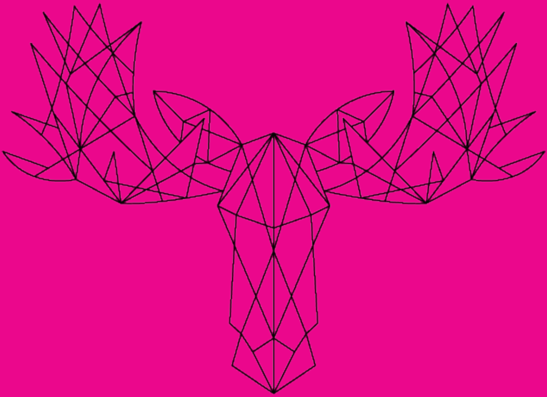
Response to NZ Building Code Update | H1 Consultation

June 2021



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The Performance Metric

H1 Objective: The objective of this provision is to facilitate efficient use of energy.

H1 Provisions: Buildings must be constructed to ensure that their building performance index does not exceed 1.55.

Building Perfomance Index (BPI): In relation to a building, means the heating energy of the building divided by the product of the heating degrees total and the sum of the floor area, and so is calculated in accordance with the following formula:

$$\text{BPI} = \frac{\text{heating energy}}{\text{heating degrees total} \times (\text{floor area} + \text{total wall area})}$$

What's Missing

This 2021 Code update does not propose any changes to the Performance Requirements of clause H1. These are proposed changes to the acceptable solution and verification methods which is intended to demonstrate compliance with the overriding code clause.

This implies either there is a change being proposed to Clause H1.3.2E, or there are fundamental errors in the current H1/AS1 resulting in non-compliance with this clause.

The Building Performance Index BPI is a unique metric to NZ. While technically accurate, the number 1.55 is meaningless to the average public and not particularly useful for anything other than it's own calculation.

Conversely, the metric kWh / sqm / year is used around the globe. This metric also describes the energy use of a building but in a metric that can actually be applied. By calculating the floor area times the energy use, one can quickly gain an understanding of the total energy use of that building for a total year. Appliances are already rated as kWH/year with Energy Star which has guided consumer purchases and manufacturer choices. In the same way, this simple change could be paramount in the public understanding of energy use.

NIWA Temperature Normals For BPI Calculation

Wellington Aero	17.8	17.7	16.6	14.3	11.9	10.1	9.2	9.8	11.2	12.8	14.5	16.4	7.8
Christchurch Aero	17.2	16.7	15.2	12.2	8.8	6.2	5.8	7.1	9.4	11.8	13.9	15.9	22.9
Queenstown Aero	15.4	15.1	13.3	9.9	6.2	3.3	3	4.8	7.3	9.5	12.1	14.1	40.0

Heating degrees total, in relation to a location and a year, means whichever is the greater of the following:

a) the value of 12 and
b) the sum of all the heating degress (calculated using the approved temperature data) for all of the heating months of the year

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Windows - improvements in building performance from upgrading window components above H1 requirements

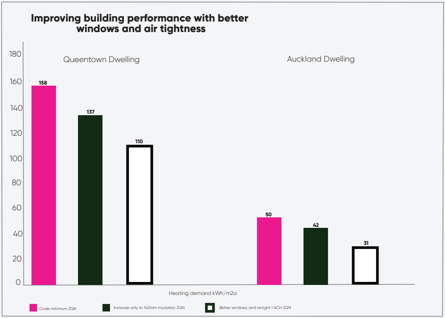
It may seem intuitive to keep adding more insulation, but this is not the only way we can improve the performance of our homes.

This graph compares the impact of two alternative improvements:
1. increasing insulation levels
2. installing better performing windows and improving airtightness

It illustrates that improving windows and airtightness has a much greater impact on energy efficiency in winter. For a home in Auckland, better windows and a more airtight construction would result in a 38% improvement. Comparatively, simply increasing insulation levels would only result in a 16% improvement.

For the same home in a colder climate like Queenstown, improving windows and airtightness would result in a 30% reduction, whereas more insulation would only result in a 13% reduction.

To effectively improve the performance of our buildings, we need to look at all options, including the "low-hanging fruit" of airtightness and better windows.



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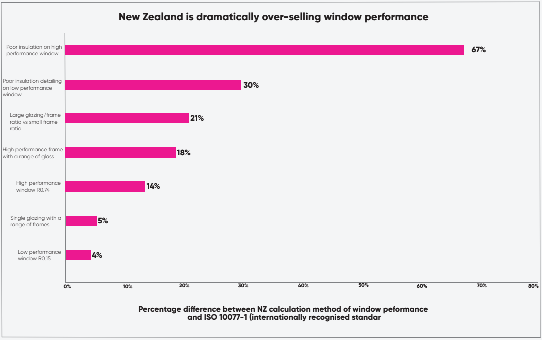
NZ windows and doors account for up to 50% of the heat losses of our homes. If we want to improve the performance of our homes, a good place to start would be improving our windows.

To improve something properly, you need to understand it and measure it accurately. We currently don't measure window performance accurately. The NZ standard dramatically over-simplifies the way we calculate window performance. It ignores two significant elements when considering heat loss through windows and doors (more on this below).

This means we are over-estimating the performance of our homes. This graph shows the percentage difference between the NZ method and the internationally-recognised ISO 10077-1 Standard across various different window types. Notably, if you pay for high-performance windows and don't understand the importance of proper installation, you could be over-estimating their performance by up to 67%!

The two elements that the NZ calculation method ignores are: glass-edge thermal bridging and installation thermal bridging. Heat loss through these elements is well understood by building scientists and relatively easy to model. We recommend the NZ standard for calculating window performance is updated to bring it into line with internationally recognised standards such as ISO 10077-1.



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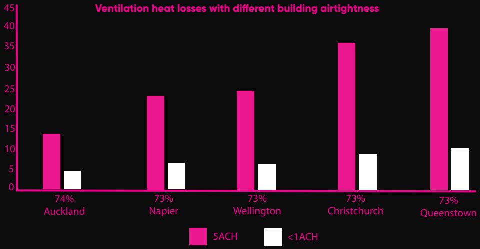
Air tightness of the building envelope

The aim of renovations and new buildings is to create comfortable living and working spaces and at the same time to increase the energy efficiency of a building. For this reason, uncontrolled energy losses should be prevented.

The limit values, i.e. the permissible air permeability due to uncontrolled, unplanned leaks, are not currently regulated, nor has there been an attempt at implementing guidance or regulations with the proposed changes.

Airtightness of the building envelope is the most underestimated aspect of building performance with effects on:

• Energy Efficiency



Energy demand for ventilation increases by 75% on average when the building is less airtight.

• Moisture protection
• Acoustic performance
• Fire performance
• Ventilation design

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Existing construction can be upgraded using suitable sealant materials and products to minimise air leakage around the building, such as:

- Silicone sealant for corners and connection details around floors, walls and installation details for Doors and windows, see images.
- Where trim can be removed temporarily a tape product can be used
- Replacing power sockets, light sockets and recessed light fittings with newer ones, such as IC Rated lights
- Where applicable replace extract fans that pose a permanent opening with newer airtight ones.

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Blower door test

The differential pressure measurement method (colloquially known as an airtightness measurement or blower door test) determines how often the air in an enclosed building is changed per m2 of building envelope by creating an artificial pressure difference. Other parameters commonly know are the air change rate, or ACH. This term comes from testing buildings to the Passive house Standard, where the internal building volume is the reference value.

Various devices are now available for carrying out the test. These are installed airtight in an opening in the outer shell (window, balcony door or front door) using an airtight tarpaulin. All doors inside the house are opened, all openings to the outside are closed. At the beginning of the test, the existing air is sucked out of the house until a pressure difference of 50 Pascal between inside and outside is reached. A connected computer determines how fast the fan has to turn in order to maintain the negative pressure in the building. Using this speed, software calculates how often the air is exchanged.

Airtight building requires ventilation strategy to match however as leakage through the building envelope can no longer be considered effective ventilation. The Airtightness Testing and Measurement Association has published a technical standard which can be referenced for residential buildings.

(i) Table 1 – Best Practice Air Leakage Against Ventilation Strategy

Ventilation Strategy	Best practice / Target Air Permeability *($m^3.h^{-1}.m^{-2}$ at 50 Pa)*	Best practice / Target Air Change Rate *(h^{-1} at 50 Pa)*
Trickle Ventilators and/or intermittent extractors	3.0 - 5.0	-
Passive Stack	3.0 - 5.0	-
Continuous Mechanical Ventilation	2.0 – 4.0	-
Continuous Mechanical Ventilation – with Heat Recovery	1.0 – 2.0	-
Other	Seek Specialist Advice	-
Passivhaus Standard	-	0.6*

* See guidance in 1.4 – Passivhaus Testing

ATTMA TSL1: Table 1

A designated air (and vapour control) layer can be a membrane product (usable in all climate zones) or a rigid board product such as OSB (Oriented Strand Board, applicable in some climate zones).

A vapour barrier, or infrared reflective foil material is not suitable in most climates and should only be used with further expert advice. Vapour barriers are applicable in more extreme weather conditions with temperature gradients usually larger than 20º C, e.g. North America (Canada), or in cold store situations.
They should be avoided in residential construction across the New Zealand Climate Zones.

Installation examples new Houses:

Vapour Variable Control Layer

OSB, Oriented Strand Board

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Indoor air quality for healthy environments

The Australian guidelines for indoor air quality are specific, targeted and closely aligned with international guidelines. If Australia can have great standards, why can't we?

Our recommendation is to create indoor air quality standards that are in line with these Australian standards.

Table FV4.1 Maximum contaminant limits for acceptable indoor air quality
Comparison between current Australian Guidelines and International Guidelines

Current Australian Guidelines				Recommended guidelines	
Pollutant	Averaging time	Maximum air quality Value		www.umweltnet.at www.umweltbundesamt.de	
CO_2	8 hours	850 ppm		8 hrs	850ppm
				Target < 1000ppm	Target < 800ppm
				Target average p/1h < 1400	Target average p/h < 1000
				Target average p/xh < 1900	Target average p/x*h < 1400
CO	15 min	90 ppm (μg/m³)		15 min	100 μg/m³
CO	1 hour	50 ppm (μg/m³)		1 hour	35 μg/m³
CO	8 hours	25 ppm (μg/m³)		8 hours	10 μg/m³
CO	24 hours	10 ppm (μg/m³)		24 hours	7 μg/m³
Formaldehyde CH_2O	30mins	0.1 μg/m³		30mins	0.1 μg/m³
NO_2	1year	40 μg/m³	0.0197ppm	24 hour	250 μg/m³
NO_2	1 hour	200 μg/m³	0.0987	1 hour	85 μg/m³
O3	8 hour	100 μg/m³	0.0437ppm		
PM2.5	1 year	10 μg/m³			
PM2.5	24 hour	25 μg/m³		24 hour	25 μg/m³
PM10	1 year	20 μg/m³			
PM10	24 hour	50 μg/m³			
Total VOC	1 hour	500 μg/m³		Recommended guidelines VOC's	
				low	< 250 μg/m³
				average	250 - 500 μg/m³
				slightly elevated	500 – 1,000 μg/m³
				elevated	1,000 – 3,000 μg/m³
				Very elevated	> 3,000 μg/m³

Notes:

CO2:
The requirements are also formulated as areas with smooth transitions, since the CO2 concentration of the outside air, which varies depending on the location of the building, also influences the CO2 concentration within the rooms. According to the Commission, there is also no clear limit from which a room can be classified as "too heavily used", but rather a smooth transition between good, acceptable and inadequate indoor air.

VOC's:
For some pollutants, e.g. CO2 or VOC (volatile organic compounds) is created because of the fact that there are no defined limits for well-being and performance-impairing concentrations, but increasing concentrations indicate continuous deterioration in indoor air quality, categories that designate air quality.

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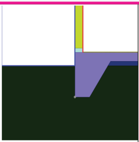
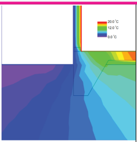
Increasing insulation & R-values	Increasing thermal bridging effects	Increasing vapour pressure	Increasing air tight building	Mold & condensation

Increasing thermal bridging effects:





	Total Heat loss	Heat loss thermal bridge	percentage of total heat loss	fRSI
Detail 1	48.709	0.97	1.99	0.361
Detail 2	40.509	0.919	2.27	0.400
Detail 3	36.993	0.965	2.61	0.427

(percentage per m length of detail)

Increasing vapor pressure:

Generating the same amount of humidity inside buildings coupled with better insulation and the capacity to maintain higher temperatures leads to an air pressure difference in buildings to the exterior.
Higher pressure from the inside to the external will cause air to move outwards, via convection, or diffusion, and must therefore be considered when increasing insulation particularly in colder climates.

Increasing airtightness:

New buildings are naturally becoming more airtight, due to a combination of airtight components and stricter weathertight detailing. Adding more insulation creates larger buffer zones, and installation practices minimize air gaps.
Previous construction methods, poor installation practices and air leakage across the whole building managed to distribute internal moisture across the gaps in the building, and prevented condensation and mould within the building fabric, partly because the internal environment and surfaces were cold enough for condensation on these visible surfaces.
Increasing insulation will increase the temperature of the internal surfaces but move the condensation risk into the structure where mold and condensation occur without becoming visible for a long time.

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Leaky Building NZ 2.0

Why increasing minimum insulation R-Values alone will lead to more problems

Definition thermal insulation

All structural measures aimed at lowering energy costs (for example by reducing the heating requirement) and improving the comfort of the room, be it by "keeping warm" or protecting against overheating, count as thermal protection. A distinction is made between winter and summer thermal insulation.

To put it more loosely, in winter it is about keeping the heat in the building, i.e. as little heat as possible is lost, while in summer as little heat as possible should be introduced into the building. The essential structural measures for winter heat protection are the use of heat insulation materials and the avoidance of thermal bridges versus the use of shading elements and sun protection glasses for summer heat protection.

Winter

Thermal bridges, condensing water and mold.

The winter thermal insulation has the task of reducing the heat loss in a building or preventing the heat flow to the outside as much as possible. This enables the residents to live a hygienically perfect way of life, and ensures permanent protection of the building structure against the effects of climate-related moisture. The prerequisite is that the rooms are adequately heated and ventilated according to their use.

The structural minimum thermal insulation is regulated in NZBC Clause H1. Minimum R-Values (wall, ceiling, roof structure) are currently defined and being reviewed for improvement. However these only address the R-Values of the components, but in reality building services components (heating, ventilation, air conditioning) and the thermal insulation (type, thickness, properties) must be taken into account. The component combination of insulating materials, structure, weathertightness and finishes, exterior and interior, make the system complex and require more careful consideration than a simple addition of thermal resistances.

The various building physics processes that play a role in the area of winter thermal insulation cannot be easily separated from one another thematically. For example, it is essential to avoid condensation, as above a certain amount this will inevitably lead to the formation of mold.

Avoiding condensation

Currently there is no specific method covering compliance with E3 but with proposed increases for H1, the follow-on effects will lead to a new wave of leaky buildings – from the inside.

Avoidance of thermal bridges = avoidance of mold

An important requirement for winter thermal protection is to avoid or minimize thermal bridges. Thermal bridges are places in the building envelope that have a significantly lower thermal resistance than the neighbouring wall and ceiling parts. Thermal bridges, for example in the form of balcony structures that are connected to the wall structure without insulation, should be avoided.

Often, however, the corners of the room also represent thermal bridges. The geometry of a corner means that the respective outer, heat-radiating wall surfaces have a much smaller area on the inside. This small area cools down much faster than a comparable area in the middle of the wall. Accordingly, problems with the surface temperature occur more frequently in the corners of the room.

Protection against the damaging effects of moisture in components with subsequent mold formation. The target is a surface temperature (on internal surfaces) of at least 12.6°C. If the temperature is lower, the air can no longer absorb the moisture it contains at a normal room temperature of 20°C and a relative humidity of 55%.

As a result, water precipitates in a drippable form. A permanent relative humidity of 80% in the area of the cooler surface of the wall is sufficient to stimulate mold to grow.

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Airtightness

All heat-transferring external surfaces of buildings must be made airtight in the areas of joints, connections and penetrations. In this way, an uncontrolled exchange of air due to pressure differences between inside and outside can be reduced.

Insufficient airtightness leads to unnecessary heat loss and structural damage from condensation. The so-called blower door test can be used to determine whether a building envelope is airtight.

Vapour control
Water vapor diffusion

In terms of building physics, water vapor diffusion represents gas diffusion and is a transport process due to a concentration or partial vapor pressure gradient of the water vapor. An exchange of gas molecules takes place between rooms with air of the same total pressure but different partial pressures until the same partial pressures prevail. Temperature, air pressure, relative humidity and vapor tightness of the separating components influence the speed of the exchange and the amount of diffusing vapor.

This moisture transport occurs regardless of airtightness and is a material dependant property. Large temperature, or humidity differences lead to larger forces of vapour diffusion. The process is dynamic and while colder climates have larger vapour pressure from the inside of the building to the outside (from warm to cold) hotter climates (or seasons) reverse the process from the exterior to the interior.

Managing indoor environments - comfort and prevention of building damage

The goals of room ventilation are essentially to ensure comfort in the rooms and to avoid structural damage due to condensation. This means that pollutants, odors, moisture and heat must be removed through the ventilation.

These groups of substances accumulate quickly within the limited air reservoir "space". The Ventilation effectiveness depends both on the volume of the room and on occupancy, but also on the method of ventilation, e.g. window, mechanical.

Moisture removal

Moisture in buildings arises from various internal or external sources. Due to these sources, the absolute moisture content inside a building is always higher than in the outside air.

Since air can only absorb a certain amount of water vapor, which is dependent on the air temperature, the moisture content is also described by the relative humidity. Depending on the surface material, a relative humidity of approx. 75% can lead to the formation of mold.

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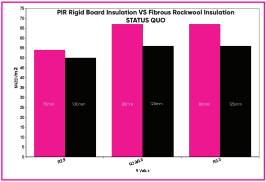
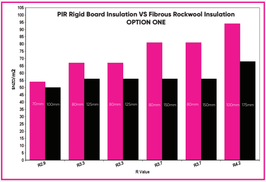
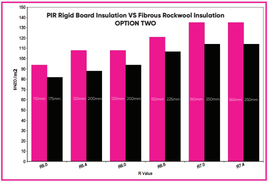
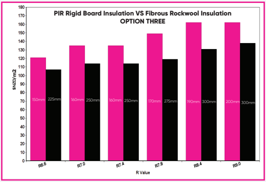
Rates for <u>roof</u> insulation based on recent MBIE changes









Note:
All prices are excl GST
Prices and thicknesses calculated from standard board sizes only
R value achieved with insulation only, not wall or roof build up (construction R value)
These are standard TRADE pricing, not Commercial pricing for project quantities

PIR Rigid Board Insulation

Fibrous Rockwool Insulation

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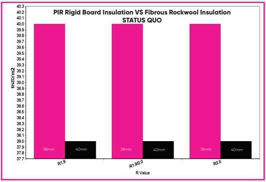

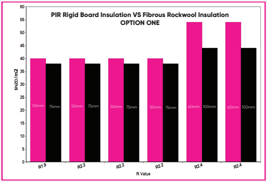

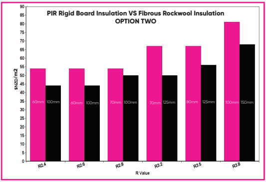

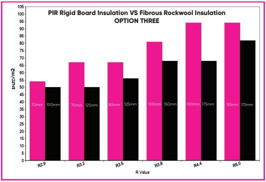

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Overheating

Overheating is already a big problem in certain types of homes.

Uninsulated homes needed the sun's heat to compensate for the losses, but losses in current houses has plummeted with insulation.

The same amount of solar gain was still being provided but the losses reduced. This creates an energy imbalance which raises the internal temperatures during the day.

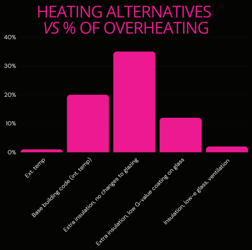
The majority of heating needs are overnight when solar gain is zero. Unfortunately this difference in peaks is hard, if not impossible to overcome.

Overheating is also associated with poor health outcomes.

The NZ climate is predominantly a heating climate. Cooling is not particularly onerous unless shading and solar control are ignored.

Components that are important for establishing the risk for overheating:

- The orientation of the windows
- The position of the window surfaces (wall or roof surface)
- The type of glazing
- The type and location of the sun protection
- The size of the window area in relation to the envelope area
- The type of ventilation of the rooms
- The use of passive cooling
- The construction method of the space-encompassing components (thermal storage capacity)vero eros et



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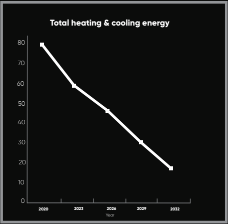
Future Roadmap

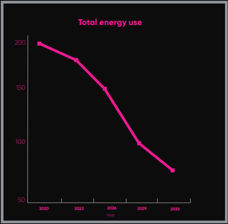
While the proposals are a first step, a longer term focus is needed.

The industry tends to take multiple years to adapt to any change and many will see this as a first step towards an unknown end game.

This uncertainty makes building beyond the code very difficult. Conversely, placing future projections into the code would incentivise higher performance if we know where the future targets will land. This has been critical driver of improving housing standards.

Many have proposed roadmaps including NZGBC, ESCAPE Step Code, MBIE Building for Climate Change, Jasmax. It then follows that the building code should start to reflect the private sector drivers.





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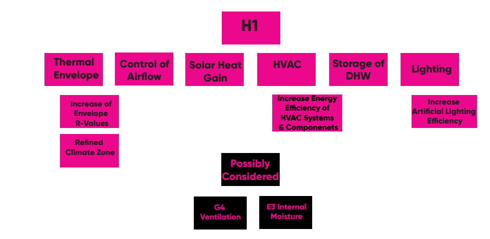
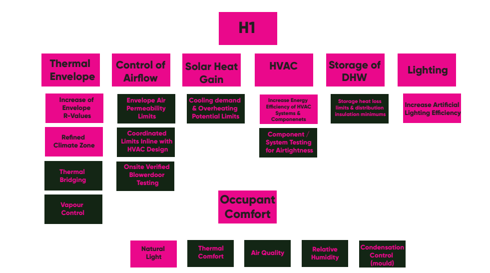
H1 Energy Efficiency - What Is Proposed

The flow chart below outlines what is proposed in the current H1 Consultation, as well as variants that are possible considerations.



H1 Energy Efficiency - What Is Missing

The below chart then outlines all of the variants that are missing. Among the missing variants is the failure to consider occupant comfort levels.



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