rating encompasses the overall design, with each design element contributing to reach the overall result.

Key Features of a 7 Star Residential Building

1. **Thermal Comfort:** Homes with a 7 Star rating provide better thermal comfort, meaning they keep a more consistent, comfortable indoor temperature all year round, with lower reliance on artificial heating and cooling.
2. **Insulation:** These homes typically have better levels of insulation in walls, roofs, and floors, responding to the demands of different climate zones and reducing the need for heating in winter and cooling in summer.
3. **Glazing:** Energy-efficient windows, for example double or triple glazing, are generally used to meet the needs of specific climate zones and minimise heat loss in winter and heat gain in summer.
4. **Orientation and Design:** The design and orientation of the building take advantage of natural light and heat during winter and limit heat gain in summer. This will vary by climate zone. Thinking about where to place windows and shading devices is essential. Shading can be used to prevent overheating during summer and in hot climates; however, too much shading can have a negative effect during the winter or in colder climates.
5. **Building Materials:** Using materials with good thermal properties is encouraged to enhance the home's overall energy performance.
6. **Ventilation:** Proper ventilation systems are incorporated to ensure good indoor air quality and energy efficiency.

Implementing a 7 Star standard is part of a broader national strategy to improve energy efficiency that fall within the NCC. The NCC sets the minimum technical requirements for constructing new buildings and building work in existing buildings. As a performance-based code, the NCC demands that a building, plumbing or drainage solution must meet the relevant performance requirements to comply. Simply explained, the performance requirements set the compliance level. Several optional compliance pathways are available to achieve the necessary compliance level, such as Deemed-to-Satisfy (DTS) Provisions, Verification Methods and Performance Solutions.

Which route should you go down to achieve thermal performance equivalent to a 7 Star NatHERS rating?

As a set of prescriptive provisions within the NCC, DTS lays out compliance pathways for building and construction projects. These provisions are designed to ensure that building designs and construction practices meet the NCC's minimum performance requirements without the need for extra documentation or approval processes.

It is important to note that there are two Deemed-to-Satisfy pathways for energy efficiency.

Option 1: Energy Rating

Under this pathway, each component of the construction undergoes evaluation using NatHERS-accredited energy-use simulation software. This software simulates the energy demands for heating or cooling in every livable space within the residence to a comfortable level throughout each hour of every day across the entire year. It integrates variables including regional climate conditions, building orientation, natural ventilation patterns, construction materials, roof colouration and more.

The Star Rating method offers a significantly enhanced and detailed means of forecasting energy consumption for heating residences. It provides greater flexibility to builders, allowing them to offset specific design decisions. For instance, in colder climates, recommendations might favour darker-coloured roofing materials to optimise energy ratings.

Option 2: Elemental Provisions

This methodology involves a detailed examination of each individual building component to ensure compliance with the NCC's energy efficiency requirements. Critical aspects include calculating the total R-Value of roofs, walls and, occasionally, floors in accordance with AS/NZS 4859.2 standards, alongside verification that glazing and ventilation systems meet regulatory provisions.

An obvious drawback of this method lies in its strict adherence to minimum standards for each element, thereby limiting flexibility in optimising overall building performance by balancing higher and lower performing components, as facilitated by the Energy Rating approach.

This document looks at how builders can implement the Deemed-to-Satisfy pathway using house energy rating software as stipulated in Clause H6D2 of NCC Volume 2.

Compliance for Class 1a Buildings

Victoria

From 1st May 2024 all new homes in Victoria are required to meet the 7 Star standard and a whole-of-home rating not less than 60, which involves a detailed assessment using NatHERS-accredited software. The software simulates the home's energy usage, taking into account its design, materials, orientation and climate zone. Builders and designers work with accredited assessors to make sure that the design meets the rating criteria.

A 7 Star rating within this scheme shows that a new home has been constructed to the minimum standard for energy efficiency and will still need some mechanical heating and cooling to keep it comfortable to live in. Higher ratings indicate that it is more energy efficient. Note that there are separate heating and cooling load limits to achieve a 7 Star rating:

NatHERS climate zone	Applicable state and/ or territory	Heating load limit (MJ/ m2.annum)	Cooling load limit (MJ/ m2.annum)
20	VIC	87	34
21	VIC	48	41
22	VIC	110	12
23	N/A	N/A	N/A
24	ACT, VIC	129	34
25	N/A	N/A	N/A
26	N/A	N/A	N/A
27	VIC, SA	71	43

Extract: Class 1 Concrete Slab-on-Ground – Heating and cooling load limits applying to NatHERS 7 Stars in Victoria

New South Wales: BASIX (Building Sustainability Index)

Forming part of the development application process, BASIX requirements apply to all residential dwelling types in NSW. Assessments using the BASIX tool estimate the water and energy consumption, thermal performance and the embodied emissions of the building materials based on the information provided.

This includes the floor area; the size, location and type of windows; type of insulation and the type of hot water system being installed, allowing the Thermal Performance Index of the BASIX tool to assess the heating and cooling loads based on the fabric of a new dwelling. Heating and cooling appliances (except ceiling fans) and fuel type are assessed separately under the Energy Index.

Note that, as well as all new residential dwellings in NSW, there are also BASIX standards for water and energy usage and thermal performance that apply to alterations and additions to dwellings that cost $50,000 or more, and to swimming pools of 40,000 litres or more.

Thermal Performance Index methodology

There are three different methods for completing the Thermal performance Index

- **Do-It-Yourself (DIY) method** – This is intended for use for single-dwelling houses built using common construction materials and methods. It is effectively a simplified DTS assessment.
- **Simulation method** – This is suitable for more complex designs and larger developments with multiple dwellings and allows for greater flexibility and use of innovative materials and methods. It employs NatHERS-accredited software to create a detailed assessment.
- **Passive House standard method** – This method is only applicable to homes that are designed and constructed to Passivhaus standards and requires the services of a Certified Passive House Designer to input the building design information into the Passive House Planning Package (PHPP) software.

This document focuses on how to comply using the simulation method.

Climate Zones

The NCC's climate zones are classified into eight types based on temperature and humidity patterns. This zoning helps us understand the variations in weather and environmental conditions across the continent. It influences building design, insulation requirements, and energy efficiency strategies to optimise comfort and minimise energy use in buildings across Australia. The zones are as follows:

Climate zone 1	High humidity summer, warm winter
Climate zone 2	Warm humid summer, mild winter
Climate zone 3	Hot dry summer, warm winter
Climate zone 4	Hot dry summer, cool winter
Climate zone 5	Warm temperate
Climate zone 6	Mild temperate
Climate zone 7	Cool temperate
Climate zone 8	Alpine

NatHERS also divides Australia into regions of similar climatic conditions, While there are only eight NCC climate zones, there are 69 NatHERS climate zones, identifiable via its interactive climate zone map.

These multiple climate zones accurately account for Australia's diverse geographic and climatic conditions, reflecting the wide-ranging temperature, humidity and seasonal variations across the continent, influencing the energy efficiency and thermal comfort requirements of residential buildings.

By categorizing regions into highly specific climate zones, NatHERS ensures that energy ratings are precise and applicable to local conditions, helping builders and homeowners to make informed decisions about insulation, heating and cooling systems and overall building design. This approach supports national energy efficiency goals, aligns with regulatory standards and supports ongoing research into bespoke solutions for sustainable building practices across Australia.

Note that separate heating and cooling load limits need not be achieved in all 69 NatHERS climate zones. This is because some climates are dominated by hot or cold weather, such as the climate zones in the Northern Territory (NT), Tasmania (Tas) and some climates zones in Queensland (Qld) and Western Australia (WA). New South Wales (NSW) already has separate heating and cooling load limits (or "caps") covered in its Building Sustainability Index (BASIX) thermal performance standards. Hence, heating and cooling load limits do not apply in NSW, NT, Tas and parts of Qld and WA.

This document will focus on climate zones within the states of Victoria and New South Wales.

Orientation

Orientation refers to which way the home faces in relation to the path of the sun. In the warmer parts of Australia, the orientation of a dwelling is crucial for enhancing comfort and energy efficiency. NatHERS-accredited software models a home's thermal performance based on its orientation, among other factors. This simulation predicts the energy required for heating and cooling throughout the year, which contributes to the overall star rating. It considers orientation in the context of several factors:

North Orientation: How well the design uses solar access for winter heating. In cooler climates, north-facing living areas can capture more sunlight, reducing the need for artificial heating. Placing sleeping areas on the south side of the home makes them cooler and more comfortable at night.

Shading: It also considers the effectiveness of shading devices such as eaves and pergolas in preventing excessive heat gain in summer.

Window Placement and Glazing

Window Orientation: The orientation and size of windows are evaluated to determine how they contribute to heat gain and loss. Correctly oriented windows can maximise natural light and warmth in winter while minimising overheating in summer.

Glazing Type: The type of glazing used (for example, single, double, or low-E glass) and its orientation impacts thermal performance and is factored into the rating.

Cross Ventilation

Airflow: The design's ability to facilitate natural cross-ventilation is checked. Homes oriented to capture prevailing breezes can cool more effectively without relying on air conditioning.

Ventilation Pathways: The layout and orientation that allow for effective airflow through the home are considered.

Thermal Mass

Heat Distribution: The orientation affects how thermal mass elements such as concrete floors or brick walls absorb and release heat. Proper orientation ensures that thermal mass stores heat during the day and releases it at night, enhancing comfort and energy efficiency.

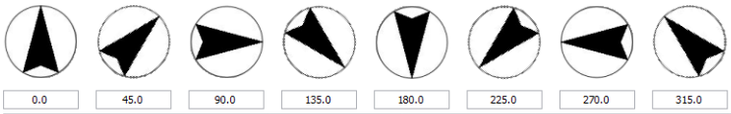
Site-Specific Climate Data

Local Climate Zones: NatHERS uses climate data specific to the dwelling's location. The star rating considers how well the home's orientation and design respond to local climate conditions, including temperature variations, solar exposure, and wind patterns.

Orientation – Warmer Climates

Single-storey Homes:
Single-storey = 0.8 Star Deviation

In warmer climates, single-storey homes might experience a greater challenge in achieving high star ratings due to higher roof exposure to the sun, leading to increased cooling loads. However, efficient design features such as wide eaves, good insulation, reflective roofing, and strategic window placement can mitigate this.



Azimuth	Heating	Cooling	Total	Stars
0.0	10.7	36.8	47.5	7.4
45.0	12.7	37.4	50.1	7.2
90.0	13.1	34.1	47.1	7.4
135.0	14.3	38.8	53.1	6.9
180.0	13.1	40.7	53.7	6.9
225.0	15.9	42.3	58.2	6.6
270.0	15.5	37.0	52.5	7.0
315.0	15.3	37.5	52.8	7.0

Double-Storey Homes:
Double-storey = 1 Star Deviation

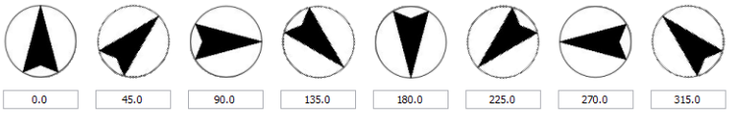
Double-storey homes can potentially achieve better star ratings if designed to optimise thermal performance, as they can have reduced roof exposure and better zoning. However, managing the stack effect and ensuring effective ventilation between floors are crucial.

Azimuth	Heating	Cooling	Total	Stars
0.0	22.0	42.0	64.0	6.2
45.0	23.2	39.4	62.6	6.3
90.0	23.0	35.3	58.3	6.6
135.0	23.5	36.8	60.3	6.4
180.0	21.3	38.8	60.1	6.4
225.0	24.5	40.9	65.4	6.1
270.0	24.5	42.9	67.4	5.9
315.0	26.3	47.1	73.4	5.6

Orientation – Cooler Climates

Single-storey Homes
Single-storey = 0.3 Star Deviation

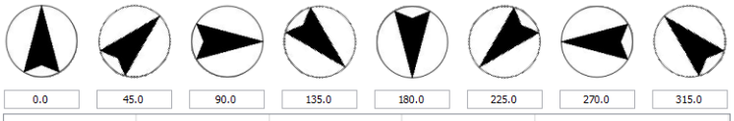
When oriented properly (north-facing), single-storey homes can achieve high star ratings due to their ability to maximize solar gain and utilize thermal mass effectively. Regarding energy efficiency, these homes typically have a larger roof area relative to their volume, which can be an advantage in capturing solar energy, but also a potential disadvantage if not properly insulated.



Azimuth	Heating	Cooling	Total	Stars
0.0	41.7	19.2	61.0	7.1
45.0	40.4	17.8	58.2	7.2
90.0	38.7	16.2	54.9	7.4
135.0	39.8	18.5	58.3	7.2
180.0	38.9	19.4	58.3	7.2
225.0	37.4	18.5	56.0	7.3
270.0	36.1	16.0	52.1	7.4
315.0	39.7	17.6	57.2	7.2

Double-storey Homes:
Double-storey = 0.4 Star Deviation

Double-storey homes can also achieve high star ratings with a north-facing orientation, but they require careful design to manage the stack effect and ensure heat is evenly distributed across both floors. Double-storey homes often have a smaller roof area relative to their volume, which can reduce heat gain from the roof but requires efficient design to manage thermal performance between floors.



Azimuth	Heating	Cooling	Total	Stars
0.0	35.2	19.1	54.3	7.4
45.0	35.5	15.4	50.9	7.6
90.0	34.2	12.5	46.6	7.8
135.0	38.0	15.0	53.0	7.4
180.0	36.3	16.4	52.7	7.4
225.0	35.1	15.1	50.2	7.6
270.0	35.0	12.3	47.4	7.8
315.0	37.5	16.3	53.8	7.4

Insulation

Many factors contribute to heating and cooling loads, including insulation levels, solar gain, airtightness and local climate. Increased Insulation is a key to reducing heating and cooling loads as it is crucial for controlling the flow of heat into and out of a building. In acting as a barrier to heat transfer, it helps keep indoor temperatures stable and reduces the need for heating and cooling. Effective insulation minimises heat loss in winter and heat gain in summer, leading to more energy-efficient and comfortable buildings.

How Insulation Works

There are three kinds of **heat transfer mechanisms:**

1. **Conduction:** Direct transfer of heat through materials. Insulation materials with low thermal conductivity are used to reduce conduction.
2. **Convection:** Heat transfer through movement of air or fluids. Properly installed insulation can reduce air leaks and convection currents within walls and roofs.
3. **Radiation:** Transfer of heat through electromagnetic waves. Reflective insulation materials, such as radiant barriers, are used to reduce radiant heat gain.

Benefits of Increased Insulation

Better insulation has a positive impact in a number of ways:

- **Energy Efficiency:** In reducing the amount of heat that escapes in winter and enters in summer, insulation decreases the energy required for heating and cooling systems to keep the indoor temperature comfortable.
- **Cost Savings:** Lower energy consumption translates into reduced utility bills. Investing in high-quality insulation can lead to significant long-term savings.
- **Comfort:** Proper insulation helps maintain consistent indoor temperatures. It reduces drafts and cold spots in winter and keeps interiors cooler in summer.
- **Environmental Impact:** Reduced energy consumption lowers greenhouse gas emissions for a more sustainable building.

Installation Considerations

- **Continuous Insulation:** Ensuring there are no gaps, voids, or compression in insulation coverage is vital for its effectiveness and contributes to reduced energy consumption, which lowers greenhouse gas emissions.
- **Air Sealing:** Proper sealing of gaps, cracks, and openings in the building envelope complements insulation by preventing air leaks, which can undermine the insulation's effectiveness.
- **Moisture Control:** Insulation must be protected from moisture to avoid degradation and mould growth. A vapour control layer and proper ventilation are essential to maintain insulation performance.
- **NatHERS:** In Australia, NatHERS provides guidelines for energy efficiency, including insulation requirements to achieve high star ratings. NatHERS and BASIX modelling for construction methodologies includes looking at insulation in the walls, ground floor, roof and ceiling.

By understanding the mechanisms of heat transfer, selecting appropriate insulation materials, and ensuring proper installation, builders can significantly improve their buildings' energy efficiency, comfort and sustainability. Investing in high-quality insulation not only helps to achieve NCC compliance but also provides long-term economic and environmental benefits.

Building fabric thermal insulation

Clause 13.2.2 of the NCC Housing energy efficiency Handbook aims to ensure that insulation of any type is installed correctly so that it performs as intended, and does not compromise the safety or performance of electrical or plumbing systems.

The guidance provides a summary of the key requirements as set out in the table below (Ref: Table 3.3, page 18, Housing energy efficiency Handbook)[2]

Clause 13.2.2	Key Requirements
3. Integrity of the insulation	• Meets AS/NZS 4859.1 Materials for the thermal insulation of buildings • Adjoins or overlaps to form a consistent and continuous thermal barrier, except at supporting members[15] • 'Consistent and continuous' insulation means filling any voids in the framing unless a gap is otherwise required. Voids may include between window and door jambs, surrounding lintels, and voids in intersecting walls • Does not affect the safe or effective operation of any plumbing or electrical component[16]
2. Installation of reflective insulation	• Necessary airspace[17] between the reflective side of insulation and lining/ cladding • Closely fits against any penetration and adequately supported by framing • Adjoining sheets must overlap or be taped
3. Installation of bulk insulation	• Maintains its position and thickness, except where it crosses roof battens, water pipes etc. • Ceiling insulation must overlap the external wall by greater than or equal to 50 mm. This only applies when there is no insulation in the external wall below.

2. https://www.abcb.gov.au/sites/default/files/resources/2023/NCC-2022-Housing-energy-efficiency-handbook-fa.pdf

AS/NZS 4859.1:2002 and AS/NZS 4859.1:2018

The AS/NZS 4859.1:2002 standard has been superseded by AS/NZS 4859.1:2018, which contains significant updates regarding thermal insulation materials for buildings. These changes primarily focus on how products are tested and how thermal performance (R-value) is determined and declared.

Key alterations include stricter requirements for thermal testing, including a statistical assessment of test results to establish R50/90 or ⍰50/90 values. Insulation materials such as Phenolic Foam (PF), Polyisocyanurate (PIR), Polyurethane (PUR), Extruded Polystyrene (XPS), and Expanded Polystyrene (EPS) must now undergo specific aging methods to better reflect long-term performance.

In addition, manufacturers must now provide a thermal value summary report that meets standardised labelling requirements, ensuring consistency across product declarations, including the R-value. These updates aim to enhance the accuracy and reliability of thermal performance information available to consumers and construction professionals, aligning with evolving regulatory standards and improving overall building energy efficiency.

What is an R-value?

The effectiveness of insulation is measured by its R-value, which indicates its resistance to heat flow. Higher R-values represent better insulating properties, so materials with high R-values slow the transfer of heat. The R-value has an impact on a building's performance in several ways:

- **Energy Efficiency:** Proper insulation with the desired R-value can significantly reduce heating and cooling costs by maintaining indoor temperatures.
- **Comfort and Space:** Higher R-value insulation materials can help maintain a consistent temperature with less material, using less internal space.
- **Environmental Impact:** Efficient insulation reduces energy consumption, lowering greenhouse gas emissions.

Insulating materials declare their R-value in millimetres (mm). AS/NZS 4859.2:2018 provides generic thermal conductivity values for these insulating materials, although individual products are likely to differ.

We can split R-value into two categories:

Product R-value (R)

The product R-value measures a material's ability to resist the flow of heat. The higher the R-value, the greater the insulating effectiveness. Product R-value depends upon the material, its thickness and its density.

Total R-value (R_T)

The Total R value is the total resistance of a building element and considers the resistance provided by all the building materials used in a wall, roof or ceiling.

Builders and developers can ensure they use the right insulation products to achieve a 7 Star rating by following a series of steps to understand regulations, select appropriate materials and ensure proper installation:

Understand regulatory requirements: The latest NCC, which includes the Building Code of Australia (BCA) outlines the minimum energy efficiency requirements, including insulation R-values based on different climate zones.

NatHERS requirements: Become familiar with the NatHERS requirements for achieving a 7 Star rating, including the energy performance standards homes must meet in the relevant region.

Climate-specific requirements: Use the NCC Climate Zone Map to find the R-value requirements for roofs, walls and floors in your region.

R-Value matching: Choose insulation materials with R-values that can meet or exceed the climate zone's regulatory requirements with a suitable thickness.

Material types: Consider different types of insulation materials for different applications, such as phenolic foam board Insulation or reflective insulation.

Use simulation and modelling tools: NatHERS-accredited software tools can simulate your design's thermal performance to show how different insulation products and configurations will perform.

Thermal performance assessment: A detailed thermal performance assessment during the design phase can help ensure compliance with the 7 Star rating criteria.

Implement best practices in insulation installation: Professional installation is important to ensure continuous insulation strategies and air tightness.

Innovative products: Keep up with insulation technology and consult with suppliers to identify which products can offer better performance and/or ease of installation, and where they can be used.

Documentation and compliance: Make regular checks during construction to ensure that insulation meets the right specification. Maintain thorough documentation of the insulation materials used, including their R-values and installation locations.

Talk to experts and consultants: Speaking to specialists can save time and reduce overall costs in the long term in achieving a 7 Star rating.

Insulation
Thermal Bridging & Condensation Management

Thermal Bridging

Thermal bridges are weak points or areas in the building envelope that allow heat to pass through more easily. They arise when materials that are better conductors of heat are able to form a 'bridge' between a construction's inner and outer face. Typical instances are when there is a gap in the insulation layer, at junctions or where an element like a joist penetrates through the construction. Thermal bridging effects both directions of heat flow – heat inwards and heat outwards.

What problems does thermal bridging cause?

Heat will always try to find the path of least resistance through a space. As we insulate buildings to a higher level, thermal bridges can become a significant source of heat loss or heat gain, accounting for as much as 30% of total losses or heat gain. This can undermine the benefits of installed insulation and contribute to the performance gap between the expected and actual energy demand of the building.

As the surface of a construction where a bridge occurs will be cooler than the surrounding area, there is a further risk that condensation can form, potentially damaging the surface or leading to mould growth, and its associated health risks.

NatHERS and thermal bridging

The effects of thermal bridging are accounted for in NatHERS software. This means there are no additional thermal bridging requirements when using this compliance option. However, the thermal break requirements of subclauses 13.2.3(7) and 13.2.5(5) of the Housing Provisions still need to be met, where applicable. Note that reflective insulation alone is not suitable for use as a thermal break since it requires an adjoining airspace to achieve its specified R-Value.

It is important to bear in mind that the NCC's prescriptive DTS provisions on thermal bridging in residential buildings targets their avoidance in metal-framed walls, roofs, ceilings and floors rather than applying to buildings with a timber-frame construction. The reason behind this distinction is to ensure that metal-framed buildings have a minimum performance level of 90-95% of that of timber-framed buildings.

The NCC states: *"...you are not required to consider thermal bridging in timber-framed buildings. The exception to this is when you calculate Total R-Value for external walls of apartment buildings. Importantly, there are different thermal bridging requirements for houses, the common areas of apartment buildings and the SOUs (apartments)."*

In the absence of specific NCC guidelines, we would recommend using the principles of timber-frame thermal bridging as appropriate.

Guidance on installing bulk insulation in houses can be found in the Australian Standard AS 3999: Bulk thermal insulation – Installation.

Condensation Management

Insulation must be protected from moisture to avoid degradation and mould growth, meaning that vapour barriers and proper ventilation are essential to maintain insulation performance. When warm, moist air encounters a cold surface, the air cools down, and its moisture condenses into water droplets. This can occur on windows, walls, and ceilings, especially in areas with poor insulation or where there are thermal bridges. In addition to a thermal rating, the selection and installation of reflective and bulk insulation must meet other NCC requirements such as Part 10.8 Condensation management in the Housing Provisions.

Here are some key points to bear in mind:

- **Thermal bridging** can lead to localised cooling of surfaces, which increases the likelihood of condensation forming at these points.
- Condensation creates the ideal conditions for **mould and mildew,** which thrive in damp environments
- Persistent condensation can lead to **damage** to building materials over time. For example, water trapped within walls or ceilings can weaken structural integrity, leading to costly repairs.
- High humidity levels resulting from condensation can create an uncomfortable and **unhealthy indoor environment,** causing problems such as allergies and respiratory issues for occupants.
- Condensation often results in aesthetic issues such as unsightly water stains, peeling paint and deteriorating wallpaper, which can diminish the appearance and value of a property.

The primary issues relate to condensation in or on walls, as the predominance of ventilated pitched roofs helps to reduce the risk of condensation on ceilings. To mitigate these problems, proper insulation installation is crucial. Australia's extreme temperature variations make it critical to use insulation materials with appropriate R-values for the climate zone. Choosing between vapour-permeable insulation or vapour-resistant insulation is an important factor your supplier or building designer can advise on. You can play safe by commissioning a condensation risk analysis at the start to identify potential problems. Additionally, managing indoor humidity levels by pre-planning ventilation can help reduce the occurrence of condensation and its associated issues. And once you are on site, ensure that insulation is continuous and properly installed without gaps or compression.

Note that the consultation period for the 2025 version of the NCC is now closed, so the release of Draft NCC 2025 can be expected soon. Whilst the primary changes will apply to commercial buildings, there will be updates to condensation management that apply to housing.

Modelled Single-Storey Building
Timber Frame Buildings

This example is a four bedroom single-storey home with a total floor area of 235.17m^2. It comprises 184.43m^2 of ground floor space, 25.72m^2 garage, 4.68m^2 porch and 10.34m^2 of alfresco. The wall, roof and window frame colours have been considered as medium*. It has assumed solar panels on the side of the roof, which faces North, but the front of the house has a west facing orientation. IC4 rated downlights have been used throughout. The ceiling perimeter is insulated to R2.5 as per AS 3999:2015.

* Medium is defined as a solar absorbance of between 0.475 ≤ M ≤ 0.7.

Timber Frame Buildings – Climate Zone 21 (Victoria)

By adding more insulation to the home, to areas that have previously been left uninsulated, you can reduce the window specification or reduce insulation in other areas. This is demonstrated in the table below for Climate Zone 21.

Ground Floor	Windows	Sliding Doors	External Wall Insulation	Ceiling Insulation	Garage Ceiling Insulation	Roof Insulation Blanket	Laundry Perimeter Wall Insulation (within the studs)
Concrete Slab on Ground (uninsulated)	Triple Glazed Low-E	Triple Glazed Low-E	**R2.7 + 25mm Kingspan Kooltherm® K12 Framing Board***	R7.0	None Required	None Required	R2.7
Concrete Slab on Ground (uninsulated)	Triple Glazed Low-E	Triple Glazed Low-E	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	None Required	None Required	**80 mm Kingspan Kooltherm K12 Framing Board**
Wafflepod	Double Glazed	Double Glazed	**R2.7 + 25mm Kingspan Kooltherm K12 Framing Board***	R7.0	R7.0	None Required	R2.7
Wafflepod	Double Glazed	Double Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	R7.0	None Required	**80 mm Kingspan Kooltherm K12 Framing Board**
Concrete Slab on Ground + Kingspan Kooltherm® K3 Floorboard (50mm) + Kingspan GreenGuard® GG350 (40 mm)	Double Glazed	Double Glazed	R2.7	R6.0	None Required	None Required	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Single Glazed	**R2.7 + 25mm Kingspan Kooltherm K12 Framing Board***	R7.0	None Required	None Required	R2.7
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Single Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	R7.0	None Required	**80 mm Kingspan Kooltherm K12 Framing Board**

* Added to the frame internally or externally. A performance solution may be required for any external application of Kooltherm to the frame.

Modelled Single-Storey Building
Timber Frame Buildings

Timber Frame Buildings – Climate Zone 28 (New South Wales)

By adding more insulation to the home, to areas that have previously been left uninsulated, you can reduce the window specification or reduce insulation in other areas. This is demonstrated in the table below for Climate Zone 28.

Ground Floor	Windows	Sliding Doors	External Wall Insulation	Ceiling Insulation	Garage Ceiling Insulation	Roof Insulation Blanket	Laundry Perimeter Wall Insulation (within the studs)
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E	Double Glazed	**R2.7 + 25 mm Kingspan Kooltherm K12 Framing Board***	R7.0	None Required	None Required	R2.7
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E	Double Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	None Required	None Required	**80 mm Kingspan Kooltherm K12 Framing Board**
Wafflepod	Double Glazed	Double Glazed	**R2.7 + 25 mm Kingspan Kooltherm K12 Framing Board***	R5.0	None Required	None Required	None Required
Wafflepod	Double Glazed	Double Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	R5.0	None Required	None Required	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard® GG350 (40 mm)	Double Glazed	Single Glazed	R2.7	R6.0	None Required	None Required	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard® GG350 (40 mm)	Single Glazed	Single Glazed	**R2.7 + 25 mm Kingspan Kooltherm K12 Framing Board***	R7.0	None Required	R1.3	R2.7
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Single Glazed	Single Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	None Required	R1.3	**80 mm Kingspan Kooltherm K12 Framing Board**

* Added to the frame internally or externally. A performance solution may be required for any external application of Kooltherm to the frame.

Modelled Single-Storey Building
Timber Frame Buildings

Timber Frame Buildings – Climate Zone 56 (New South Wales)

By adding more insulation to the home, to areas that have previously been left uninsulated, you can reduce the window specification or reduce insulation in other areas. This is demonstrated in the table below for Climate Zone 56.

Ground Floor	Windows	Sliding Doors	External Wall Insulation	Ceiling Insulation	Garage Ceiling Insulation	Roof Insulation Blanket	Laundry Perimeter Wall Insulation (within the studs)
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E	Double Glazed	**R2.5 + 25 mm Kingspan Kooltherm K12 Framing Board***	R6.0	R6.0	None Required	None Required
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E	Double Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	R6.0	R6.0	None Required	None Required
Wafflepod	Double Glazed	Double Glazed	**R2.7 + 25 mm Kingspan Kooltherm K12 Framing Board***	R5.0	None Required	None Required	R2.0
Wafflepod	Double Glazed	Double Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	R5.0	None Required	None Required	**80 mm Kingspan Kooltherm K12 Framing Board**
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Double Glazed	R2.7	R5.0	None Required	None Required	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Single Glazed	**R2.7 + 25 mm Kingspan Kooltherm K12 Framing Board***	R7.0	None Required	None Required	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Single Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	None Required	None Required	R2.0

* Added to the frame internally or externally. A performance solution may be required for any external application of Kooltherm to the frame.

Modelled Single-Storey Building
Steel Frame Buildings

Steel Frame Buildings – Climate Zone 21 (Victoria)

By adding more insulation to the home, to areas that have previously been left uninsulated, you can reduce the window specification or reduce insulation in other areas. This is demonstrated in the tables below for Climate Zone 21.

Ground Floor	Windows	Sliding Doors	External Wall Insulation	Internal Wall Insulation	Ceiling Insulation	Garage Ceiling Insulation	Roof Insulation Blanket	Laundry Perimeter Wall Insulation (within the studs)
Concrete Slab on Ground (uninsulated)	Triple Glazed Low-E	Triple Glazed Low-E	**R2.2 + 25mm Kingspan Kooltherm K12 Framing Board***	None Required	R7.0	R7.0	R1.3	R2.2
Wafflepod	Double Glazed	Double Glazed Low-E	**R2.2 + 25mm Kingspan Kooltherm K12 Framing Board***	None Required	R7.0	R7.0	R1.3	R2.2
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Double Glazed	R2.2	R2.2	R7.0	R7.0	R1.3	R2.2
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Double Glazed	**R2.2 + 25mm Kingspan Kooltherm K12 Framing Board***	None Required	R6.0	R6.0	None Required	R2.2

* Added to the frame internally or externally. A performance solution may be required for any external application of Kooltherm to the frame.

Modelled Single-Storey Building
Steel Frame Buildings

Steel Frame Buildings – Climate Zone 28 (New South Wales)

By adding more insulation to the home, to areas that have previously been left uninsulated, you can reduce the window specification or reduce insulation in other areas. This is demonstrated in the tables below for Climate Zones 28 and 56.

Ground Floor	Windows	Sliding Doors	External Wall Insulation	Internal Wall Insulation	Ceiling Insulation	Garage Ceiling Insulation	Roof Insulation Blanket	Laundry Perimeter Wall Insulation (within the studs)
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E	Double Glazed	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	None Required	R6.0	R6.0	None Required	None Required
Wafflepod	Double Glazed	Double Glazed	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	None Required	R6.0	R6.0	None Required	R2.2
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Single Glazed	R2.2	None Required	R6.0	R6.0	R1.3	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Single Glazed	Single Glazed	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	R2.2	R7.0	R7.0	R2.5	R2.2

* Added to the frame internally or externally. A performance solution may be required for any external application of Kooltherm to the frame.

Steel Frame Buildings – Climate Zone 56 (New South Wales)

Ground Floor	Windows	Sliding Doors	External Wall Insulation	Internal Wall Insulation	Ceiling Insulation	Garage Ceiling Insulation	Roof Insulation Blanket	Laundry Perimeter Wall Insulation (within the studs)
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E	Double Glazed	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	None Required	R6.0	R6.0	R1.3	R2.2
Wafflepod	Double Glazed	Double Glazed	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	None Required	R6.0	R6.0	R1.3	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Double Glazed	R2.2	None Required	R7.0	R7.0	None Required	R2.2
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Single Glazed	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	R2.2	R7.0	R7.0	R1.3	R2.2

* Added to the frame internally or externally. A performance solution may be required for any external application of Kooltherm to the frame.

Modelled Double-Storey Building

This example is a four bedroom double-storey home with a total floor area of 384.70m^2. It comprises 168.06m^2 of ground floor space, 36.59m^2 garage, 3.93m^2 porch and 176.12m^2 of first floor space. The wall, roof and window frame colours have been considered as medium*. It has assumed solar panels on the side of the roof, which faces North, but the front of the house has a west facing orientation. IC4 rated downlights have been used throughout. The ceiling perimeter is insulated to R2.5 as per AS 3999:2015.

* Medium is defined as a solar absorbance of between $0.475 \leq M \leq 0.7$.

Modelled Double-Storey Building
Timber Frame Buildings

Timber Frame Buildings – Climate Zone 21 (Victoria)

By adding more insulation to the home, to areas that have previously been left uninsulated, you can reduce the window specification or reduce insulation in other areas. This is demonstrated in the table below for Climate Zone 21.

Ground Floor	Windows	Sliding Doors	External Wall Insulation – Ground Floor	External Wall Insulation – First Floor	Ceiling Insulation	Roof Insulation Blanket	Laundry Perimeter Wall Insulation (within the studs)	Bathroom Perimeter Wall Insulation (within the studs)	W/C Perimeter Wall Insulation (within the studs)
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E	Double Glazed Low-E	**R2.5 + 25mm Kingspan Kooltherm K12 Framing Board***	**R2.5 + 25mm Kingspan Kooltherm K12 Framing Board***	R6.0	None Required	R2.5	R2.5	R2.5
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E	Double Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	None Required	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**
Wafflepod	Double Glazed Low-E	Double Glazed	**R2.5 + 25mm Kingspan Kooltherm K12 Framing Board***	**R2.5 + 25mm Kingspan Kooltherm K12 Framing Board***	R4.0	None Required	R2.5	None Required	None Required
Wafflepod	Double Glazed	Double Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	R1.3	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Double Glazed	R2.7	R2.7	R7.0	None Required	R2.7	R2.7	R2.7
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Double Glazed	**R2.7 + 25mm Kingspan Kooltherm K12 Framing Board***	**R2.7 + 25mm Kingspan Kooltherm K12 Framing Board***	R7.0	None Required	None Required	None Required	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Double Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	R5.0	None Required	**80 mm Kingspan Kooltherm K12 Framing Board**	None Required	None Required

* Added to the frame internally or externally. A performance solution may be required for any external application of Kooltherm to the frame.

Modelled Double-Storey Building
Timber Frame Buildings

Timber Frame Buildings – Climate Zone 28 (New South Wales)

By adding more insulation to the home, to areas that have previously been left uninsulated, you can reduce the window specification or reduce insulation in other areas. This is demonstrated in the table below for Climate Zone 28.

Ground Floor	Windows	Sliding Doors	External Wall Insulation – Ground Floor	External Wall Insulation – First Floor	Ceiling Insulation	Roof Insulation Blanket	Laundry Perimeter Wall Insulation (within the studs)	Bathroom Perimeter Wall Insulation (within the studs)	W/C Perimeter Wall Insulation (within the studs)
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E	Double Glazed Low-E	**R2.5 + 25 mm Kingspan Kooltherm K12 Framing Board***	**R2.5 + 25 mm Kingspan Kooltherm K12 Framing Board***	R6.0	None Required	R2.5	None Required	None Required
Concrete Slab on Ground (uninsulated)	Double Glazed	Double Glazed Low-E	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	R1.3	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**
Wafflepod	Double Glazed Low-E	Double Glazed	**R2.5 + 25 mm Kingspan Kooltherm K12 Framing Board***	**R2.5 + 25 mm Kingspan Kooltherm K12 Framing Board***	R4.0	None Required	R2.5	R2.5	R2.5
Wafflepod	Double Glazed	Double Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	R1.3	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Double Glazed Low-E	R2.7	R2.7	R7.0	None Required	R2.7	R2.7	R2.7
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Double Glazed	**R2.7 + 25 mm Kingspan Kooltherm K12 Framing Board***	**R2.7 + 25 mm Kingspan Kooltherm K12 Framing Board***	R7.0	None Required	R2.7	R2.7	R2.7
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Single Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	R1.3	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**

* Added to the frame internally or externally. A performance solution may be required for any external application of Kooltherm to the frame.

Modelled Double-Storey Building
Timber Frame Buildings

Timber Frame Buildings – Climate Zone 56 (New South Wales)

By adding more insulation to the home, to areas that have previously been left uninsulated, you can reduce the window specification or reduce insulation in other areas. This is demonstrated in the table below for Climate Zone 56.

Ground Floor	Windows	Sliding Doors	External Wall Insulation – Ground Floor	External Wall Insulation – First Floor	Ceiling Insulation	Roof Insulation Blanket	Laundry Perimeter Wall Insulation (within the studs)	Bathroom Perimeter Wall Insulation (within the studs)	W/C Perimeter Wall Insulation (within the studs)
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E Thermally Broken	Double Glazed Low-E Thermally Broken	**R2.7 + 25 mm Kingspan Kooltherm K12 Framing Board***	**R2.7 + 25 mm Kingspan Kooltherm K12 Framing Board***	R6.0	None Required	R2.7	R2.7	R2.7
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E Thermally Broken	Double Glazed Low-E Thermally Broken	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	R6.0	None Required	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**
Wafflepod	Double Glazed Low-E Thermally Broken	Double Glazed Low-E	**R2.5 + 25 mm Kingspan Kooltherm K12 Framing Board***	**R2.0 + 25 mm Kingspan Kooltherm K12 Framing Board***	R6.0	None Required	None Required	None Required	None Required
Wafflepod	Double Glazed Low-E	Double Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	R1.3	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed Low-E	Double Glazed Low-E	R2.7	R2.7	R7.0	None Required	R2.7	R2.7	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed Low-E	Double Glazed	**R2.7 + 25 mm Kingspan Kooltherm K12 Framing Board***	**R2.7 + 25 mm Kingspan Kooltherm K12 Framing Board***	R7.0	None Required	None Required	None Required	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed Low-E	Double Glazed	**80 mm Kingspan Kooltherm K12 Framing Board**	**80 mm Kingspan Kooltherm K12 Framing Board**	R7.0	None Required	None Required	None Required	None Required

* Added to the frame internally or externally. A performance solution may be required for any external application of Kooltherm to the frame.

Modelled Double-Storey Building
Steel Frame Buildings

Steel Frame Buildings – Climate Zone 21 (Victoria)

By adding more insulation to the home, to areas that have previously been left uninsulated, you can reduce the window specification or reduce insulation in other areas. This is demonstrated in the table below for Climate Zone 21.

Ground Floor	Windows	Sliding Doors	External Wall Insulation – Ground Floor	External Wall Insulation – First Floor	Ceiling Insulation	Roof Insulation Blanket	Laundry Perimeter Wall Insulation (within the studs)	Bathroom Perimeter Wall Insulation (within the studs)	W/C Perimeter Wall Insulation (within the studs)
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E	Double Glazed Low-E	**R2.2 + 25mm Kingspan Kooltherm K12 Framing Board***	**R2.2 + 25mm Kingspan Kooltherm K12 Framing Board***	R7.0	R1.3	R2.2	R2.2	R2.2
Wafflepod	Double Glazed Low-E	Double Glazed	**R2.2 + 25mm Kingspan Kooltherm K12 Framing Board***	**R2.2 + 25mm Kingspan Kooltherm K12 Framing Board***	R6.0	None Required	R2.2	R2.2	R2.2
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed Low-E	Double Glazed	R2.2	R2.2	R5.0	None Required	R2.2	None Required	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Double Glazed	**R2.2 + 25mm Kingspan Kooltherm K12 Framing Board***	**R2.2 + 25mm Kingspan Kooltherm K12 Framing Board***	R7.0	R1.3	R2.2	None Required	None Required

* Added to the frame internally or externally. A performance solution may be required for any external application of Kooltherm to the frame.

Modelled Double-Storey Building
Steel Frame Buildings

Steel Frame Buildings – Climate Zone 28 (New South Wales)

By adding more insulation to the home, to areas that have previously been left uninsulated, you can reduce the window specification or reduce insulation in other areas. This is demonstrated in the table below for Climate Zone 28.

Ground Floor	Windows	Sliding Doors	External Wall Insulation – Ground Floor	External Wall Insulation – First Floor	Ceiling Insulation	Roof Insulation Blanket	Laundry Perimeter Wall Insulation (within the studs)	Bathroom Perimeter Wall Insulation (within the studs)	W/C Perimeter Wall Insulation (within the studs)
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E	Double Glazed Low-E	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	R4.0	R1.3	R2.2	None Required	None Required
Wafflepod	Double Glazed Low-E	Double Glazed	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	R3.0	R1.3	None Required	None Required	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Double Glazed Low-E	R2.2	R2.2	R7.0	R1.3	R2.2	R2.2	R2.2
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed	Double Glazed	**R2.2 + 25mm Kingspan Kooltherm K12 Framing Board***	**R2.2 + 25mm Kingspan Kooltherm K12 Framing Board***	R7.0	R1.3	R2.2	R2.2	R2.2

* Added to the frame internally or externally. A performance solution may be required for any external application of Kooltherm to the frame.

Modelled Double-Storey Building
Steel Frame Buildings

Steel Frame Buildings – Climate Zone 56 (New South Wales)

By adding more insulation to the home, to areas that have previously been left uninsulated, you can reduce the window specification or reduce insulation in other areas. This is demonstrated in the table below for Climate Zone 56.

Ground Floor	Windows	Sliding Doors	External Wall Insulation – Ground Floor	External Wall Insulation – First Floor	Ceiling Insulation	Roof Insulation Blanket	Laundry Perimeter Wall Insulation (within the studs)	Bathroom Perimeter Wall Insulation (within the studs)	W/C Perimeter Wall Insulation (within the studs)
Concrete Slab on Ground (uninsulated)	Double Glazed Low-E Thermally Broken	Double Glazed Low-E Thermally Broken	**R2.2 + 25mm Kingspan Kooltherm K12 Framing Board***	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	R7.0	R1.3	R2.2	R2.2	R2.2
Wafflepod	Double Glazed Low-E Thermally Broken	Double Glazed Low-E	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	R5.0	R1.3	None Required	None Required	None Required
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed Low-E	Double Glazed Low-E	R2.2	R2.2	R7.0	R1.3	R2.2	R2.2	R2.2
Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard (50 mm) + Kingspan GreenGuard GG350 (40 mm)	Double Glazed Low-E	Double Glazed	**R2.2 + 25 mm Kingspan Kooltherm K12 Framing Board***	**R2.2 + 25 mm Kingspan n Kooltherm K12 Framing Board***	R6.0	R1.3	R2.2	R2.2	R2.2

* Added to the frame internally or externally. A performance solution may be required for any external application of Kooltherm to the frame.

Kingspan Insulation Solutions
for Timber Frame Buildings

Timber frame wall build ups - Brick or Timber Cladding

Insulation between and outside* Timber Studs with Dry-Lining and Brick or Timber Cladding.
Cladding options: Timber, brick veneer or lightweight fibre cement cladding.

Internal Insulation

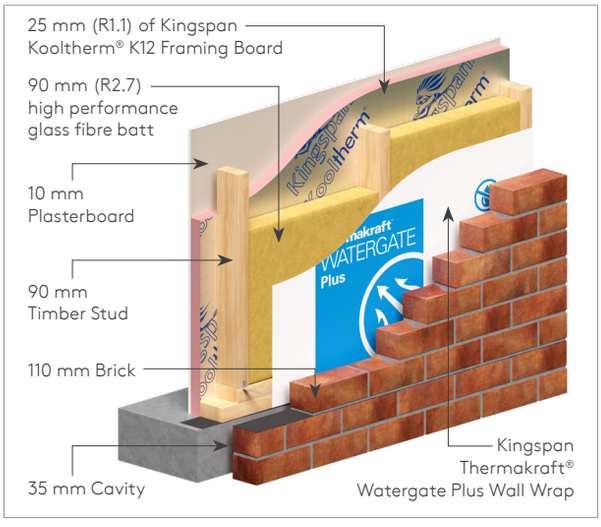


Figure 1. Internally lined Continuous Insulation for Timber Frame.

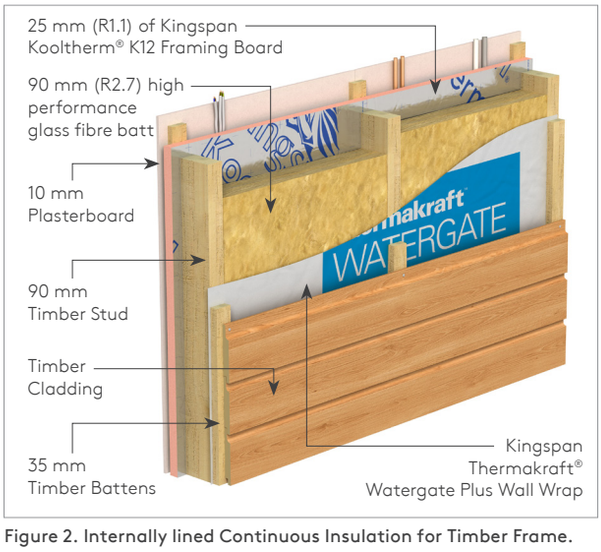


Figure 2. Internally lined Continuous Insulation for Timber Frame.

External Insulation*

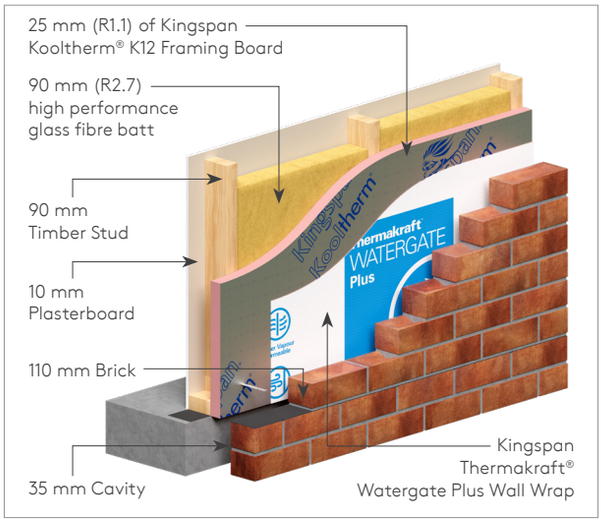


Figure 3. Externally* lined Continuous Insulation for Timber Frame.

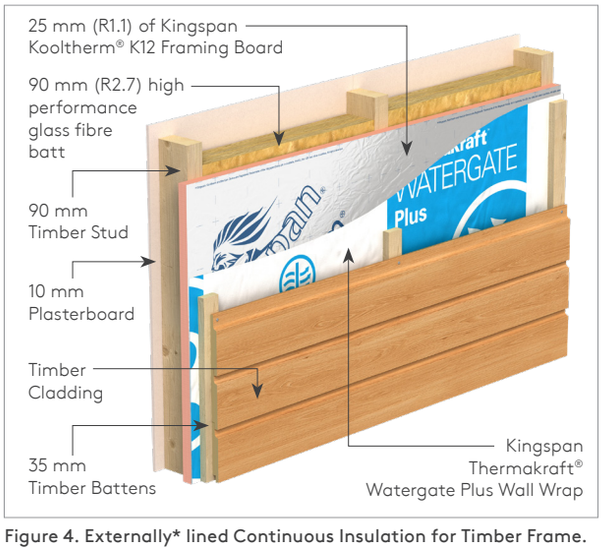


Figure 4. Externally* lined Continuous Insulation for Timber Frame.

Build up to achieve R2.7, R2.5 or R2.0 within the stud with 25 mm of Kingspan Kooltherm K12 Framing Board on the inside (Refer Figures 1 and 2)

Wall Build Up

Stud Depth (mm)	Between studs insulation – Glass Fibre Insulation (mm)	Internal Insulation – Kingspan Kooltherm K12 Framing Board (mm)
90	90 (R2.7, R2.5 or R2.0)	25 (R1.1)

Build up to achieve R2.7, R2.5 or R2.0 within the stud with 25 mm of Kingspan Kooltherm K12 Framing Board on the outside* (Refer Figures 3 and 4)

Wall Build Up

Stud Depth (mm)	Between studs insulation – Glass Fibre Insulation (mm)	External Insulation* – Kingspan Kooltherm K12 Framing Board (mm)
90	90 (R2.7, R2.5 or R2.0)	25 (R1.1)

* A performance solution may be required for any external application of Kooltherm to the frame.

Kingspan Insulation Solutions
for Timber Frame Buildings

Timber frame wall build ups - Brick or Timber Cladding

Insulation between Timber Studs with Dry-Lining and Brick or Timber Cladding.
Cladding options: Timber, brick veneer or lightweight fibre cement cladding.

Insulation Between the Studs

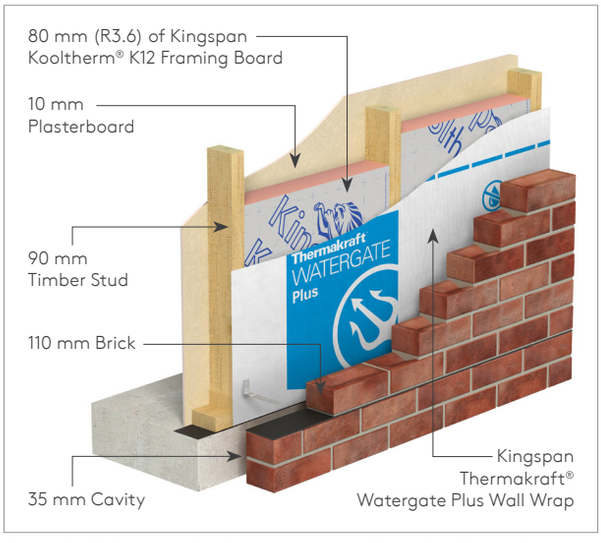


Figure 5. Rigid Insulation Boards between Studs for Timber Frame.

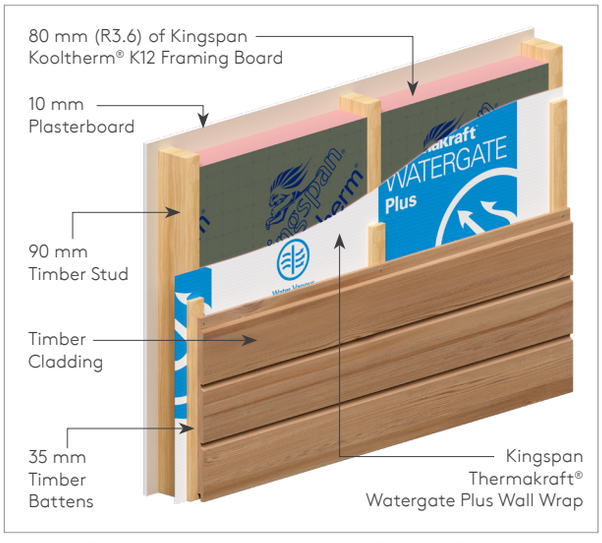


Figure 6. Rigid Insulation Boards between Studs for Timber Frame.

Build up for Kingspan Kooltherm K12 Framing Board within the stud (Refer Figures 5 and 6)	
Wall Build Up	
Stud Depth (mm)	Between studs insulation – Kingspan Kooltherm K12 Framing Board (mm)
90	80 (R3.6)

Kingspan Insulation Solutions
for Steel Frame Buildings

Steel frame wall build ups - Brick or Timber Cladding

Insulation between and outside* Steel Studs with Dry-Lining and Brick or Fibre Cement Cladding.
Cladding options: Timber, Brick veneer, lightweight fibre cement cladding.

Internal Insulation

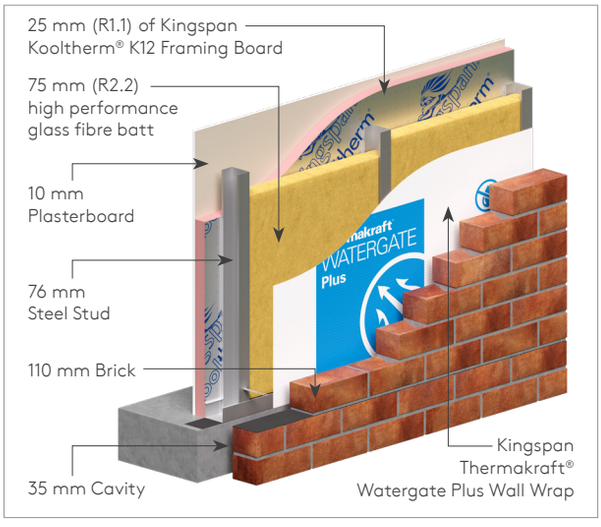


Figure 7. Internally lined Continuous Insulation for Steel Frame.

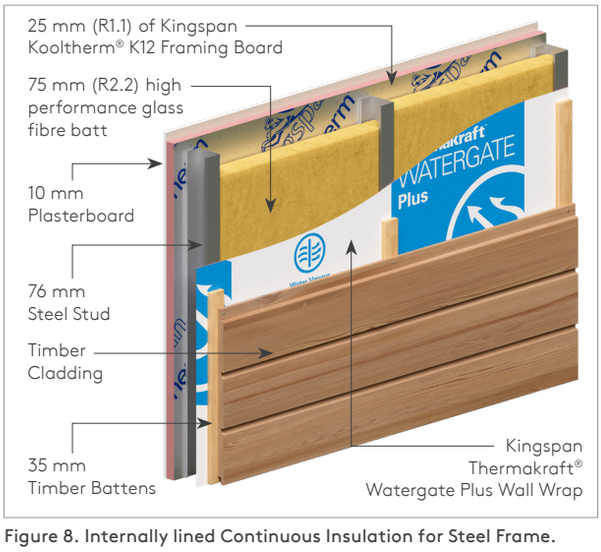


Figure 8. Internally lined Continuous Insulation for Steel Frame.

External Insulation*

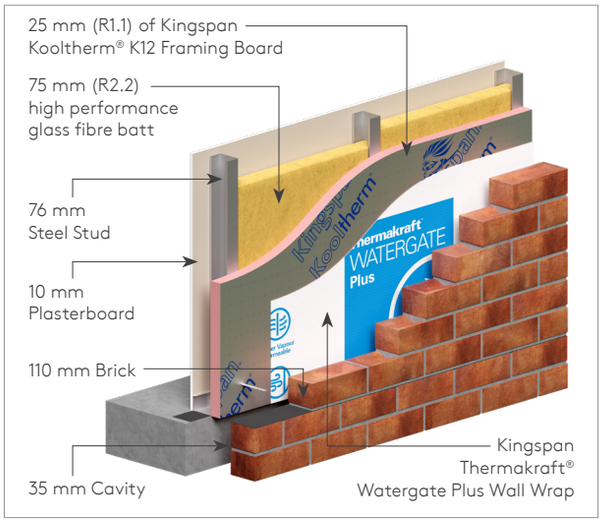


Figure 9. Externally* lined Continuous Insulation for Steel Frame.

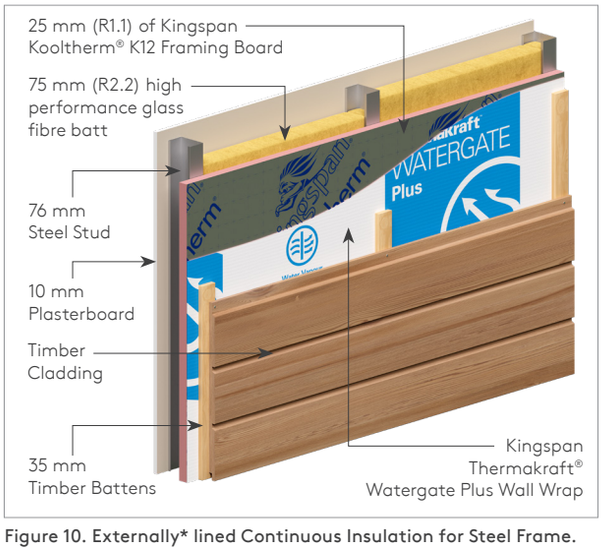


Figure 10. Externally* lined Continuous Insulation for Steel Frame.

Build up to achieve R2.2 within the stud with 25 mm of Kingspan Kooltherm K12 Framing Board on the inside (Refer Figures 7 and 8)		
Wall Build Up		
Stud Depth (mm)	Between studs insulation – Glass Fibre Insulation (mm)	Internal Insulation – Kingspan Kooltherm K12 Framing Board (mm)
76	75 (R2.2)	25 (R1.1)

Build up to achieve R2.2 within the stud with 25 mm of Kingspan Kooltherm K12 Framing Board on the outside* (Refer Figures 9 and 10)		
Wall Build Up		
Stud Depth (mm)	Between studs insulation – Glass Fibre Insulation (mm)	External Insulation* – Kingspan Kooltherm K12 Framing Board (mm)
76	75 (R2.2)	25 (R1.1)

* A performance solution may be required for any external application of Kooltherm to the frame.

Kingspan Insulation Solutions
for Steel Frame Buildings

Steel frame wall build ups - Fibre Cement Cladding

Insulation between and outside* Steel Studs with Dry-Lining and Brick or Fibre Cement Cladding.
Cladding options: Timber, Brick veneer, lightweight fibre cement cladding.

Internal Insulation

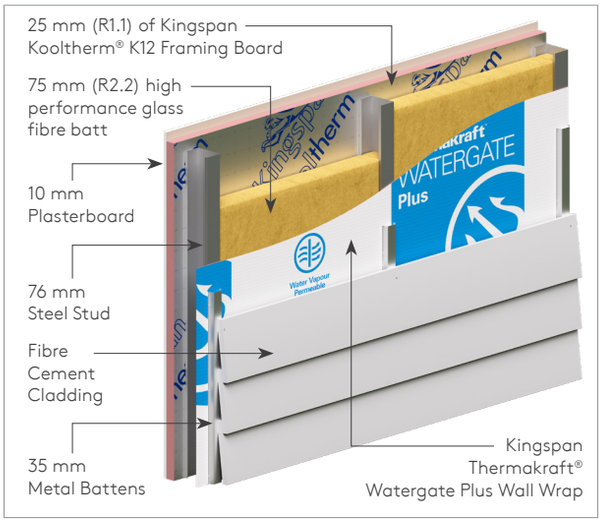


Figure 11. Internally lined Continuous Insulation for Steel Frame.

External Insulation*

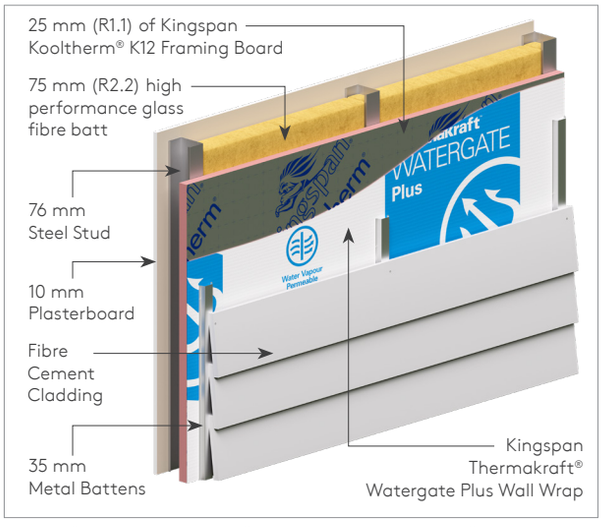


Figure 12. Externally* lined Continuous Insulation for Steel Frame.

Build up to achieve R2.2 within the stud with 25 mm of Kingspan Kooltherm K12 Framing Board on the inside (Refer Figure 11)		
Wall Build Up		
Stud Depth (mm)	Between studs insulation – Glass Fibre Insulation (mm)	Internal Insulation – Kingspan Kooltherm K12 Framing Board (mm)
76	75 (R2.2)	25 (R1.1)

Build up to achieve R2.2 within the stud with 25 mm of Kingspan Kooltherm K12 Framing Board on the outside* (Refer Figure 12)		
Wall Build Up		
Stud Depth (mm)	Between studs insulation – Glass Fibre Insulation (mm)	External Insulation* – Kingspan Kooltherm K12 Framing Board (mm)
76	75 (R2.2)	25 (R1.1)

* A performance solution may be required for any external application of Kooltherm to the frame.

Kingspan Insulation Solutions
for Floors

Solid Concrete Slab with Insulation below Floor Slab

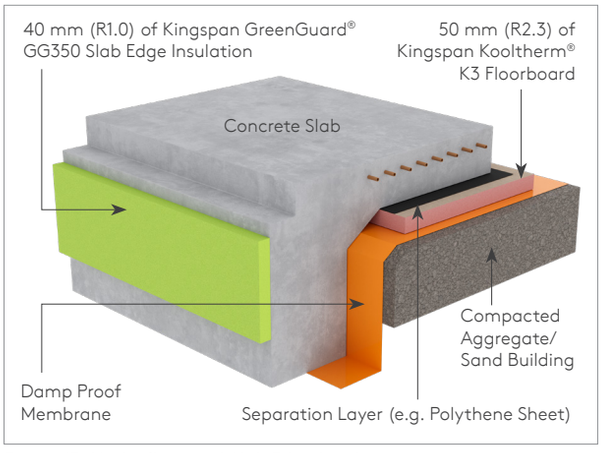


Figure 13. Underfloor and Slab Edge Insulation.

Concrete Slab on Ground + Kingspan Kooltherm K3 Floorboard 50 mm + Kingspan GreenGuard GG350 40 mm (Refer Figure 13)	
Floor Build Up	
Under Slab Insulation – Kingspan Kooltherm K3 Floorboard (mm)	**Perimeter Insulation –** Kingspan GreenGuard GG350 (mm)
50 (R2.3)	40 (R1.0)

Suspended Timber Floor with Insulation Underneath

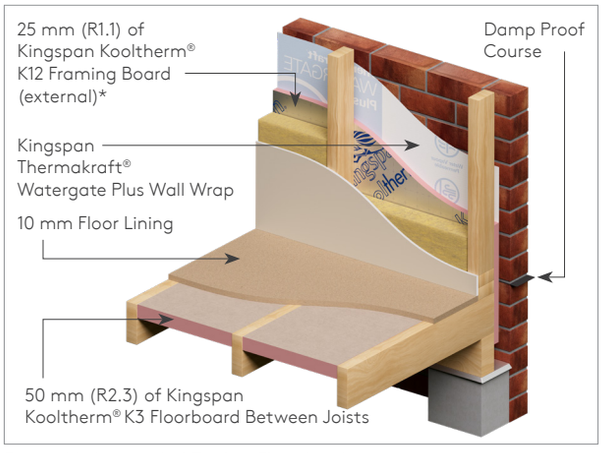


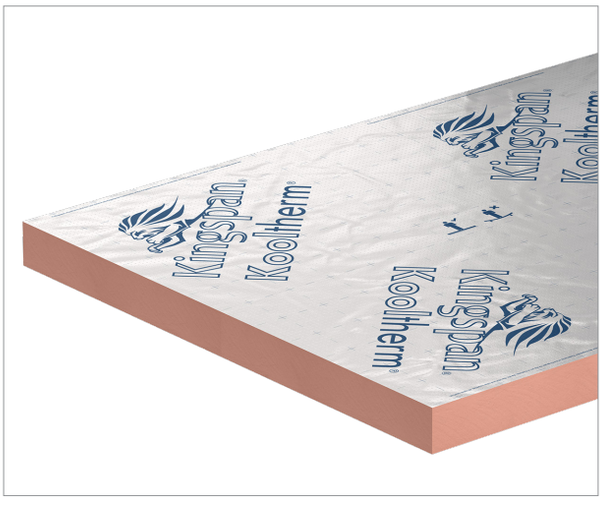
Figure 14. Suspended Timber Floor Insulation.

Suspended Timber Floor + Kingspan Kooltherm K3 Floorboard 50 mm + Kingspan GreenGuard GG350 40 mm (Refer Figure 14)	
Floor Build Up	
Under Floor Insulation – Kingspan Kooltherm K3 Floorboard (mm)	**Perimeter Insulation –** Kingspan Kooltherm K12 Framing Board (mm)
50 (R2.3)	25 (R1.1)

* A performance solution may be required for any external application of Kooltherm to the frame.

Product Pack Sizes
for Walls

Kooltherm®



Kingspan Kooltherm K12 Framing Board Pack Sizes

25 mm x 2400 mm x 1200 mm	12 x per pack
80 mm x 1200 mm x 403 mm	6 x per pack
80 mm x 1200 mm x 413 mm	6 x per pack
80 mm x 1200 mm x 553 mm	6 x per pack
80 mm x 1200 mm x 563 mm	6 x per pack

Thermakraft™

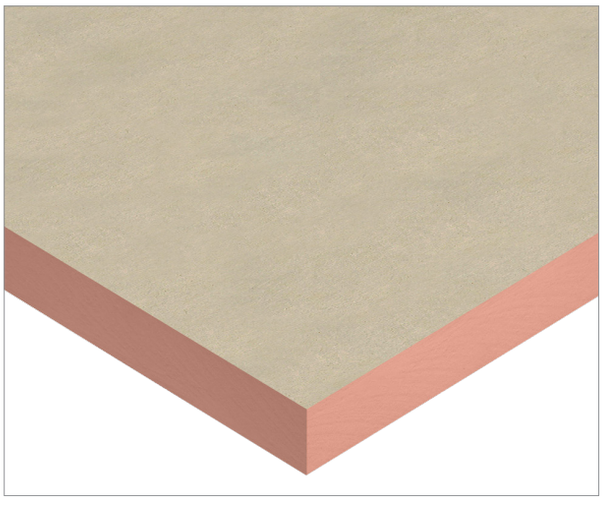
Thermakraft Watergate Plus Wall Wrap Pack Sizes

1370 mm wide x 36.5 m long	50m² coverage*
1500 mm wide x 30 m long	45m² coverage*
2740 mm wide x 30 m long	82m² coverage*
3000 mm wide x 30 m long	90m² coverage*

* Note:
m² is the roll size. For actual coverage, allow for laps and joins.

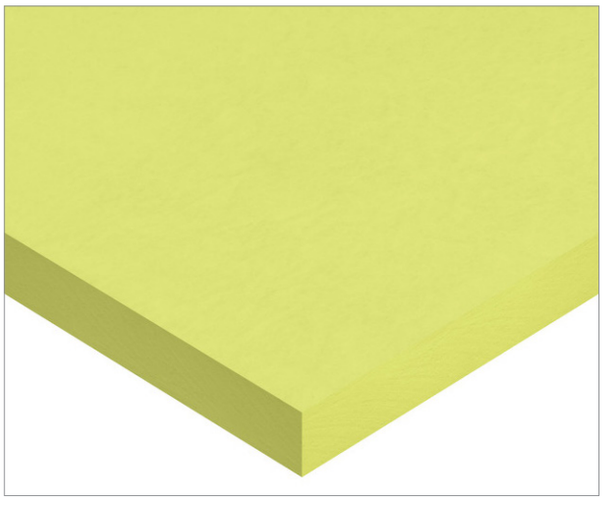
Product Pack Sizes
for Floors

Kooltherm®



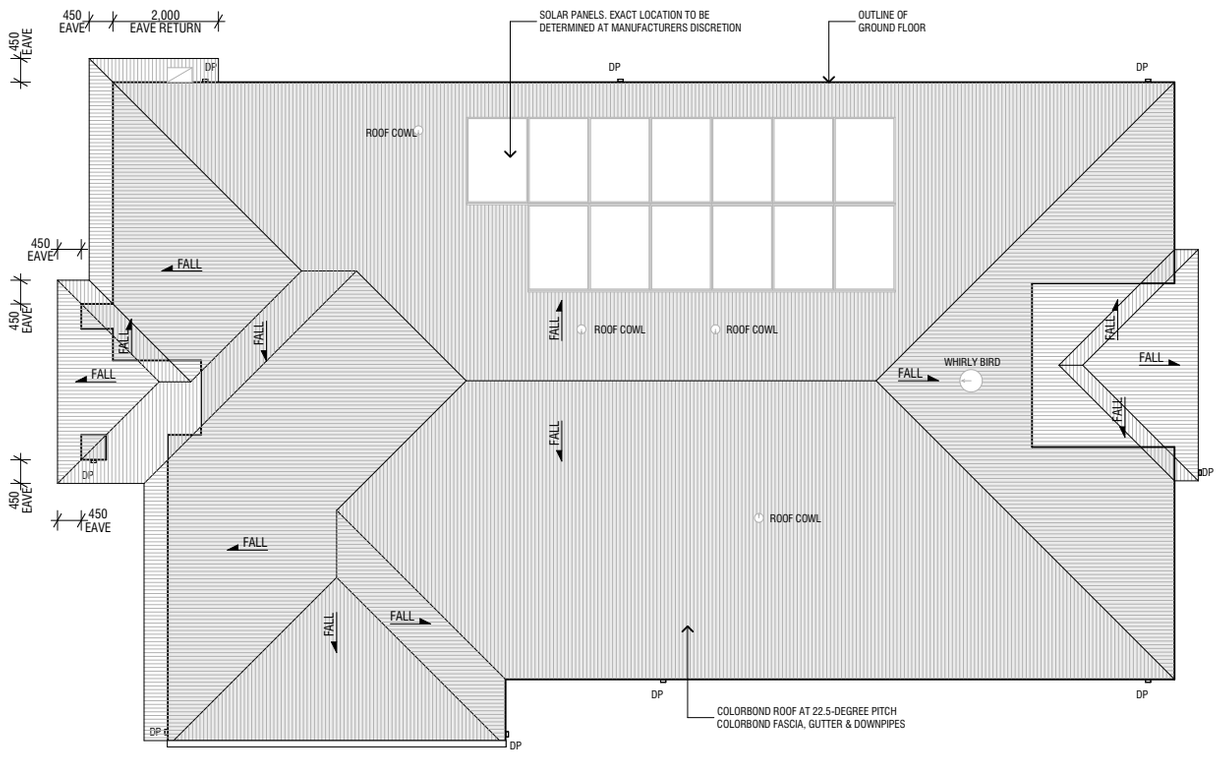
Kingspan Kooltherm K3 Floorboard Pack Sizes	
25 mm x 2400 mm x 1200 mm	12 x per pack
50 mm x 2400 mm x 1200 mm	6 x per pack

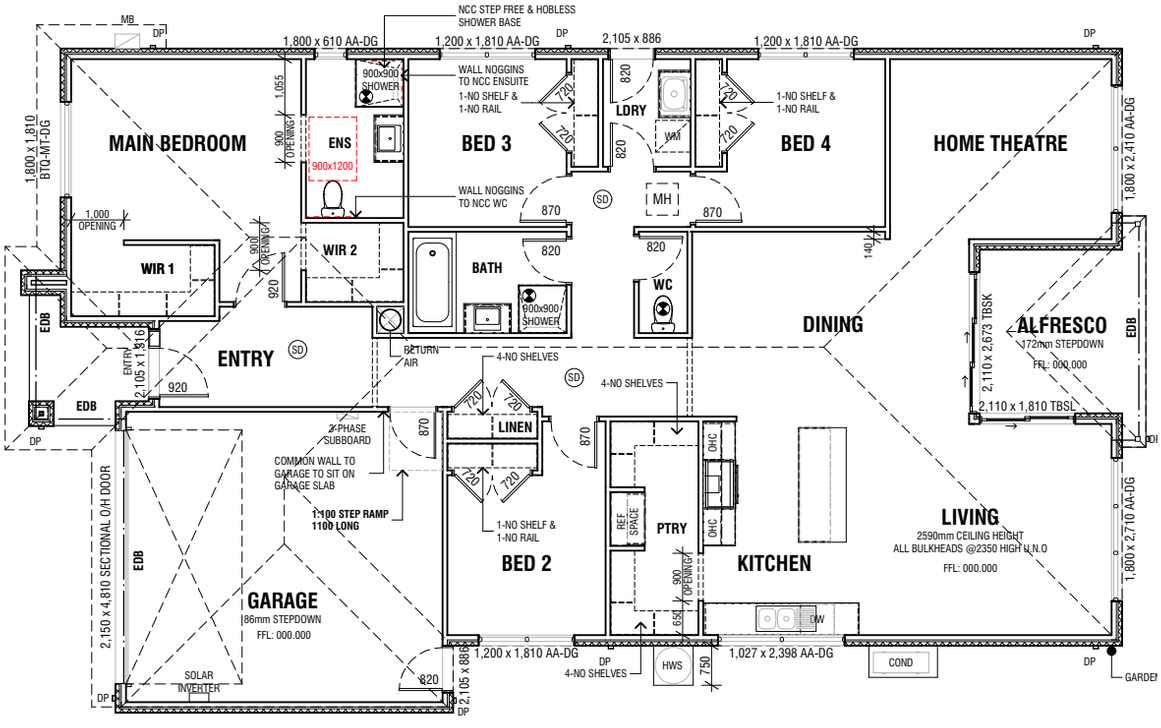
Kingspan GreenGuard®



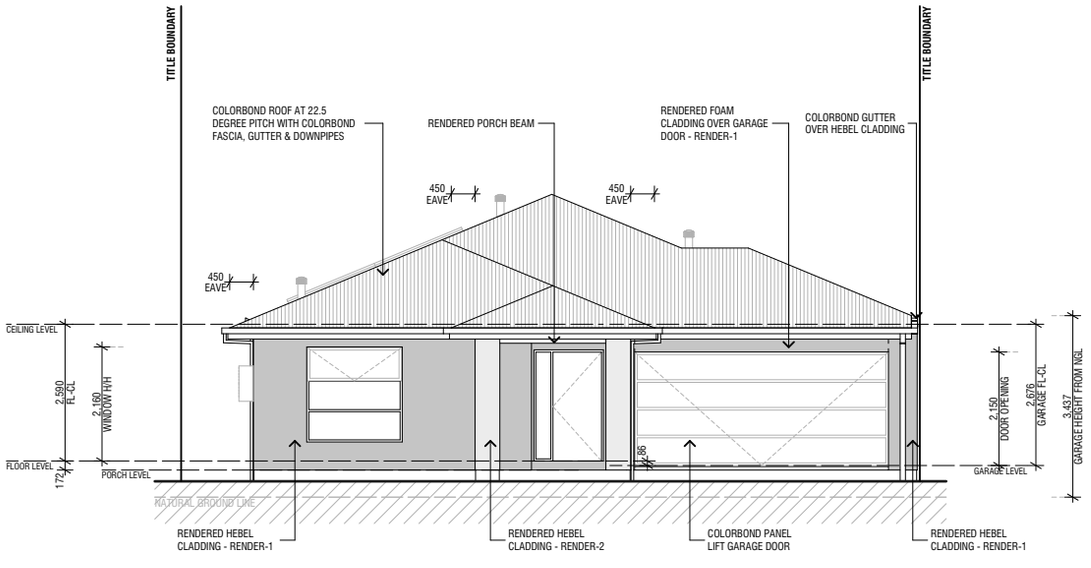
Kingspan GreenGuard GG350 Slab Edge Insulation Pack Sizes	
40 mm x 2400 mm x 300 mm	5 x per pack

Appendix
Single-Storey Home Plans

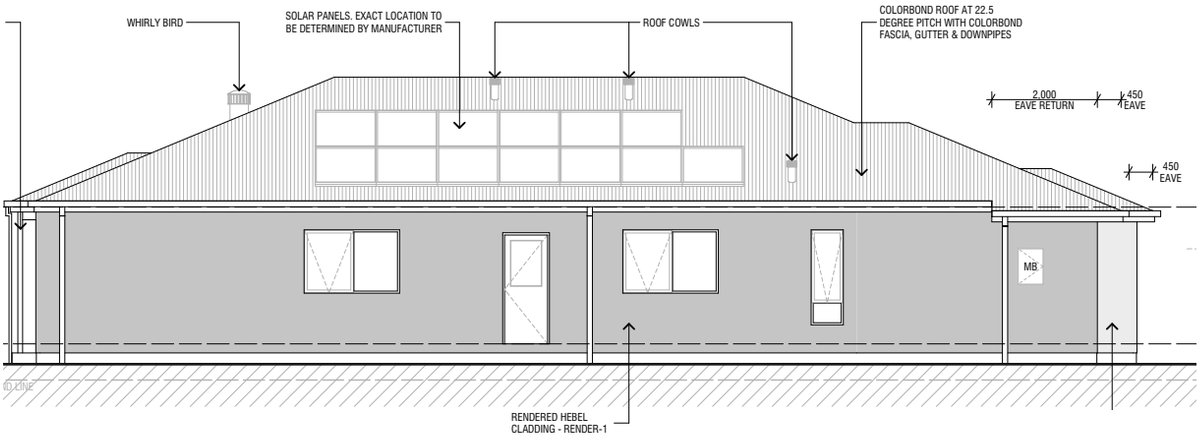




Appendix
Single-Storey Home Elevations

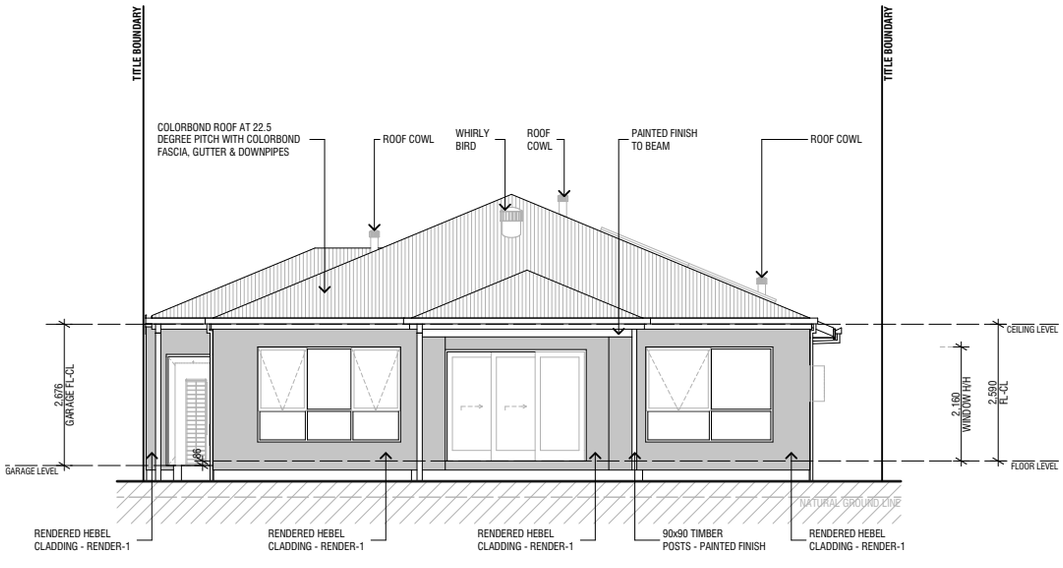


ELEVATION A

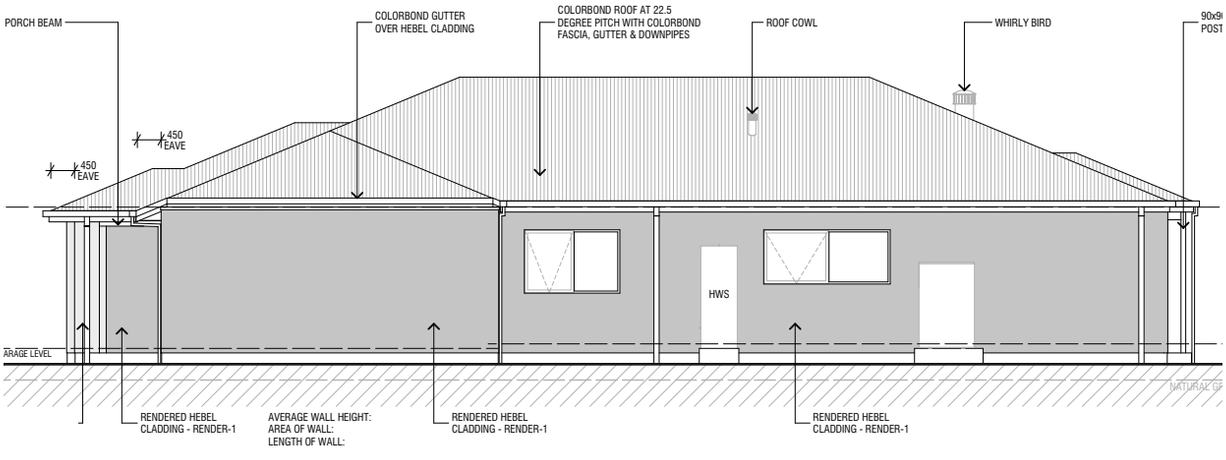


ELEVATION B

Appendix
Single-Storey Home Elevations

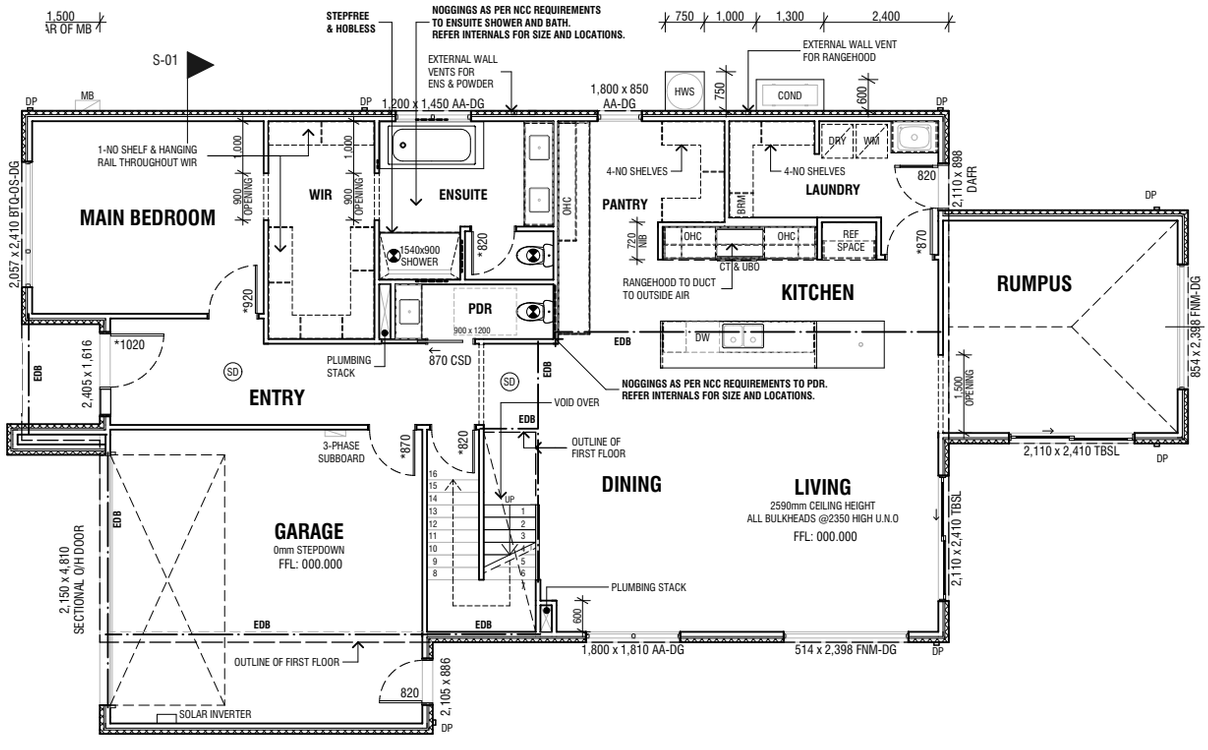


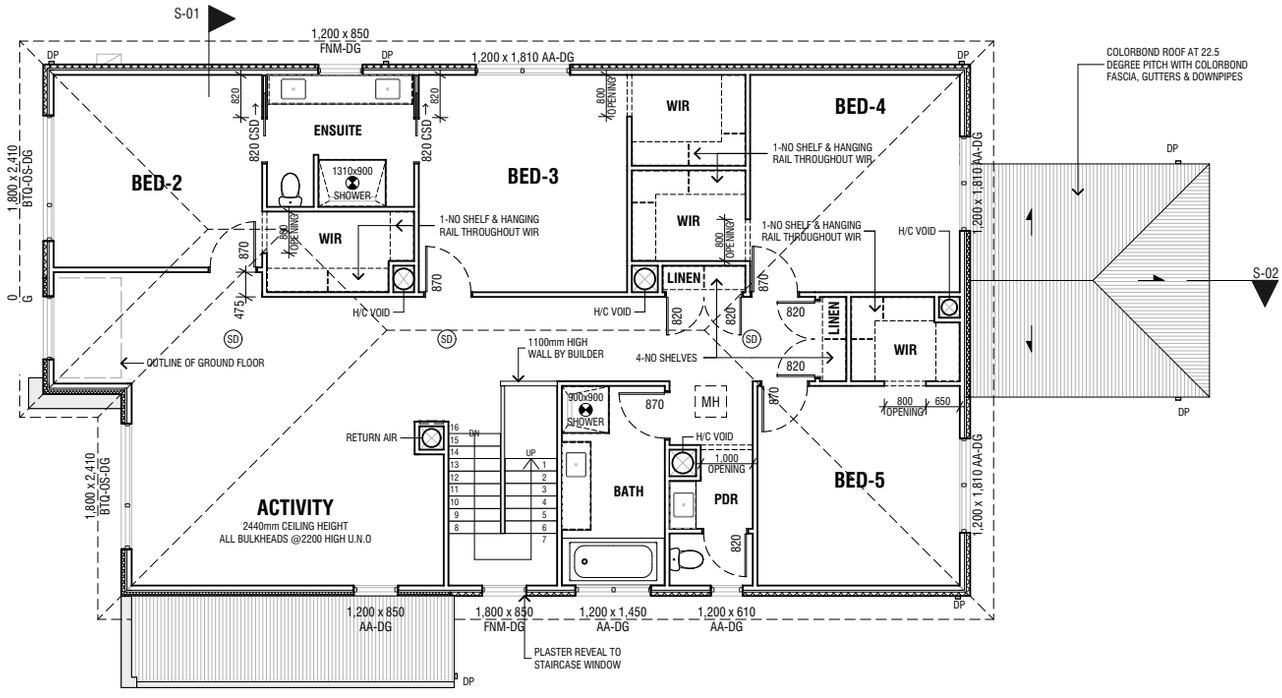
ELEVATION C



ELEVATION D

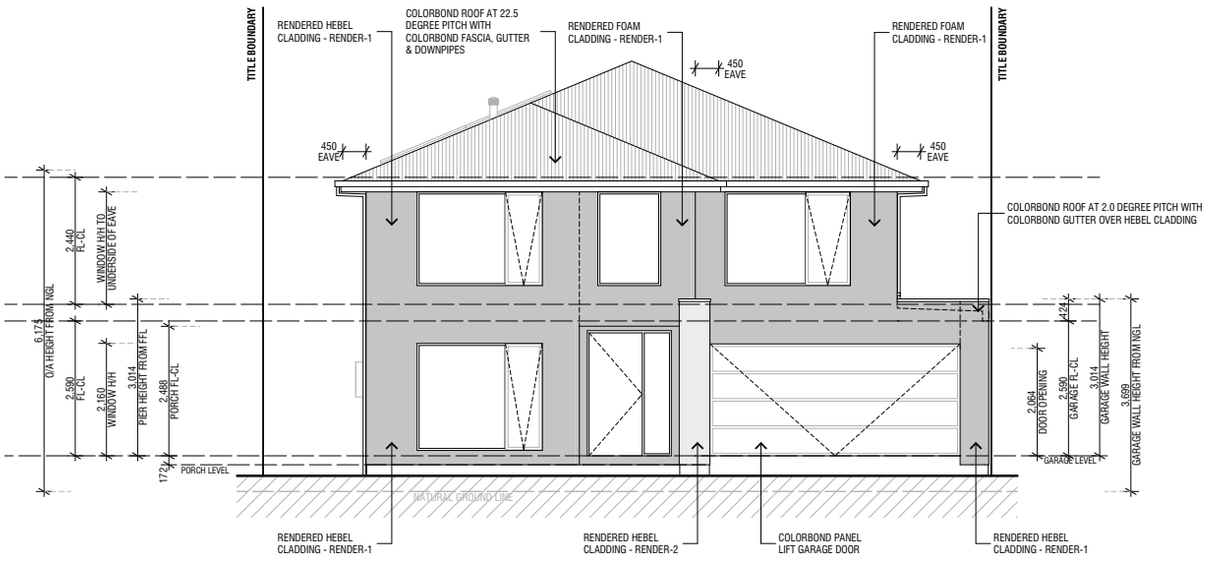
Appendix
Double-Storey Home Plans



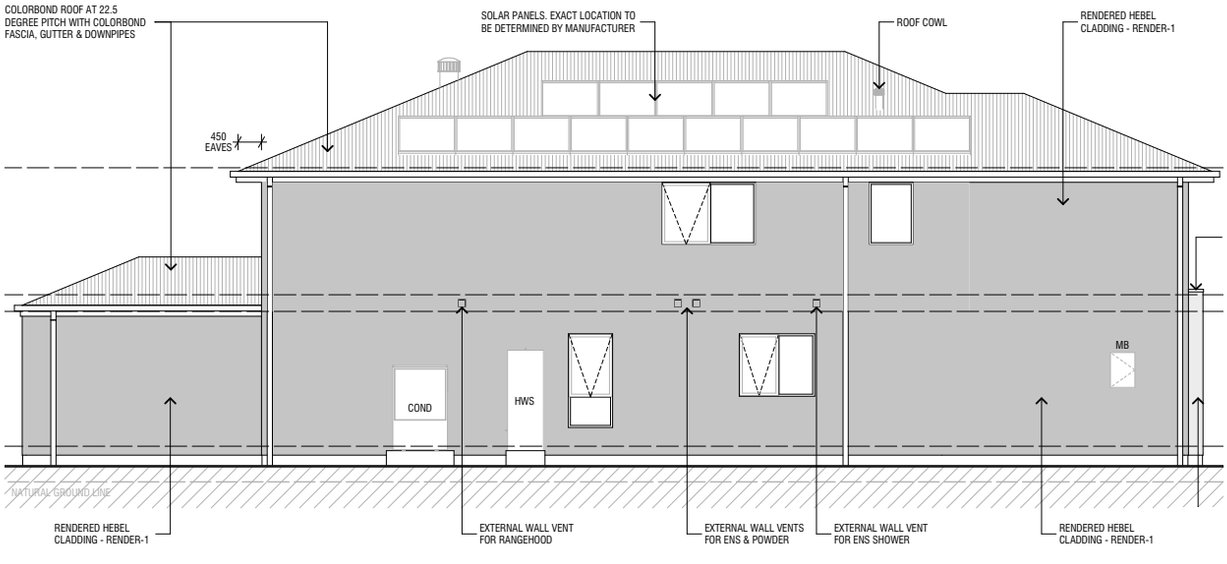


FIRST FLOOR

Appendix
Double-Storey Home Elevations

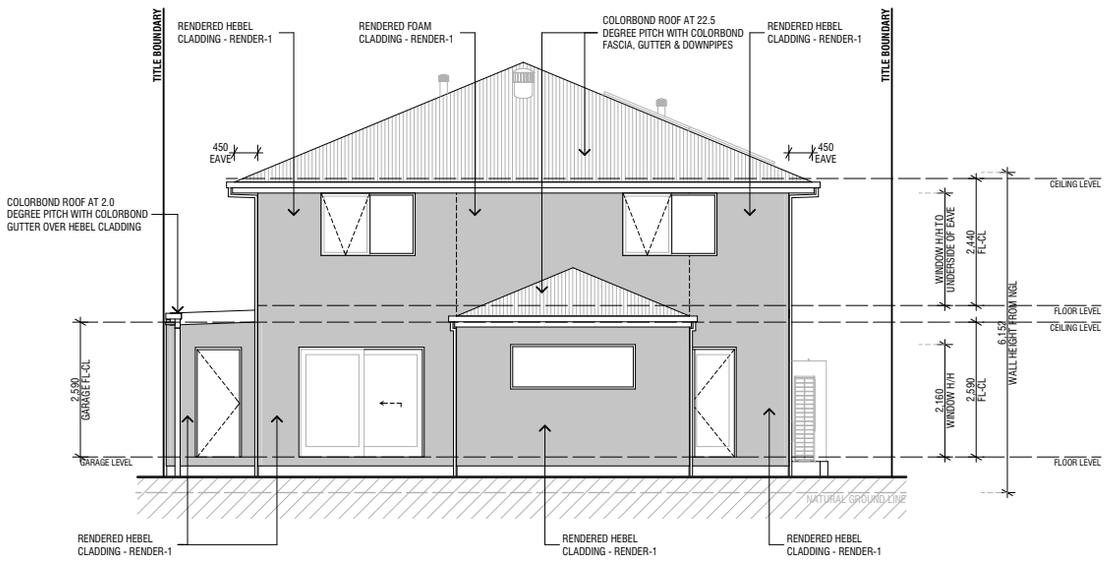


ELEVATION A



ELEVATION B

Appendix
Double-Storey Home Elevations



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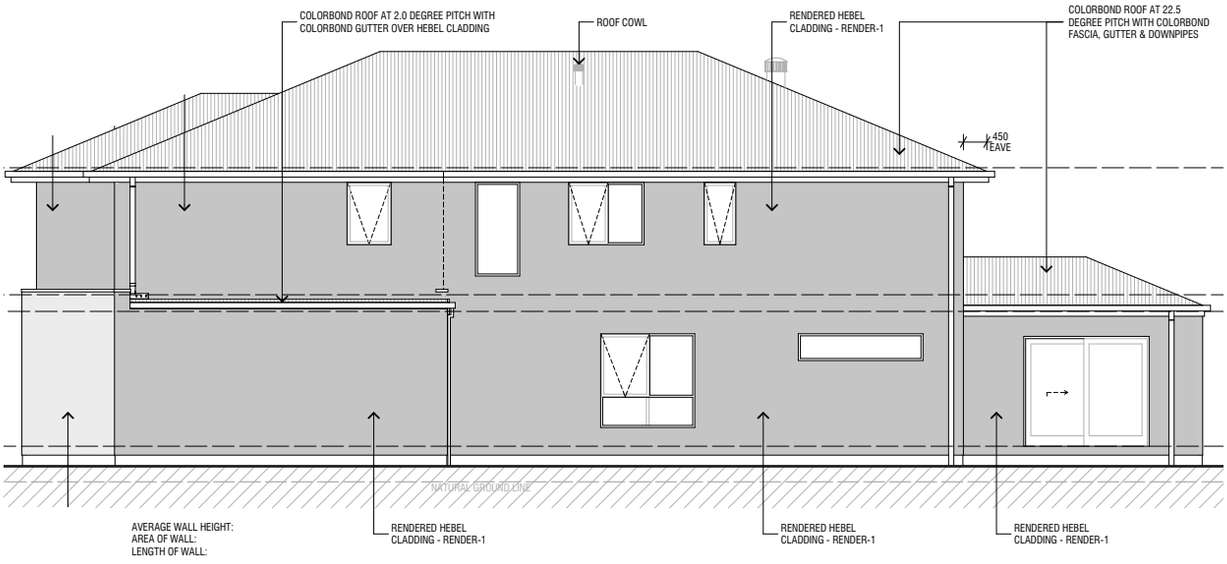

ELEVATION D

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For More Information

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KIAU0216 I Second Issue I February 2025