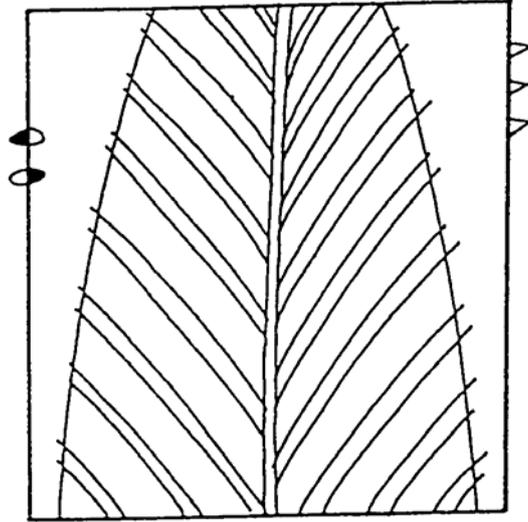


# INSULATION



Waitakere City Council  
*Te Taiao o Waitakere*

# Contents

## **Why insulate? 3**

*Energy savings, health, comfort 3*

*How does it work? 3*

## **How to do it 4**

*Where to insulate 4*

*To what level (R-values)? 5*

*Installing insulation 7*

*What material to choose 9*

## **How much does it cost? 11**

## **Further information 12**

*This chapter is part of the Waitakere City Council's Sustainable Home Guidelines. The complete set can be obtained through most libraries or from the Waitakere City Council, Private Bag 93109, Henderson, Waitakere City 0650, New Zealand, phone (09)-839 0400, email: [info@waitakere.govt.nz](mailto:info@waitakere.govt.nz).*

*The guidelines are also available on the council's web site: <http://www.waitakere.govt.nz>.*



## Why insulate?

### Energy savings, health, comfort

Insulating your home will save energy and provide a healthier and more comfortable indoor environment. The heat captured from the sun (see *Design for the Sun* chapter) or generated by your heater needs to be stopped from escaping through walls, ceilings and floors. Insulated surfaces are warmer. Condensation is less likely to form on them, so reducing the likelihood of mould and mildew and consequent respiratory illness and allergies. In summer, insulation will keep the heat out, making your home cooler. Insulation will help provide a more even temperature year-round.

The initial investment of installing higher insulation than the Building Code prescribes will pay off over time because you save money in energy bills. Older homes often have little or no insulation but some insulation can usually be retrofitted, making them much more comfortable and saving energy for heating. The payback period for installing ceiling insulation, for example, is about five years in the Waitakere climate. However the main motivation behind installing insulation is often the added comfort and warmth, rather than financial savings.

### How does it work?

Most insulation works by trapping air in cavities. The smaller the cavities of trapped air, the better the insulation material will work. Good examples in nature are animal shelters, such as bird's nests, which have the ability to keep eggs and young birds at an even temperature in extreme weather conditions. The birds themselves have an added layer of insulation provided by their feathers. Humans have learned from nature's example and clothes have been used for thousands of years to provide warmth.

We can insulate our homes by providing cavities of still air, such as in wall insulation or double-glazing. This reduces heat transfer because air is a poor conductor of heat. Another method is to use surfaces that reflect heat, such as silver foil behind radiators.

The orientation of your home and the location of the main windows also make a huge difference to your heating bills. Please read the *Design for the Sun* chapter in conjunction with this chapter.

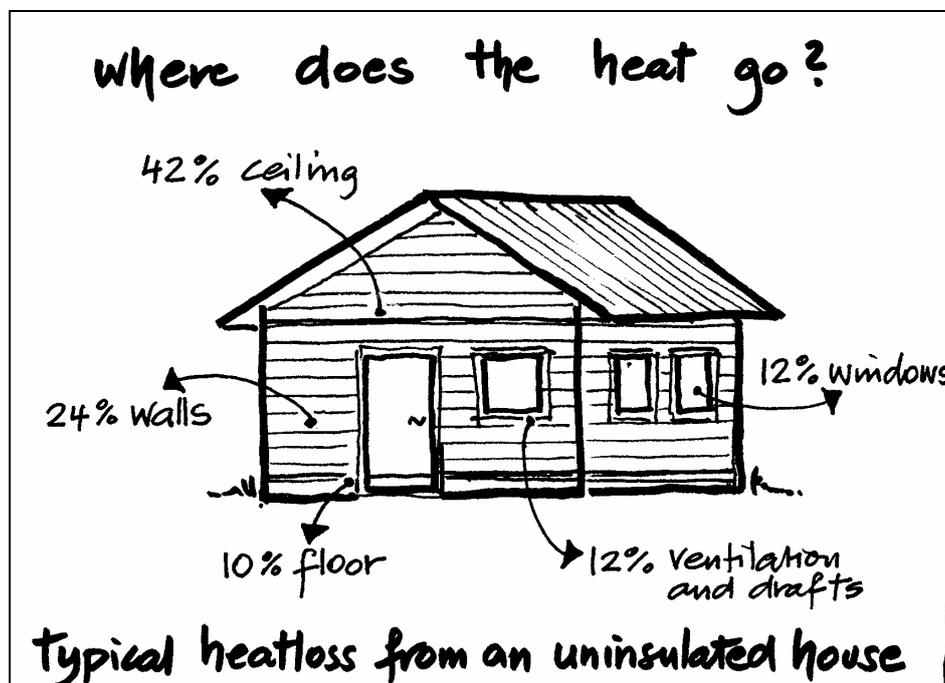


## How to do it

### Where to insulate

Space heating is the largest part of your power bill (averaging 34% nationwide). Water heating is next, averaging 29%.

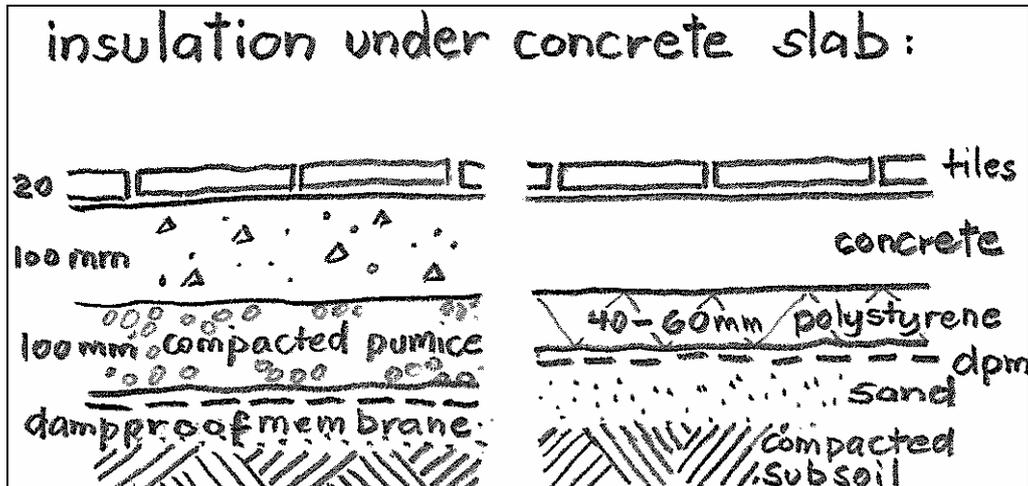
Insulating your hot water system is an obvious priority because it takes little effort (see *Heating Water* chapter). If your hot water cylinder has an 'A' rating it is already well insulated; if not it will benefit from a hot water cylinder wrap. Insulating all your hot water pipes also helps reduce water heat losses.



The main heat loss in an uninsulated home is through the ceiling (about 40%). Walls also lose a significant amount of heat, but they are difficult to retrofit with insulation without removing the internal lining. Floors lose only about 10% of heat, but they are easy and cheap to insulate and the comfort benefits of a warmer floor are great, so this is worth doing. Windows are the biggest heat drain for their area. They can be fitted with drapes or blinds, but these need to be well fitted (see the chapter *Heating your Home*). Alternatively, use double-glazing. Although it costs more than single glazing, the difference is rapidly decreasing and it provides a much better outcome – for not only thermal performance, but also condensation control and acoustic separation.

It's also a good idea to have a look at your habits and preferences. If, for example, you leave curtains open at night to enjoy the view, double-glazing is a sensible choice. Or if your family likes to go barefoot in the middle of winter, under-floor insulation becomes important.

Different houses need different types of insulation. Where heat is stored in the thermal mass of a building it is important to install the insulation on the cold side of the mass. A concrete floor used for heat storage needs to have the insulation underneath, not on top. Concrete floors lose heat mainly at the edges, so the detailing there is important. Generally the best option is a mixture of heavy materials for heat storage, and light materials that are well insulated.



#### To what level (R-values)?

The ability of a material to insulate is measured as thermal resistance, or R-value. The higher the R-value the better the insulation. The R-value increases with the thickness of a material. The Building Code prescribes a minimum insulation level for new buildings and major renovations. This standard should be seen as the absolute minimum and we recommend that you insulate to higher R-values. You usually get only one shot at installing it, and energy prices will continue to rise for the foreseeable future.

One good option would be to insulate to the “best” levels suggested in NZS PAS 4244: a non-mandatory standard outlining insulation options. Our tables are based on this.

R-values listed in standards and in our tables are “construction R-values”. This means the R-value of the *complete* wall, ceiling or floor, not just the insulation material. Depending on the type of construction, the construction R-value can be higher or lower than the insulation material R-value. The BRANZ *House Insulation Guide* outlines methods of achieving R-values, or you can use the online calculator at [www.design-navigator.co.nz](http://www.design-navigator.co.nz).



Here are our suggestions for new homes in the Auckland climate.

### Non-solid construction (e.g. timber frame)

	Best practice
<i>R-value</i>	
<b>Roof</b>	<b>4.0</b>
<b>Wall</b>	<b>2.4</b>
<b>Floor</b>	<b>2.0</b>
<b>Window</b>	<b>0.31</b>

### Solid construction (e.g. concrete, earth, solid timber)

	Best Practice
<i>R-value</i>	
<b>Roof</b>	<b>4.6</b>
<b>Wall</b>	<b>1.9</b>
<b>Floor</b>	<b>3.1</b>
<b>Window</b>	<b>0.31</b>

Note: These R-values for windows can be achieved only with double glazing.

For other combinations of insulation to achieve the same performance levels, use the ALF software (available at [www.branz.co.nz](http://www.branz.co.nz)), the Design Navigator tool ([www.design-navigator.co.nz](http://www.design-navigator.co.nz)), or consult a specialist such as your council's Eco Design Advisor or an architect or engineer with experience in thermal modelling.

It's much easier to fit insulation while building than to retrofit it later. Increasing the R-value at the time of construction or renovation is relatively cheap and the cost difference between the bare minimum and the values above is often less than a thousand dollars (2008 prices) for the entire house.

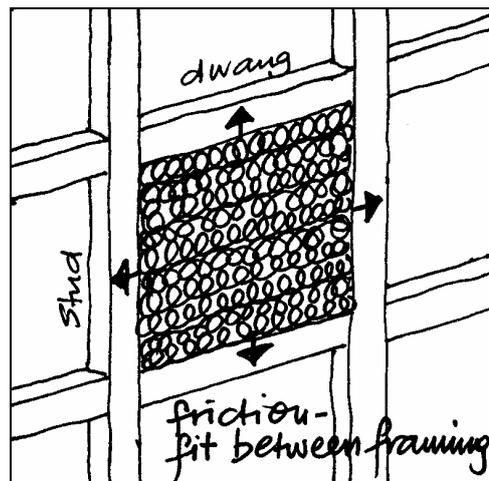
When retrofitting, choose a product of at least R-3.6 for your ceiling -- the higher the R-value the better. If you're upgrading a ceiling which already has some old insulation, you don't need to remove the old material. It will be doing some good: just make sure it's evenly spread and lay the new insulation on top of it.

For under the floor, polystyrene, polyester, or wool are generally the most economical solutions. Even though the R-values are not high they offer good comfort and value for money.

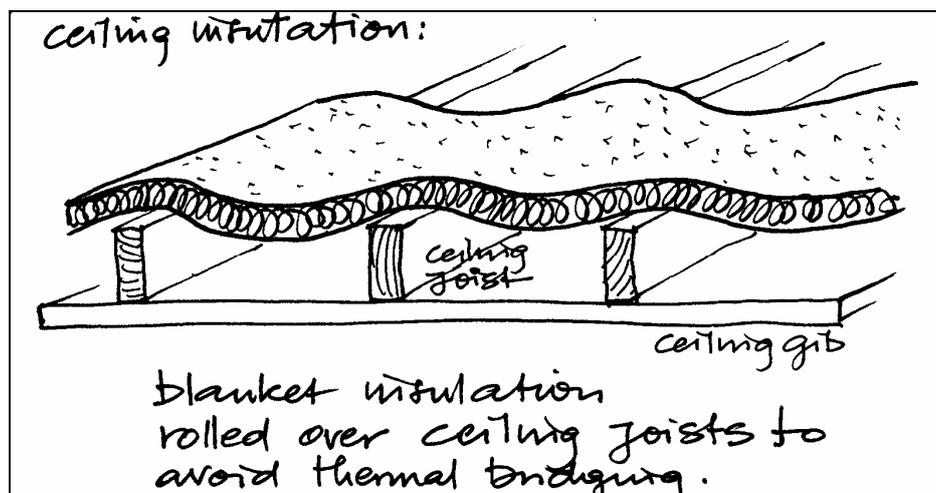


## Installing insulation

The best insulation material can be ineffective if it is installed poorly. It's important how well your insulation is fitted, because heat can easily escape through small gaps. Heat losses can also occur through *thermal bridging*. Thermal bridging occurs when a material with lower thermal resistance allows the heat to by-pass the insulation. An example is timber stud framing, which has a lower thermal resistance than insulation. Sneaky heat takes the path of least resistance, flowing mainly through the framing rather than through the insulation in the spaces between.



Proper installation is crucial because a gap of only 4mm in a panel of insulation can reduce the R-value of that panel by 40%! Compressing or folding insulation material also reduces its R-value. To avoid gaps, segments fitted into walls or ceilings should be cut slightly larger than the size of the cavity for a friction fit. They can be stapled to the framing to hold them in place more securely. Where they are fitted under the floor they should be fitted snugly against the floor and stapled to the floor joists.

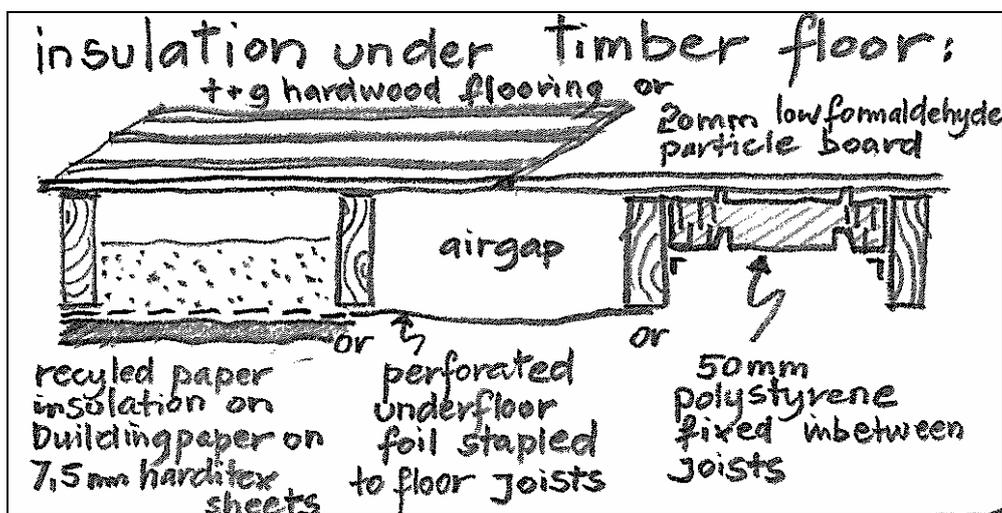


Blanket-type insulation can be rolled over the ceiling framing, which will save time cutting segments to size. It also has the benefit of covering the framing, reducing thermal bridging. When used in walls or under the floor it needs to be stapled to the framing to prevent sagging.

It's best to avoid recessed downlights in ceilings, particularly in wet areas. They act as little chimneys that pump warm room air into the space above. In wet areas they funnel moisture as well, which will condense on cold roof materials or framing. Drafts can blow dust and insulation fibres from the ceiling cavity into the room.

Older recessed downlights needed a large gap in the insulation around them because of the fire risk from heat buildup. Modern CA types allow the insulation to be installed up against them, though it mustn't go over the top. But even these have a small air channel which allows heat and moisture transfer. Use surface-mounted lighting instead – you won't need as many lamps and you won't compromise the insulation.

Generally, loose-fill insulation is cheaper than segments or blankets. It has to be installed by a contractor and is best suited for ceilings, where it should fill all small gaps and cover the framing. But loose-fill insulation can settle over time, reducing its effectiveness. It can also be blown to one end of the ceiling cavity if there are strong drafts, or moved by rats and mice. Get the contractor to give you a guarantee of the R-value and the thickness.



You can insulate under a timber-frame floor with expanded polystyrene. This is available in sizes to fit snugly in various joist spacings. Note that it reacts with PVC sheathing on electrical cables, which need to be protected from contact with it.

To achieve higher R-values you can install segment or blanket-type insulation between the floor joists and then line under the joists with cheap sheet materials such as fibre-cement boards or plywood.



The insulation value of standard concrete is extremely low – R-0.06 for 100mm. Insulation for a concrete floor slab, usually polystyrene, needs to be installed during construction by placing it before the concrete is poured. Most of the heat loss from a concrete slab occurs at the edge: insulation of the interior of the slab is usually unnecessary but the insulation needs to include the footing, or to incorporate a thermal break between the slab and the footing. It is possible (but tricky) to retrofit insulation to the outside of the footing of an uninsulated slab – consult an engineer or architect about ways to do this.

Several proprietary slab systems are available using polystyrene rafts or pods, or plastic domes, surrounded by concrete. But these usually have large thermal bridges, and if there's no insulation at the edges the insulation benefit is almost zero.

Concrete block walls can also be insulated. There are systems available that have in-built sheets of polystyrene, and others that are hollow polystyrene blocks or formwork that are then filled with concrete. The hollow polystyrene blocks provide very good insulation values. Always ask what the installed R value of the system is.

The New Zealand standard NZS 4246 for installing insulation in homes can be downloaded free from the EECA website, [www.eeca.govt.nz](http://www.eeca.govt.nz). It gives clear guidance for achieving best practice.

## **What Material to Choose**

There are several insulation materials on the market – all have their pros and cons. We only cover the commonly available types. R-values given here are conservative: check with the supplier for the actual R-value of their product.

### **Fibreglass (and mineral fibre) (approximately R 2.0 for 100mm\* thickness)**

This is a commonly used insulation material. Its technical performance is well proven and it outperforms most other materials of the same thickness in R-value. Fibreglass does not burn, but it can melt in the intense heat of a house fire. It tends to be cheaper than alternative options.

Most fibreglass insulation is made from recycled glass, so check on the source of the glass. Concerns have been raised about health impacts on installers and occupants from the small fibres entering the breathing passages. The International Agency for Research on Cancer (IARC), part of the World Health Organisation, lists glass wool insulation as “not classifiable as to its carcinogenicity to humans”.

Fibreglass can cause irritation of the skin and respiratory tract. If you do choose fibreglass or mineral fibre, wear gloves, full shirtsleeves, long trousers, and a mask while installing it. Fibreglass and mineral fibre are available as segments, blankets and loose-fill insulation.

### **Wool and wool blends (approximately R 1.8 for 100 mm of loose fill -- less for segments and blankets\*)**

Wool is a natural New Zealand resource and pleasant to handle, making it a good choice for DIY installation. Wool products do not have R-values as high as fibreglass of the same thickness, and are more expensive. Manufacturers claim that wool will balance the



moisture content in the air by absorbing moisture and releasing it later. There is evidence that wool has the ability to absorb indoor pollutants, such as those resulting from furniture or glues. A lot of research and development is taking and products are likely to keep improving.

All wool products on the market have been treated to discourage mould and pests. Wool will burn if it comes into direct contact with a flame, but will not ignite through heat or help a fire to spread.

There are two different types of wool products available. Some are sprayed with a resin to bind the fibres and provide strength, while others are blended with polyester. Wool is a relatively cheap loose-fill insulation – comparable to fibreglass in cost.

#### **Polyester (approximately R 2.0 for 100mm blanket or segment\*)**

The performance of polyester is similar to wool. It is a non-renewable resource (made from petroleum) and more expensive than fibreglass, though it is recyclable. The health concerns raised about fibreglass do not apply to polyester. Polyester will not burn easily, but it will give off dense smoke. It comes in segments and blankets.

#### **Recycled paper (approximately R 2.0 for 100mm loose fill\*)**

Recycled paper treated with a fire retardant can be used as loose fill insulation in ceilings. Like all loose fill materials its performance depends on the quality of the installation, so ask to see test results and request a written guarantee.

#### **Polystyrene (approximately R 1.4 for 50 mm sheet\*)**

Polystyrene is used increasingly in new buildings. It can be used under wooden floors, under concrete floors, or externally in sheets on framing and then plastered. Hollow polystyrene blocks or formwork filled with reinforced concrete give very good R-values for walls and retaining walls. Polystyrene is a product of the petrochemical industry and therefore a non-renewable resource, but it is recyclable. Its insulation properties are excellent. It must not be in contact with electrical cables insulated with plasticised PVC.

#### **Pumice (approximately R 1.4 for 100mm\*)**

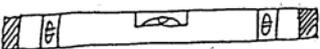
Pumice can also be used as insulation under concrete floors. It's a naturally occurring material with good insulating properties. It's an economical option if locally available and can replace some of the fill required under a concrete slab.

#### **Foil (R value dependent on air gap\*)**

It generally consists of paper coated in bitumen and aluminium foil. Because it relies on its shiny surface to reflect heat, rather than being itself an insulating material, corrosion or a coating of dust can reduce its effectiveness over time, and it's easily damaged. It conducts electricity, so be sure to observe the safety precautions when stapling around electrical wiring. Foil by itself is no longer accepted as complying with the Building Code for underfloor insulation.

#### **Injected foam products (R value varies\*)**

These are injected into cavities as a liquid which then expands and sets. The work has to be done by a trained applicator. Polyurethane foams have higher R-values than most other materials. Foams such as urea formaldehyde and polyurethane can release harmful gases such as formaldehyde (a known carcinogen) over a long period, contributing to indoor air pollution. Some foams produce toxic gases in a fire. If you plan to use these products, ask the supplier for guarantees of performance and durability. To meet the



Building Code, insulation in walls is required to maintain its performance for 50 years. Ask for evidence of an independent certification, such as a BRANZ appraisal.

### **Other products**

Other materials less commonly used include cork, woodwool, and straw. In strawbale construction, very high R-values are achieved from thick walls of straw plastered on both sides. See the *Earth Building* chapter.

Over time more products will become available. When choosing any product ask for an independent test report (such as a BRANZ appraisal) and for a guarantee of performance and durability. You could also ask for a Life Cycle Assessment of the material (see the *Materials* chapter).

\* All R-values quoted above are estimates and assume proper installation. You should obtain the exact R-value and installation instructions for a product from the supplier.

## **How much does it cost?**

Obviously the cost-effectiveness of insulation depends on the material chosen and the R-value. The Consumer website [www.consumer.org.nz](http://www.consumer.org.nz) has up-to-date comparisons. It pays to shop around, and some products are cheaper if bought directly from the distributor (*Yellow Pages*, under “Insulation”).

“Thermal” curtains are more expensive than ordinary curtains and may provide very little insulation benefit on their own. The real benefit comes when curtains or blinds of any material are sealed snugly around the sides and top of the window frame, minimising heat loss from air circulation. See the chapter *Heating your Home* for more on this. Costs vary greatly because there are so many different types and styles available. Pelmet, common in older houses, are effective in keeping the room air from getting behind the curtain and pumping heat outside. Fitting pelmet can be quite cheap if you do it yourself.

Hot water cylinder wraps are cheap and you can install them yourself. Pipe lagging is also inexpensive.

The Government offers subsidised insulation for existing homes. See [www.eeca.govt.nz](http://www.eeca.govt.nz).

All the insulation measures discussed here will pay off over the lifetime of the building, even at 2008 energy prices. You can expect quick payback periods for ceiling insulation (2–7 years), hot water cylinder wraps (1–2 years) and pipe lagging (6–18 months). Of course, the relative prices of energy and insulation will materially affect these times. Apart from the savings on your energy bill, you will be warmer, more comfortable, and have less condensation and fewer respiratory illnesses, as well as helping to reduce CO<sub>2</sub> emissions and climate change.



## Further information

### Advice at the Waitakere City Council:

Phone the call centre (09) 839 0400  
Ask for: Eco Design Advisor  
Building Consents

### In print

BRANZ *House Insulation Guide*, 3<sup>rd</sup> edition, Building Research Association of New Zealand

*Energy Efficiency – Small Building Envelope* (NZS 4218:2009), Standards New Zealand

*Insulation of lightweight-framed and solid-timber houses* (PAS 4244:2003), Standards New Zealand.

### On the web

[www.smarterhomes.org.nz](http://www.smarterhomes.org.nz) is a mine of up-to-date and independent information. Designed for the general public, it's easy to use, has case studies, and includes features such as Homesmarts, a calculator you can use to find information relevant to your needs or simply to run a home-health check.

If there are questions you can't find answers to on Smarterhomes, [www.level.org.nz](http://www.level.org.nz) goes into more depth and is aimed at the design and building industries, with drawings and links to Building Code compliance documents.

The Design Navigator, [www.design-navigator.co.nz](http://www.design-navigator.co.nz), offers a variety of online calculators and tools for thermal design. In addition, it has some great tips and a glossary of technical terms.

*BRANZ House Insulation Guide* (3<sup>rd</sup> Edition). Available through BRANZ, [www.branz.co.nz](http://www.branz.co.nz). NZ's most comprehensive guide to wall, window, ceiling and floor insulation.

NZS 4246:2006, *Energy efficiency – installing insulation in residential buildings*, free download at [www.eeca.govt.nz](http://www.eeca.govt.nz). How to install insulation so that it will be effective.

*Eco-building Products and Services Directory*, Building Biology and Ecology Institute, phone Auckland (09) 376 6767, Wellington 0800 223 272. This is updated regularly and can be obtained from the website [www.ecoprojects.co.nz](http://www.ecoprojects.co.nz).

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