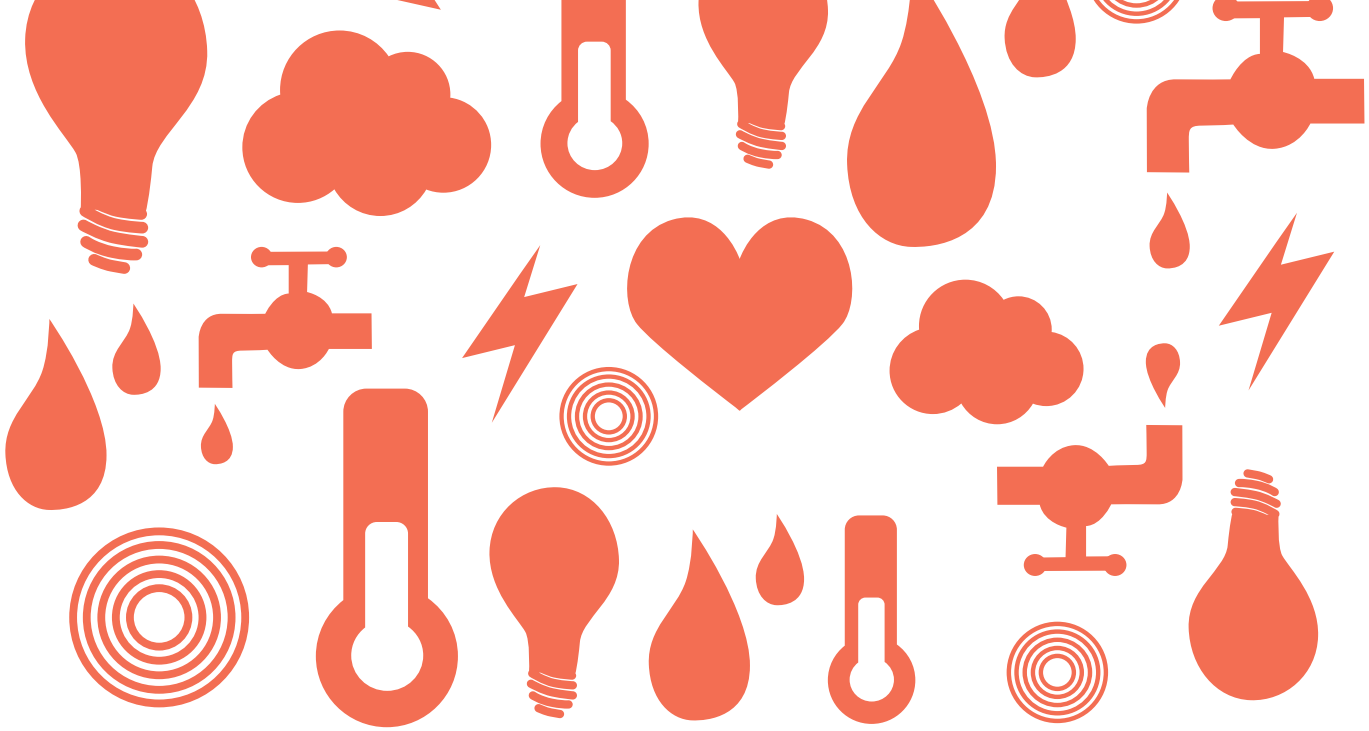

Making Your Home HomeSmart

a homeowner manual

Beacon

Creating homes and neighbourhoods that work well into the future and don't cost the Earth

About this Manual

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Abstract

The Homeowner Manual pulls together information and advice for homeowners on how to get the best performance from their home. It covers both renovating for improved performance and simple but effective changes to how homeowners use their home.

Reference

Easton, L. & Blackmore, A. Making Your Home Home*Smart*: A Homeowner Manual. Report HR2420/14 for Beacon Pathway Limited.

Acknowledgements

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Disclaimer

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Introduction

This Homeowner Manual gives you key information about the features and designs which will make your home (whether you are building new or renovating) Home*Smart*. We believe that all New Zealanders should live in a home that is warm, dry, comfortable, healthy, and costs less to run. A Home*Smart* home meets the benchmarks set in Beacon's HSS High Standard of Sustainability® for energy and water use, indoor environment, waste and material.

Home*Smart* homes use simple, proven designs and technologies in combination to address the **whole** house. We believe that sustainable homes are not just about energy efficiency: they are about using water wisely, creating a healthy indoor environment, selecting renewable and recyclable materials, and reducing construction and household waste.

The Homeowner Manual provides advice on how to get the very best from your home, firstly, by building or renovating with home performance in mind. The technology and design of a house is only half of the solution; how you use it is the other half. There is always more you can do to make your home perform better.

Who is Beacon Pathway?

Beacon Pathway is a research consortium committed to improving the performance of New Zealand homes. Our research is all about finding ways to make homes warmer, drier, healthier, cheaper to run and kinder to the environment.

Beacon takes a whole-of-house approach to renovating New Zealand homes. Our focus goes beyond energy to improving the performance of the whole house. We believe the health and environmental benefits of improved indoor environment, reducing waste to landfill, and water conservation are equally important.

You can find out more about our research at **www.beaconpathway.co.nz**

Beacon

Creating homes and neighbourhoods that work well into the future and don't cost the Earth

Disclaimer: As an independent research organisation, Beacon Pathway does not recommend for or against any particular practitioner, product, or supplier. Any mention of a practitioner, product or supplier is not intended as an endorsement for or against them.

How do we know that Home*Smart* homes work?

Beacon Pathway built prototype Home*Smart* homes in Waitakere City and Rotorua – the Waitakere and Rotorua NOW Homes®. These homes were both remotely monitored while the families living in them went about their daily lives, to tell us how well they performed.

The Waitakere NOW Home®: Joe and Hayley's experience

"We are happy here, which flows through to everything else. Everything has been better since being here".

Right from the start, Joe and Hayley loved their NOW Home®. They had come from a cold, damp house where they needed dehumidifiers on 24/7 and which was hard to heat. What a change! Sun poured into the new house during the day, and all the extra insulation and double glazing kept the warmth in. Joe and Hayley enjoyed the even heat through all the rooms – no cold back bedrooms. They only needed to get out a small fan heater for a couple of cold days in winter – the rest of the time they needed no extra heating.

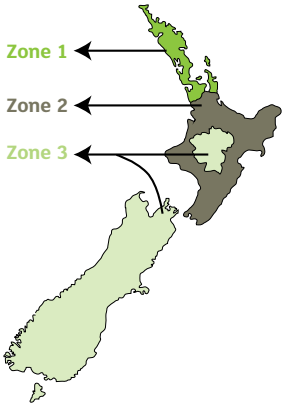
A warm house is generally a dry house. Joe and Hayley didn't unpack their dehumidifiers at all – there was no condensation and no mould. Their son's asthma improved rapidly and they were delighted to find after three months that he had hardly needed his nebuliser at all.

In fact, with little space heating, their power bills dropped considerably. They were paying 45% less than in their previous home, and 33% less than other 4 person households in the area.

Water in the Auckland region is metered and can be a big cost to households. The good news for Joe and Hayley was that their rainwater tank provided 47%-52% of their water needs, and the low flow taps and shower heads, dual flush toilets and water-efficient washing machine reduced their water use to half the average in surrounding Waitakere City.

Best of all for Joe and Hayley was the confidence and family happiness they noticed since moving into the NOW Home®. They started having friends around as the house was pleasant and spacious for entertaining.

The Waitakere NOW Home - Beacon's first live research home



New Zealand climate zones as defined in the Building Code

Based on our research and experience with the NOW Homes®, Beacon developed a set of performance standards for homes – the **HSS High Standard of Sustainability®** (we call it the HSS® for short).

RETICULATED ENERGY USE

climate zone 1:
- New homes: 5800 kWh/yr
- Existing homes: 6200 kWh/yr

climate zone 2:
- New homes: 6300kWh/yr
- Existing homes: 7300 kWh/yr

climate zone 3:
- New homes: 7300 kWh/yr
- Existing homes: 8400 kWh/yr

RETICULATED WATER USE

- 125 litres/person/day

INDOOR ENVIRONMENT QUALITY

average temperature:
- Living room 5-11pm in winter >18°C
- Bedroom 11pm-7am in winter >16°C

average relative humidity:
- Living room 5-11pm in winter 40-70%
- Bedroom 11pm-7am in winter 40-70%
- Surface relative humidity <80% year round

checklist:
- Mechanical extract ventilation of kitchen, bathroom and laundry
- Means to passively vent dwelling
- No unflued gas heaters
- Damp proof membrane under house
- No indoor clothes drying

WASTE

- A maximum of 2.6 tonnes per house or 16kg/m2 of construction waste for new building
- Separate construction wastes for collection
- Waste management plan produced for site in accordance with REBRI guidelines
- Provide space in kitchen for organic collection – 5 litres minimum capacity
- Provide space for non-organic recycling bins in or near kitchen – 20 litres minimum capacity
- For detached dwellings on suburban lot sizes, provide space in garden of at least 1 m3 for composting of organics. On sites of 250m2 or less, provide for worm farm, communal composting or kitchen waste collection.

MATERIALS

new homes:
materials which:
- promote good indoor air quality, e.g. through use of Environmental Choice certified paints and finishes
- have minimal health risks during construction or renovation
- are durable and have low maintenance requirements
- re-use existing or demolished building materials or can readily be re-used
- are made from renewable or sustainably managed resources
- have low embodied energy including minimal impacts due to transport
- minimal impact on the environment (air, water, land, habitats and wildlife)
- have third-party certification (e.g. NZ Environmental Choice, Forest Stewardship Council)

existing homes:
- Retrofit or renovation applies principles from materials checklist where appropriate

HSS High Standard of Sustainability® 2008

Alongside the HSS High Standard of Sustainability®, we developed guidelines to help designers and builders reach those standards. The **Home*Smart* Homes** project used the guidelines to work with the New Zealand Housing Foundation in bringing one of their standard home designs to HSS® benchmarks.

Home*Smart* Renovations was Beacon's New Zealand-wide research project, investigating what it takes to encourage New Zealanders to renovate their homes to higher levels of performance. 530 homeowners were given renovation plans specific to their homes and information on improving their home's performance. Monitoring showed what renovations were undertaken as a result of the plans and whether they were successful in improving the home to HSS® benchmarks.

How do Home*Smart* homes benefit New Zealand?

Improving our health

Cold homes create condensation - 45% of our homes have mould and are ideal environments for fungi and dust-mites, helping trigger increasingly high rates of allergy and asthma. Cold, damp and mould indoors, where we spend most of our time, affects the health of 25% of our households and is a key contributor to New Zealand's high winter mortality rate (1600 more people die in winter than in summer) - one of the highest in the developed world.

This costs us, as individuals and as a nation. Sick days off work and school are just the tip of the iceberg – there are doctors' visits, prescription charges, hospital costs – the list goes on.

12°C

inside your home can seriously impact your health

Making our homes affordable

Truly affordable houses are cheap to run, not just cheap to buy. Reducing energy and water requirements – and therefore costs - generates a significant increase in household disposable income, which could easily go towards repaying the mortgage.

Using the Earth's resources wisely

Research shows that more resources, materials, energy and water are being used, per person, than ever before. In New Zealand nearly a third of all electricity is used domestically – in heating, lighting and running appliances. The generation of energy, particularly by the burning of fossil fuels, depletes natural resources and pollutes the atmosphere.

The national average for water consumption is 241 litres per person, per day. However, only about 5 litres per person per day needs to be suitable for drinking and cooking – the rest of the expensively treated and reticulated water is flushed down toilets and waters our gardens.

The mounting cost of energy and water to New Zealand

If we could reduce our demand for energy and water:

- Our current supply would go further and supply more people.
- We could defer expensive new infrastructure.
- Our rates and taxes would not need to meet as many future infrastructure demands.

Beacon's *National Value Case for Sustainable Housing Innovations* calculated the value to the nation of making five simple home improvements to New Zealand homes. Each year New Zealand could:

- save enough energy to power 500,000 homes.
- reduce CO_2 emissions by 360 kilotonnes, equivalent to $54 million worth of tradeable emissions.
- save 130 million cubic metres of water.

Overall, New Zealand households would save 1% of GDP by 2017 or about $2 billion.

Managing your home's performance

As a homeowner, you have a lot of influence over how well your home performs.

Partly it is because your behaviour, your habits and the things you do in your home, affects how much water and energy you use, and how damp or cold your home is inside. The good news is that these things are easy and generally inexpensive to change. For that reason, this Homeowner Manual includes top tips for using your home.

You also make choices which affect your home's performance. What sort of heating to use? What to spend your money on when you renovate? Is a new kitchen bench more important than under-floor insulation? It can be difficult to decide what choices to make to get the best result for your home.

The Homeowner Manual aims to give you the information on what renovations to undertake. We believe that having an overall plan for improving your home's performance will get the best result and avoid the common trap of spending ad hoc without getting the results you want.

Based on our research, we believe you should renovate in this order:

1. **Keeping the heat in**
   Priority insulation order: ceiling, under-floor, south walls, south windows and rest of the walls and windows.
2. **Keeping moisture and dampness out**
   Priority: drainage and/or maintenance; then bathroom ventilation, kitchen ventilation, dryer, vapour barrier, and laundry ventilation.
3. **Efficient sustainable heat source.**
   Priority: living space; then bedrooms.
4. **Water efficiency (shower heads, taps, toilets)**
   Cheap and simple measures to reduce demand for reticulated water and energy
5. **Efficient sustainable hot water heating**
   Priority: efficient cylinder and wrap; then solar/heat pump hot water
6. **Energy efficiency (if high energy users)**
7. **Supplementary water supply**
   Rainwater tanks for garden, toilet and laundry. Greywater systems for garden and toilet.
8. **Waste**
9. **Energy efficiency (if not high energy users)**

The Homeowner Manual covers all these areas with information, both on renovating and on changing the way you use your home. We believe the result will be a home that is warm, dry and comfortable, healthy to live in, and costs less to run.

Finding your way around: the framework of the Homeowner Manual

Section One:
Keeping the heat in

- Passive solar design
- Thermal mass
- Insulation
- Double glazing
- Stopping draughts
  - > Downlights
  - > Draught proofing
  - > Curtains and pelmets

Section Two:
Heating and cooling

- Need extra heating?
- Using temperature sensors to manage your indoor temperatures
- Keeping cool in summer

Section Three:
Keeping healthy indoors

- Temperature
- Moisture and dampness
- Ventilation

Section Four:
Energy saving

- Using less energy
- Managing your energy use with an energy monitoring device
- Appliances that use electricity when you think they are off
- Choosing energy-efficient appliances
- Using energy-efficient lighting
- Energy saving tips
- Generating your own energy
- Saving with hot water
  - > Saving water means saving on water heating
  - > Wrapping your own hot water cylinder and lagging the pipes
  - > Wetbacks
  - > Hot water heat pumps
  - > Solar hot water systems

Section Five:
Water saving

- Using less water
- Using free rainwater
- Using greywater

Section Six:
Waste, maintenance and project management

- Reducing your household's waste
- Maintaining your home
- Project managing your renovations

Section One:
Keeping the heat in

Typical Home*Smart* features

The first step to a warm home is to use the sun's warmth and keep its heat inside the house. Typical features include:

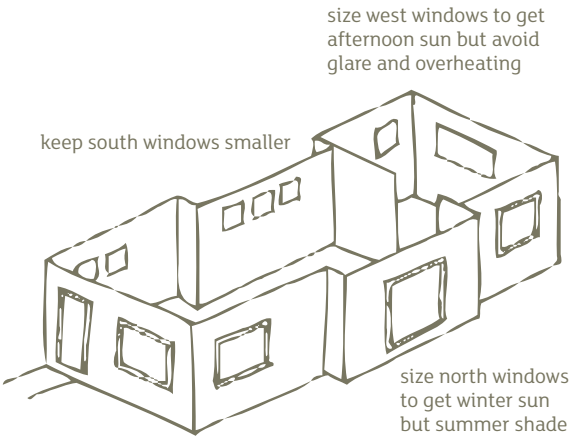
- Facing north with large windows to let the sun in and fewer, smaller windows on the south side
- Living areas on the northern side of the house
- An insulated thermal mass such as a concrete slab floor, concrete strip or brick/concrete wall to act as a heat sink
- High levels of insulation in the ceiling, walls and under the floor
- Double glazing and thick thermal curtains to prevent heat escaping out the windows
- An entry hall which can be shut off from living areas
- No downlights into roof space
- Draught stopping around doors and windows

Passive solar design

Passive solar design is about making the most of the sun's free natural energy to maximise comfort in your home.

Passive solar design can be incorporated into new homes, renovations or existing homes of all types. In some homes, passive solar design will maintain stable temperatures year-round without any need for supplementary heating or cooling. Others may need additional heating in winter - this supplementary heating will be far more effective in a home that uses passive solar design principles.

The location and size of windows are important in passive solar design. For every square metre of glass that the sun falls on, a kilowatt of heat is generated per hour – that's like running a heater all the time.



Source: www.smarterhomes.org.nz

Top tips to maximise the benefits from the sun and passive solar design

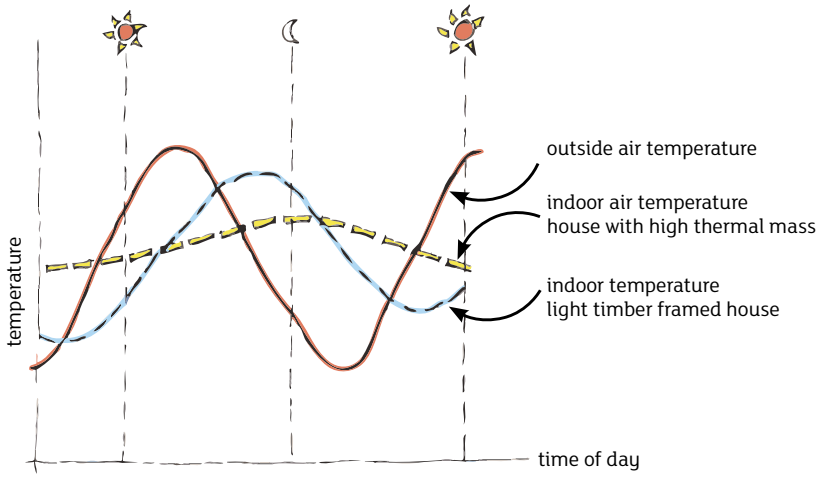
- Large, north-facing windows to let the sun in.
- Few and smaller south-facing windows.
- Moderately sized windows on eastern and western sides of the house.
- Keep windows clean.
- Prune trees to make sure they don't obstruct the sun in winter.
- Plant deciduous trees for summer shade, especially in places with cold winter temperatures.
- Take care that curtains aren't blocking sun during the day.

This house has a strip of exposed concrete thermal mass next to the north facing windows.

Thermal mass

Some building materials are good at absorbing and storing the sun's heat. These materials are high in what is known as thermal mass. They're usually dense materials - such as concrete and brick - and they're usually used in floors or walls. Used properly - the right amount in the right place, with proper insulation - thermal mass can help maintain comfortable temperatures inside your home year round.

When the weather is cool, thermal mass will absorb heat during the day and radiate it out as the temperature drops in the afternoon or evening. Thermal mass materials are also useful for cooling because they keep absorbing heat as long as the air temperature is warmer than the thermal mass.



Source: www.level.org.nz

Thermal mass can be in the form of an insulated concrete slab, a strip of insulated concrete by north-facing windows, an insulated wall exposed to sun, or an insulated wall next to a radiant heat source such as a wood burner. Insulation under and around a concrete slab will stop the heat dissipating into the ground.

Top tips to take advantage of this free warmth

- Make sure the area where the sun warms the concrete is exposed to as much sun as possible.
- Do not cover the floor with carpets, rugs etc (or only cover parts of the floor that don't get the sun). Tiling these areas is not a problem.
- Make sure the windows aren't shaded while the sun is out during cooler months of the year.
- Close the curtains when the sun goes down during the cooler months of the year.
- Use ventilation to ensure your home doesn't over-heat as warm air is released from the concrete.

Important: If you have moved into a new home with a concrete floor or wall, it will take several months for the concrete to completely dry out and give you the best results. A new 100mm thick concrete slab (the norm in most new homes) will take around four months to dry out and, in that time, produce 700 litres of moisture – it's important that your home is well ventilated at this time so that moisture doesn't stay in the house.

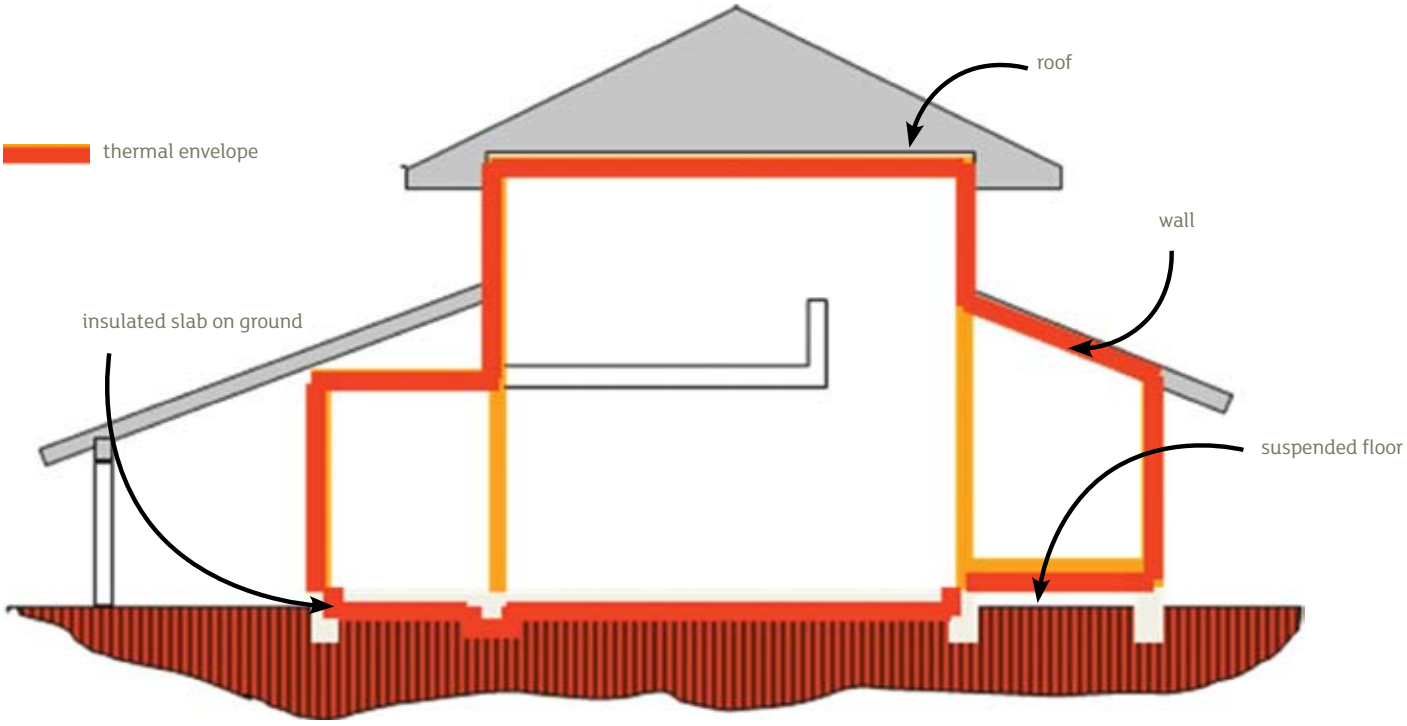
Insulation

Insulation acts in two ways – in winter, it's like a blanket keeping your home warm, and in summer, it's like the walls of a chilly bin, keeping your home cool. Having a well-insulated home means that when you heat (or cool), it's your house that gets the benefit. Heating or cooling an uninsulated house is like trying to fill a bath with water, but not putting in the plug.

As insulated surfaces are warmer, condensation is less likely to form on them. As a result, an insulated house will have less mould and mildew, and be a less appealing environment for allergy-aggravating dust mites.

Thermal envelope

The thermal envelope is the insulation barrier between the heated and unheated spaces. It is the invisible wrap which protects the inside of the home from the outside climate. Ideally it should be continuous, have no gaps and have a minimum of weak points. (Weak points in your thermal envelope are things like windows, doors, skylights, ceiling fans, downlights and chimneys)



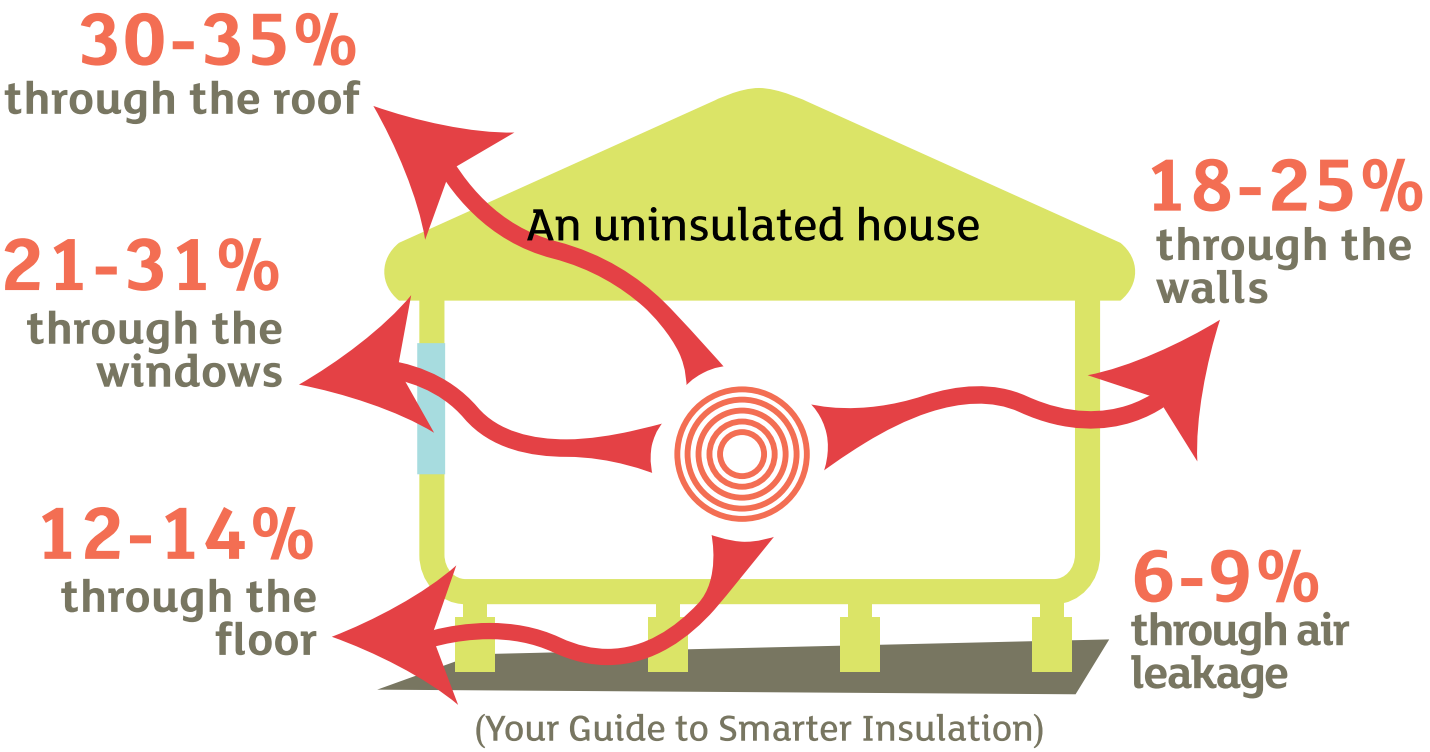
A typical thermal envelope

Old poorly laid insulation (pink) is replaced with newer thicker insulation

When thinking about insulation, it's important that you think of **all** the following areas:

- ceiling
- under the floor
- walls
- windows

Houses built before 1979 are unlikely to have any insulation, unless it has been subsequently added, and houses built before 2007 have much lower levels of insulation than necessary to keep most homes comfortable. In insulated houses without double glazing, windows are the main area where heat is lost from the home.



(Your Guide to Smarter Insulation)

Types and choices of insulation

Insulation generally works by trapping air (the most effective method) and/or reflecting heat. Materials that provide good heat insulation are lightweight because they contain large amounts of tiny pockets of still air. The 'R value' measures how good the insulation material is at containing heat. The higher the R value, the better the insulation will be. The insulation needs to be properly installed to reach the R value.

What is an R value?

The effectiveness of insulation is measured by its R value. The higher the R value on an insulation product, the more it slows down the transfer of heat. Generally, the R value of insulation gets higher as the product gets thicker. For example, an R3.0 product has greater thickness than a R1.0 product of the same type. Using R values helps you to compare the effectiveness of different types of insulation

Glass wool/Fibreglass (e.g. Pink Batts, Bradford Gold) 	• Widely available from your local hardware store or through professional installers. • A range of R value products suitable for ceilings, walls and under-floor, including high R values ("Ultra" type products). • Some products are Environmental Choice certified and have high rates of recycled glass content. • Suitable for installation in new builds or renovations. • Available as batts and as blankets. • Fibres can irritate installers, and it is not easy to install in ceilings with very low roofs or under-floors where access is very difficult. • Must be properly installed to perform well and doesn't perform when wet (fix that leaky roof!). • Early installations (e.g. those done in the 70s and 80s) may well have slumped and are of a very thin product – these need topping up or replacing. • Long lasting product - current products have an expected 50 year life.
Wool (e.g. EcoInsulation, Terra Lana, Latitude, Rockwool, Woolcote) 	• Widely available from hardware stores or through professional installers. • A range of R value products suitable for ceilings, walls and under-floor. Slightly lower R values than fibreglass for same thickness of material. Often available mixed with polyester. • Some products have a high proportion of recycled fibre. • Chemical treatment protects from fire and pests. • Suitable for installation in new builds or renovations. • Available as batts and blankets, or as loose fill. • Not easy to install in ceilings with very low roofs or under-floors where access is very difficult. • Long term durability/life expectancy not known.

Before installing under-floor insulation

Polyester (e.g. Autex Greenstuf, Novatherm, Eco Insulation, Cocoon) 	• Widely available from hardware stores or through professional installers. • A range of R value products suitable for ceilings, walls and under-floor. Slightly lower R values than fibreglass for same thickness of material. • Some products are Environmental Choice certified and have high recycled content. • Suitable for installation in new builds or renovations. • Available as batts and as blankets. • Not easy to install in ceilings with very low roofs or under-floors where access is very difficult. • Stable, long life product although prone to compression damage if stored inappropriately before installation.
Polystyrene (e.g. Expol, Retrotherm, Poly Palace, Styrofoam) 	• Widely available from hardware stores or through professional installers. • A range of R value products suitable for ceilings, walls and under-floor, although in retrofit situations mainly used under-floor. Slightly higher R values than fibreglass for same thickness of material. • Available as sheets, beads or less commonly embedded in structural elements. • Current products are CFC free but some early products used CFCs so care with their disposal is needed. Some products have high recycled content. • Stable and long lived, although can be vulnerable to damage if exposed. Some shrinkage can occur over time which can affect friction fittings (e.g. in floors).
Cellulose/Macerated Paper (e.g. Insulfluff)	• Specialist installation required for blown-in fibre into ceilings. • Has been used in ceilings where access for installation of insulation is difficult. Initial R values can be similar to fibreglass, but deteriorate over time. • Chemical treatment protects from fire and pests. • Some products contain high recycled content. • Lower cost product than other forms of insulation, but has a shorter life as it is prone to slumpage and moisture penetration over time. • Older installations (e.g. from 70s and 80s) are likely to be ineffective now. • Unsafe for use where downlights have been installed as can create a fire risk. Consequently, this product is not recommended for installation by Beacon.
Straw	• Specialist installation required for straw bale construction – used for wall insulation as a structural element in new homes. • Very high R values can be achieved. • Renewable product. • Chemical treatment protects from fire and pests. • Durability is affected by extreme sensitivity to moisture, and protection from moisture during construction is critical.

After the insulation was installed

Polymer (e.g. AirCell, Silverzone) 	• Available for DIY or by specialist installers. • Used in ceilings and under-floors. Claimed R values are higher than installations in place, and no independent information available on performance as yet. Available as foil backed rolls for under-floor installations. • Can sometimes be installed in situations where other insulation is difficult (lower under-floors). • Durability information not available but probably a stable, long-lived product.
Hardened U/F foam (e.g. Airfoam)	• Available for installation by specialist installers for retrofits into wall cavities as a blown-in foam. • Not at all suitable for brick construction as blocks drainage cavity needed to prevent your walls rotting. • Higher R values than fibreglass. • Lack of information on long term durability and impact on weathertightness of New Zealand houses.
Metallic foil (e.g. Silversark, Sisalation) 	• Available for DIY for by specialist installers. • Low R value product. • Used in new homes and retrofitted to suspended floors. • Prone to deterioration and physical damage leading to poor performance over time. Also has risk of electrocution with installation (stapling). Consequently this widely-used product is not recommended by Beacon. • Older installations (more than 5 years old) should be replaced with a better performing product.
Aerated concrete	• A specialist installation product mainly used in new installations of walls and floors as blocks and pre-formed panels. A pumped-in product is available for retrofitting under-floors. • Low R values (0.7 per 100mm) • Expected to be durable for the life of the building.
Insulated concrete 	• A specialist installation product for walls of new buildings. • R value depends on the thickness of the insulation – can be higher than fibreglass. • Available as blocks and pre-formed panels, normally with polystyrene as the insulation. • As it is an insulated thermal mass, it can be used for heat storage. • Expected to be durable for the life of the building.
Polythene 	• This is not an insulation product, but is often a key part of an under-floor insulation installation as it acts as a vapour barrier for moisture coming off the ground. • Unless your under-floor has very significant ventilation (e.g. is a pole house) or is built on very dry land, a vapour barrier is recommended. • Some under-floor insulation products claim they also perform as a vapour barrier; however, research indicates that a separate vapour barrier is still required.

Table 1: Types of insulation

Insulation disturbed by electricians and workmen in ceiling

DIY tips: Checking out your ceiling cavity

If you have had electricians in, or someone installing a ducted system (e.g. a heat transfer or ventilation system), chances are they have moved any insulation that is up there already. And there may be obvious things like ducting coming loose which you can fix easily yourself.

Here's a list of the things to look for in your ceiling:

- **Ceiling hatch – is it insulated?** If the rest of the ceiling is insulated but your hatch isn't, it will act as a chimney for heat to escape. It's easy to insulate the hatch yourself, by taping the insulation onto the top of the hatch so it stays on, even when you move the hatch.
- **Has any insulation been piled up somewhere? Are there bare areas with no insulation?** Move any piled up insulation back into place, trying to make it fit closely to the wooden rafters and next pieces of insulation. However, if there have been downlights installed in your ceiling, those areas might be bare for a reason – insulation mustn't be placed over downlights as it could catch fire.
- **Is ducting in the ceiling connected?** If it has come adrift, tape it back together again with duct tape.
- **Do you have a leak in your roof? Can you see holes or damp patches?** Sometimes the nails pop up on corrugated iron roofs, and you can see this easily from inside the cavity.
- **Is there building paper between your roof surface and the framing?** (e.g. corrugated iron or tiles) If there isn't, next time you re-roof, make sure the roofer installs building paper to help keep your ceiling cavity drier.

Roof insulation piled up after electrical work.

Double glazing

Types and choices of double glazing

When thinking about double glazing, there are two key considerations – the type of frame and the type of glass. For new homes, most houses use standard aluminium frames; however, a range of other (but more expensive) frames are available which will perform better – thermally-broken aluminium, wood and PVC. When it comes to glass, there are a wide range of options. Some key differences in window frame and glazing are outlined in the table below.

Aluminium frames	• Standard, cheapest frames available. • Has poor thermal performance because the heat and cold easily transfers through the aluminium. • A standard double glazed pane in aluminium frames has an R value of 0.26. • Relatively low maintenance.
Thermally broken aluminium	• Aluminium frames which include a "thermal break" so that heat and cold don't pass through the frame. • Widely used overseas and becoming much more widely available, and therefore more affordable, in New Zealand. • A standard double glazed pane in a thermally broken aluminium frame has a R value of 0.31.
Wooden frames	• The standard frame in older houses. • Much more expensive than aluminium but performs much better thermally. • A new wooden window frame with a standard double glazed pane of glass has an R value of 0.36. • Wooden frames need to be painted and have regular maintenance.
PVC frames	• More expensive than aluminium but performs similarly to wood. • A new option available, although widely used overseas. • A PVC window frame with a standard double glazed pane of glass has an R value of 0.36. • As these have only recently been used in New Zealand, durability in high sunshine and coastal situations is not proven.
Ventilated frames	• Although double glazed windows are less likely to have condensation forming than single glazed windows, this may still occur. • Some types of frames have built-in ventilation which stops condensation forming on the glass.
Clear double glazing glass	• Standard glass available. • Two layers of glass, with an air gap in between. • The thicker the air gap, the better performing the glass. A standard air gap of 12 mm is assumed in most R value calculations.

Double glazed windows have been retrofitted into the existing wooden frames in this 1901 villa

Low emissivity (low E) glass	• A higher performing glass which lets light and heat in, but is more resistant to heat escaping. • If low E (emissivity) glass is used instead of standard glass, a large increase in performance occurs. For example, a window with low E double glazed glass in a standard aluminium frame has an R value of 0.31 (compared to 0.26), and a window with a low E double glazed glass in a wooden or PVC frame has an R value of 0.47 (compared to 0.36).
Secondary glazing	• Secondary glazing means inserting a second pane of glass, acrylic or plastic sheet in or onto an existing window frame. It's an alternative to retrofitting new double-glazed windows, especially for old wooden houses. • This approach can help reduce heat loss and noise. • Secondary glazing can achieve similar R values to standard double glazing, and is usually cheaper. • It is also possible to retrofit secondary glazing with low E glass or tints.

Table 2: Choices in double glazing

Retrofitting double glazing

There are a number of different options if you are considering double glazing your home.

Firstly you can prioritise the order in which you double glaze. Start with windows which give you the most improvement – these tend to be south-facing windows because these get very little winter sun, and are a major source of heat loss. Next consider west or east facing windows (particularly in bedrooms), and then finally north-facing windows. If you have a problem with glare or overheating in the afternoon, then western windows should be double glazed as a second priority after south-facing windows.

When it comes to retrofitting double glazing, there are two main options – replace the whole window frame with new frames and glass, or install inserts into your existing window frames. The second option is a lot cheaper, if your window frames are still in good condition. Low E and tinted glasses can be included in either retrofit option.

Before double glazing

After double glazing

This draughty west-facing bedroom window was retrofitted with aluminium double glazing inserts in the existing window frame. Low E glass was included, upping the R value from R0.26 to R0.31.

Alternatively you can consider secondary glazing which leaves your existing window in place and puts a second window inside the frame made of either glass or acrylic. This gives you many of the benefits of double glazing without having to fully replace your windows. The most recent research indicates that glass or acrylic secondary glazing systems perform as well as some types of double glazing, and are cheaper again than a full double glazing option.

Even cheaper are shrink wrap secondary glazing kits. These can be an effective way of improving your window performance in winter – they help with condensation as well as reducing heat loss. Shrink wrap plastic is attached to your window frame with double-sided tape, and then shrunk to fit using a hair dryer. You can buy these from a hardware store, or online. Generally they will only last one year though, so you need to redo your windows each autumn.

This window has been fitted with shrink wrap double glazing, an ideal option for rental homes and those on a budget.

Secondary glazing	Double glazing
• Is cheaper. • Is available both as glass and acrylic inserts. • Can be a better option if you want to address external noise issues. Secondary glazing can be really good at blocking external noise. • Can be swapped in summer for insect screens fitted to your windows in the same way - this is very popular in Europe. • Can look ugly to some people, and this may be a consideration for you. • Will reduce condensation on your windows.	• Is usually not as good for noise as secondary glazing, but still makes a big difference to noise levels. • Can use advanced glass (e.g. low E (emissivity) glass which has great thermal properties). Double glazing with low E glass should perform better thermally than secondary glazing. • Is probably a more permanent/long term option than secondary glazing (but, again, check that warranty). • Is probably going to be valued by the market more in the long term than secondary glazing (since new houses are now required to have double glazing). • Will reduce condensation on your windows.

Table 3: Pros and cons of double vs secondary glazing

Before double glazing

After double glazing

This old louvre toilet window let in lots of draughts, and was replaced with aluminium double glazing inserts in the existing window frame at a cost of only $400

Downlights create a gap in your insulation, as insulation cannot touch them due to fire risk.

Stopping draughts

Draughts are caused by cold air forcing its way through gaps around windows or doors. By blocking the gap, you will stop the draught. Windows, doors, cat doors, skylights, ceiling fans, downlights and chimneys are all weak points where you might get a draught.

DIY tips: Draught proofing

The good news, especially for those renting homes, is that there are simple and inexpensive things you can do yourself to stop draughts.

- **Curtain banks** – These are a cheap way to get curtains. Make sure they are a snug fit from floor to ceiling, and keep those pelmets – they stop cold air getting in
- **Shrink wrap glazing -** These are a cheap and effective way of improving your window performance in winter – they help with condensation as well as reducing heat loss. The kits are attached to your window frame with double-sided tape, and then shrunk to fit using a hair dryer. You can buy these from a hardware store, or online. Generally they will only last one year though, so you need to redo your windows each autumn.
- **Door sausages -** These are easy to make yourself, or you can buy deluxe versions (which go under the door and surround both sides) from community organisations such as Community Energy Action (their online shop at www.cea.co.nz sells these).
- Block off your chimney by boarding it up or having a cap professionally fitted over your chimney pot.
- **Draught proof around doors and windows** (see p.26)
- Make sure your **cat door** is close-fitting and has a strong return mechanism.

Downlights

Downlights create a hole in your ceiling which reduces the effectiveness of your insulation. Downlights used in lower storeys are fine, but when there is only roof space above the ceiling, they penetrate the insulating bubble (often called the thermal envelope) that surrounds your home. This is made worse by the need to leave a safety gap between the downlight and any insulation in the ceiling. Because the incandescent or halogen bulbs used in downlights run very hot, fire is a very real possibility. Safety regulations mandate a 150mm un-insulated gap around the downlights, and downlight cans should never be covered.

The upshot is that your warm heated air is drawn up into the colder roof-space and your ceiling insulation cannot work as well as it should. This is shown in a 2006 Standard for the installation of insulation: *NZS4246 (Energy Efficiency – Installing insulation in residential buildings: 2006*). It includes a table which quantifies the effect on R-values of the number of downlights in a ceiling. To meet the Building Code, new homes in the South Island, for example, are required to have ceiling

insulation rated at R3.3. Downlights installed every 3 square metres would reduce your insulation effectiveness by R0.6 bringing your insulation rating down to R2.7. In most of the North Island, new homes should have ceiling insulation rated at R2.9. Install downlights every 5 square metres, and your insulation effectiveness is reduced by 10% to R2.6.

As well as leaking heat, downlights in wet areas, like bathrooms and kitchens, can allow moist air into roof spaces and around concealed framing, resulting in condensation and possible moisture damage.

Case studies show downlights reduce the performance of insulation

Downlights were a prominent feature in many of the homes Beacon renovated in the Papakowhai Renovation project.

	Case study 1	Case study 2
No. of downlights	38 in living areas	47 throughout the house
Coverage	1 downlight per 1.6m2	1 downlight per 1.2m2
Total area un-insulated	7.6m2	6.1m2
Ceiling insulation level	R5.2	R4
Actual insulation level	R2.5, less than the current Building Code minimums	R2.2, less than current Building Code minimums
Temperature improvements	Low, improving only 1.1°C to a chilly average of 14.7°C	Very little change. This house had so many downlights that extra insulation made very little difference.

What can you do?

The best option: To get the most benefits from your ceiling insulation, replace your downlights with non-downlight fittings and fill in the hole in the insulation. You may be able to source a surface-mounted fitting which will cover and seal the downlight hole, or if you are undertaking major renovations, re-do your ceiling plasterboard.

Until you can renovate: Replace your old downlights with CA-rated downlights. These downlights allow insulation to be butted directly up to them ('closed abutted' or 'CA-rated'). They have an enclosed canister to stop the insulation being exposed to the heat from the bulb. However, you still cannot fit insulation, such as a blanket, over the top of the downlights. As well as changing your downlights, you should consider upgrading your ceiling insulation to compensate for the lost warmth.

There is a range of CA-rated downlights available on the market. If you are not sure of the type you need, check with a registered electrical contractor. Further advice on alternative lighting options is available from **www.rightlight.govt.nz**

Draught proofing

Autumn is a great time to do draught proofing and weatherising before winter. Hopefully your house is dry after the long summer and, because many weather proofing products use adhesives, this means they will stick better than if you wait until winter to install them.

As a rule of thumb, all houses built before the 1960s, and most houses built before the 1980s, will need some draught stopping. And all ages of homes suffer some weather proofing problems over time. If you've done draught proofing before, it's also important to make sure they are still clean and working. New draught proofing may need to be done in heavy wear areas every 3-5 years.

Doors
Draughts from outside doors are a major source of heat loss in our houses, but they are easy to fix with draught stoppers (for that gap under the door) and using draught strips around the door frame. There are plenty of DIY products available in the hardware stores. Draught sausages are a cheap and effective way of stopping draughts from internal doors also. If you have one, it's also important to check your cat door – these need to close properly otherwise they will let a big draught in.

Curtains
These are a great winter and summer protector from the elements (see p.28). Make sure your curtains close well, and that there are no gaps around the edges. If your curtains move when your windows are closed, then this is a sure sign that your windows need some draught proofing.

Windows
Draughts from windows are common but often they are a symptom of a need for wider window maintenance. Before you draught stop, make sure window catches and hinges are working properly and fix any that are broken or damaged.

When draught stripping wooden windows, you need to take care to use a product that won't warp your windows - rubber or foam products are better for use with doors. There are products which create a thin folded V of plastic which perform better for windows.

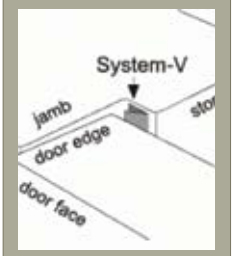
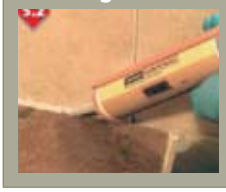
To help find the source of a draught, light a candle and use it to find the source. Move the candle around the edge of a frame - the flame will flicker where the draught is coming in.

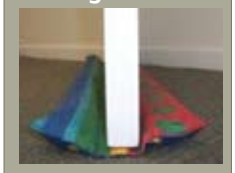
It is often difficult to calculate the size of the gap when draught proofing. To help you measure small gaps, a useful gauge can be the thickness of the edge of a coin. A quick reference is:

Old style 50 cent piece = 2mm

$2 coin = 3mm

Table 4: Types of draught proofing products

Self-adhesive foam strip 	• Widely available from your local hardware store – usually in packs of different millimetres thickness, or strips you can cut off to the length you want. • This product is best used around doors – on the door frame, so that the door fits snugly when closed. • Eyeball the gap you want to fill and, if possible, measure its width in millimetres before buying your draught strips. • Make sure the surface is clean when you stick it on (clean and then wipe with methylated spirits to remove any grease). • If you use this product on windows, don't use one which is too thick – otherwise it will be hard (or impossible) to close the window. • Don't use this product on wooden windows as it can warp them over time.
Self–adhesive rubber strip	• Similar to foam in terms of availability and use. • It is a more long-lasting product, so although it is slightly more expensive, it is probably worth the cost.
Brush strips 	• Widely available from your local hardware store in a range of colours and styles. • These are generally for installation on the bottom of external doors to stop draughts coming in the gap under the door. • Can be mounted (with screws) on either side of the door (inside or out) depending on the way the door opens. • May need to be cut to size.
V Seal 	• This is not very widely available in New Zealand. It is stocked by Community Energy Action (**www.cea.co.nz**) in Christchurch (they have online sales), Negawatt Resources in Wellington, or Energy Options in Whakatane. • These are able to be used on doors or windows and are particularly good for older wooden sliding windows, double-hung sash windows (as in a villa) or wooden casement windows (as in a bungalow or houses built in the 1940s and 1950s). • These are self adhesive also, and you need to fold the plastic tape in half (make sure it's a really good fold) before doing the installation. • Again clean the frame surface and wipe with methylated spirits to get rid of any grease.
Silicone sealant cartridge 	• For filling gaps such as between skirting and floorboards. A flexible sealant will last for many years when used in this way. Silicone-based products are more expensive than other flexible sealants but are generally less prone to deterioration. • Vacuum carefully around the gaps to be sealed and then apply the sealant directly into the gaps. • If you have not used a sealant cartridge before (and even if you have), it may be wise to mask either side of the join before applying the sealant – the tape should be removed immediately after application as it will be extremely difficult and messy to remove once the sealant has cured.

Draught sausages 	• These are easy to make yourself, or you can buy deluxe versions (which go under the door and surround both sides) from community organisations such as Community Energy Action (their online shop at www.cea.co.nz sells these).
Keyhole covers 	• For a lock with a hole that goes right through the door, you can buy a range of products from a locksmith that fit over the external hole to prevent draughts when the lock is not in use. • These normally pivot at the top and are simply swung out of the way when the lock is used and swung back afterwards. • They can also be fitted to the inside of the door.
Cat doors	• An ill-fitting or damaged cat flap is guaranteed to produce a draught. • If yours is broken, replace it with a good quality cat flap with a close-fitting flap and strong return mechanism so it doesn't blow open in the wind.

Curtains and pelmets

Curtains are an effective way of improving your window performance – in summer and in winter – because they keep an air pocket between the curtain and glass. In winter a good thick lined curtain will reduce heat loss through your windows, as well as reducing drafts and the feeling of cold radiating into the room.

The air between the curtain and the pane of glass needs to be still for the curtains to be effective. This means that you should:

- Keep your pelmets to stop cold air escaping at the top.
- Have curtains that go down to the floor to stop cold air escaping at the bottom.

If you have wall mounted radiators, you need to make sure the curtain doesn't cover them – as well as being a fire risk, the heat from the radiator won't move into the room.

Making your own insulated curtains is easy – you can buy the insulating lining and sew it on the back of existing curtains. Velcro strips sewn on one side to the back of the curtain can also be used to tightly fit your curtain around the side of the window frame.

Try curtain banks for a cheap source of second-hand curtains – make sure they fit your windows down to the floor.

Section Two:
Heating and cooling

Typical Home*Smart* features

While new well-designed homes in the northern part of New Zealand should not need any fixed heating source, older homes, and those in the rest of New Zealand, do need to be heated. The major heat sources recommended by Beacon are:

- Solid fuel heating: Ministry for the Environment-approved wood or pellet burners
- Heat-pump: with an Energy Rating of at least 5 stars for both heating and cooling cycles

And for new homes, we also recommend:

- Under-floor heating utilising solar hot water system
- Ground-sourced heat pump system

Features which minimise overheating year round include:

- Overhanging eaves to keep out summer sun from the north
- Awnings and movable shades to keep out low-angled sun on the western side
- Solar powered ventilation units
- Passive ventilation systems such as wooden louvres
- Opening windows with security stays so they can be left open
- Curtains or blinds

Need extra heating?

When it comes to being healthy in winter, one of the most important things you need to consider is having a warm home. The HSS® benchmarks recommend that living room temperatures should be above 18°C from 5pm to 11pm in the evenings, and that bedroom temperatures should be above 16°C from 11pm to 7am overnight. These recommendations match those of the World Health Organisation for healthy indoor temperatures. If you are an older adult, or you have young children, or you are sick, then the minimum recommended temperatures increase to 18°C in the bedroom and 21°C in living areas.

This means that, even if your home is designed to retain as much heat as possible, you may need to heat your home to ensure your family is healthy.

Very few New Zealand homes are consistently heated to these levels. One of the reasons, of course, is that our poorly insulated, draughty homes are really hard to heat! That's why we recommend you increase your insulation as the first step in any renovation. But, unless you have a super dooper, heavily insulated, energy efficient eco home, in most of New Zealand you are still going to need to heat.

A pellet fire provides good background heating

Temperature and moisture

There's a strong link between temperatures in your home and moisture levels. If you have cold temperatures in your house, then the air can hold less moisture and your relative humidity levels increase. The moisture in cold air naturally settles on cold surfaces such as un-insulated walls, ceilings and windows as condensation. This creates the perfect conditions for growing mould – the root of many respiratory illness and asthma, as well some allergies and some forms of gastroenteritis.

Radiant vs convective heat

There are two main types of heating devices:

1. Radiant heaters (e.g. the sun, a wood burner, a bar heater, a flued gas heater)
2. Convective heaters (e.g. a heat pump, oil column heater, wall-mounted panel heaters, night store heaters or a pellet burner).

Some people prefer radiant heat. You sit closer to the heater or fire and you get toasty warm. Some people prefer convective heat, which creates background warmth. Either works well - it's your personal choice what you like.

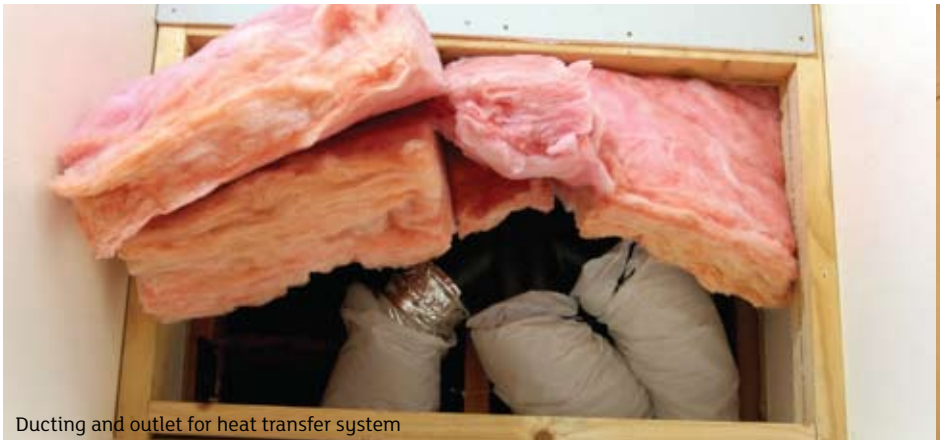
Your main heat source

We generally recommend a large heat source to complement your well-insulated home – a low emission wood burner, a pellet burner or an a 5 star Energy Rated heat pump. All of these methods are efficient ways to heat your home. However, without insulation, a large amount of the heat will be heating the planet (literally) rather than your house.

Generally wood burners and heat pumps have the lowest running costs – though some people find that they heat their home much more with a heat pump and their heating bills increase.

From a sustainability perspective, low emission wood burners and pellet burners are generally regarded as the best option. While wood burners work even when there is a power cut, pellet burners won't unless you have a back-up battery installed.

It's worth reading your heater's manual so you can use your heating system as efficiently as possible. Make use of thermostats and timers, if they are available, to ensure you only heat the room when you need to.



Ducting and outlet for heat transfer system

Heating bedrooms

In some houses, your main heat source will be enough to keep you warm; in others, you might need a heat transfer system to help move the warm air to the bedrooms.

Heat transfer systems have ducting installed into your ceiling, or between floors, with a fan which moves heat from one room to another. They are not a ventilation system or a heating system – they use the heat that is produced by your main heater – e.g. your wood or pellet burner. Heat transfer systems are most commonly used to move heat from the living spaces to the bedrooms. You can buy DIY installation kits from your local hardware store, or get them professionally installed.

Top tips for heat transfer systems

- Heat transfer systems only work well if there is spare heat to move around. If you are under-heating your living area, there won't be spare heat to move to the bedrooms.
- Hot air rises, so you can only transfer heat from downstairs to upstairs.
- It is easier to transfer heat short distances. As the air moves through the ducting from one room to the next, it cools down - if it has to go too far, it won't be very warm when it arrives.
- Transfer the heat to where you want it. If you want to warm your bedroom, make sure that the outlet is in the bedroom – preferably in the middle of the room. Don't transfer heat to a hallway outside a number of bedrooms – it won't make much difference to how warm your bedrooms are if you do.
- Fewer outlets are better than a lot. Transfer the heat to only one or two rooms. If you want to warm more rooms, you will probably need to consider having a second heating device.
- Get a heat transfer system with a thermostat – that way you can set the temperature at which you want it to start transferring heat (Beacon recommends a minimum of 18°C in your main living area) and it will siphon off the excess heat without you needing to think about it.
- Make sure the fan size is sufficient. If you have several outlets, you might need a bigger fan than if you only have one.

Heating bedrooms in the Papakowhai Renovation project

Case study 1: In House 1 the renovations included a change from an old wood burner to a new low emission pellet burner. This was combined with a heat transfer system to the bedrooms. Not only did this see average winter temperatures in the main bedroom rise by 1.5°C but very low temperatures in the bedroom occurred far less frequently. Using the pellet burner more often and for longer will bring even warmer temperatures.

Case study 2: In House 3 the change to a ducted heat pump system (a type of central heating using heat pumps) resulted in significant temperature improvements in both living areas and bedrooms. In fact the average winter temperatures in the main bedroom rose by 3.8°C and sub 16°C temperatures (the minimum for good health) were almost totally eliminated.

This house in the Papakowhai Renovation project combined solar water heating with wood burner and wet back. Over winter, almost all the hot water heating energy was being supplied by the wetback and solar water heater.

Secondary heating

For many people, secondary or spot heating will be needed as well as your major heat source, and different spaces will need to be heated in different ways.

Secondary heating is generally a portable or fixed heater. Don't place these heaters under a window – all the heat will go out it.

Combined water and space heating

Both wood burners and pellet burners are able to have wetback water heaters installed with them to heat your hot water (see p.60). This generally works best where your hot water cylinder is close to the burner (within about 5 metres); otherwise plumbing costs can get high. If you live in an urban area, make sure that your burner will still meet the clean air standards set out by the Ministry for the Environment – visit **www.mfe.govt.nz** to find a list of authorised wood and pellet burners which meet National Environmental Standards.

Choosing the right heater

Choosing a good heater is dependent on many factors, including:

- Upfront cost / ongoing costs. The emphasis should always be on the **combined** costs – particularly as energy prices only go up, not down.
- Size of the space you are heating.
- Levels of insulation.
- Amount of temperature control.
- Occupants' personal preferences and aesthetics.
- Cheap fuel sources (e.g. firewood).

Consumer New Zealand produces useful and comprehensive information on types of heating devices and recommendations on brands of heaters. It also includes a heater size calculator so you can work out what size heater you need for a room. Visit **www.consumer.org.nz**

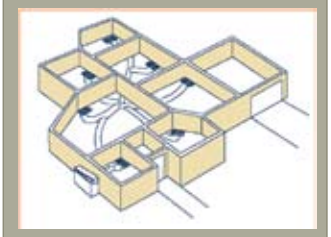
Table 5 lists heaters **roughly** in order of Beacon's recommendations. The **actual** order needs to take into account the preferences and needs of the people in the home.

Table 5: Pros and cons of different heaters

Heater Type	Pros	Cons	Good For
Solar 	• Free, renewable, no greenhouse pollution.	• Requires thought in design process. • Not always available on the colder days. • Only heats during the daytime. • Generally insufficient to heat a whole home unless it is very heavily insulated (well beyond Building Code) and carefully designed.	• A well-chosen section and a well-designed building with good year-round sun. • New houses and major extensions.
Enclosed wood burner 	• Near-carbon neutral and renewable heating. • Cheapest heater to run. • Works even in a power cut. • Can be combined with a wetback to provide hot water heating. • Wide range of models available (8kW – 30kW) means most houses can be heated by a wood burner.	• Generally are large heaters – at least 8 kW - which can result in hot spots if the heat is not moved around though open doors or through a heat transfer system. • Does require a dry space for storing wood. Stacking, chopping and moving wood are required. • Older models and those burning damp wood can contribute to air pollution.	• Heating large areas. • Where wood is cheap or freely available. • Areas with poor electricity security.
Pellet burner 	• Very clean burning. • Easy fuel source to handle and control. • Can heat very large spaces. • Carbon neutral and a renewable heating type. • By buying bags of pellets, heating costs can be managed on a weekly budget, although pellets are cheaper to buy in bulk. • A fairly cheap way to heat. • Can be combined with a wetback to provide hot water heating also. • Are controlled by thermostat - some models have timers and remote controls to tailor operation.	• Requires electricity to run. • A limited range of wood pellet suppliers. • Convective heat rather than the radiant heat of a wood burner. • To warm whole house, heat needs to be moved around through open doors or a heat transfer system. • Smaller output than wood burners (mostly 8kW -15kW) means large houses may need more than one pellet burner.	• Heating large areas

One house in the Papakowhai Renovation project upgraded from an old wood burner to a ducted heat pump system. This brought both much warmer indoor temperatures in winter and a 62% saving on heating costs. However, with the heat pump also used to cool the house over summer, the household saved only 9% on their annual power bills.

Heater Type	Pros	Cons	Good For
Heat pump  	• More efficient than other electric heaters and very efficient models are now available. • Highly controllable with a thermostat setting and, in most models, a timer for switching on and off to suit needs. • Able to act as an air filter as well. • A safe form of heating (fewer chances of accidental burns or fires than other types of heater).	• Efficiency reduced when outside temperatures drop below 7°C which increases running costs. • Can stop working completely in deep snow or in very cold, humid conditions. • Given they are essentially a one room heater, they are expensive to install. • Can be noisy (particularly for neighbours). • Running costs, if used for cooling in summer, can negate any energy savings from winter. • Heating costs can be higher than expected for those who have changed from a wood burner as their main heater or who have increased the amount that they heat. • Must be installed by a qualified installer. • Completely reliant on electricity supply.	• Room-specific heating. • Areas (such as Christchurch) where there are severe air pollution problems. • Houses with small sections/limited room for storing wood or pellets. • A good money saving option for people who are currently heating a lot with electric heaters.
Flued gas 	• Fast. • Responsive. • A good use of gas (compared with burning it to make electricity in power stations).	• Unknown future in terms of supply. Not a renewable resource. • Gas prices are now high, and line /bottle hire charges mean it's expensive if you are only using gas for heating. • Generally, will only heat one room.	• A range of space sizes. • A good option if the house is already hooked up to the gas supply.

Heater Type	Pros	Cons	Good For
Central heating 	• A range of fuel types possible (e.g. heat pumps, gas, diesel, wood pellet). • Will heat the entire home to an even temperature. • Can be timed to come on and temperature set using a thermostat.	• Not easy to retrofit into existing homes. • Heat losses occur from ducting under the floor or in the ceiling.	• Highly controlled heating. • If the homeowner is always at home.
Central heating with radiators 	• A range of fuel types possible (e.g. electric, gas, wood, pellet, solar hot water). • Controllable with thermostat and timer settings (some cover 7 days to allow weekend and weekday settings).	• Still expensive to retrofit in this country. • Radiators can take up space in the house.	• Heats the whole house in a controlled way.
Electric convection (e.g. oil column, fan) 	• Quiet. • Can be operated on off-peak rates. • Generally has a thermostat and some have a timer setting.	• Only good for smaller spaces. • Provides indirect heat.	• Background heating of bedrooms.

Heater Type	Pros	Cons	Good For
Electric resistive (bar) 	• Highly responsive. • Provides more direct heat – a good single person heater.	• Fire risk. • Not very adjustable. • Heats a person, not a space.	• Houses which have very good insulation, and where spot heating of a person is desired.
Under-floor heating 	• A range of fuel types possible (e.g. electric, gas, diesel). • Controllable with thermostat and timer settings (some with room-by-room control).	• Not possible to retrofit to existing homes without substantial renovation. • Although fairly maintenance free, expensive to repair if something does go wrong. • Not very responsive – takes time for the heat to build up. • Carpeting over heated floor will trap heat under-floor.	• If the homeowner is always at home. • Houses with very good under-floor insulation.

Top tips for efficient heating

- Put heaters away from windows so they heat the room more effectively.
- Turn off heaters in rooms you're not using.
- Use the thermostat and timer on your heaters so they only come on when you need them and automatically switch off when they reach a certain temperature.
- Use a heat transfer system to move heat from a central main heater to bedrooms.
- Use smaller spot heaters to warm bedrooms.
- Don't heat hallways; the heat will not get into bedrooms.

Unflued gas heaters – don't use them!

These heaters, either the portable LPG ones, or fixed LPG or piped gas heaters, are considered to be a real bugbear. They are banned in most developed countries, for good reason.

They emit gases into the air of your home:

- nitrogen dioxide
- carbon dioxide
- carbon monoxide

These gases are bad for your health, particularly for people with asthma or respiratory illness. That's why the Ministry of Health issues warnings to only use these heaters in a well-ventilated space.

Unflued gas heaters produce about a litre of moisture into the air for each hour of use. Moisture brings condensation, mould and mildew, which are also bad for your health (see Section Three, p.43). A common response to the dampness is to run a dehumidifier as well. Dehumidifiers are expensive to run – they cost between $0.14-$0.42 per litre of water removed. This creates a 'hidden' cost of keeping warm.

With recent increases in gas prices, unflued gas heaters are actually a more expensive form of heating than most other methods.

If you have one, **don't run it,** and we urge you to take it to the tip (or scrap metal recycling centre).

Using temperature sensors to manage your indoor temperatures

If you are interested in monitoring your own home's performance on an ongoing basis, there is a range of temperature sensors and loggers which you can purchase from hardware stores and electronics shops.

While you can get quite technical – using loggers to collect your data over time - one of the most useful things is a real time temperature sensor, which is commonly and quite cheaply available in many hardware and electronics stores.

One type, available in New Zealand, is an indoor/outdoor sensor. If you look at these several times a day, they provide the snapshot information you need to manage temperatures in your home.

The inside temperature lags a couple of hours behind the outside temperature. In summer, when you see it heating up outside, open windows and close the blinds on the western and northern sides of the house to keep the sun out. In winter, look at the indoor temperature first thing in the morning to see if you need to do some more heating.

Top tips to managing temperatures

You can ensure your home retains warmth by:

- Opening curtains to let the sun in during cooler months.
- Shutting curtains and windows once the sun goes down and temperatures drop – use your temperature sensor to tell you when your indoor temperatures are dropping
- If you have an entry hall, keeping the doors through to living areas shut off when the front door is open.
- Closing the doors of rooms that you're heating.

You can cool your home by:

- Closing curtains on the northern and western sides of the house during the summer months.
- Opening windows and doors on the opposite sides of the house to allow cross ventilation.
- Leaving high windows open while you are out or installing security stays on windows so they can be left open.
- Leaving windows open overnight to allow the house to cool.
- Leaving doors open in the house to increase airflow.

Keeping cool in summer

Getting the ventilation right in your home can have a big impact on temperature – at 50% relative humidity, a ventilation rate of 0.5 metres per second feels like a drop of 3 degrees in temperature.

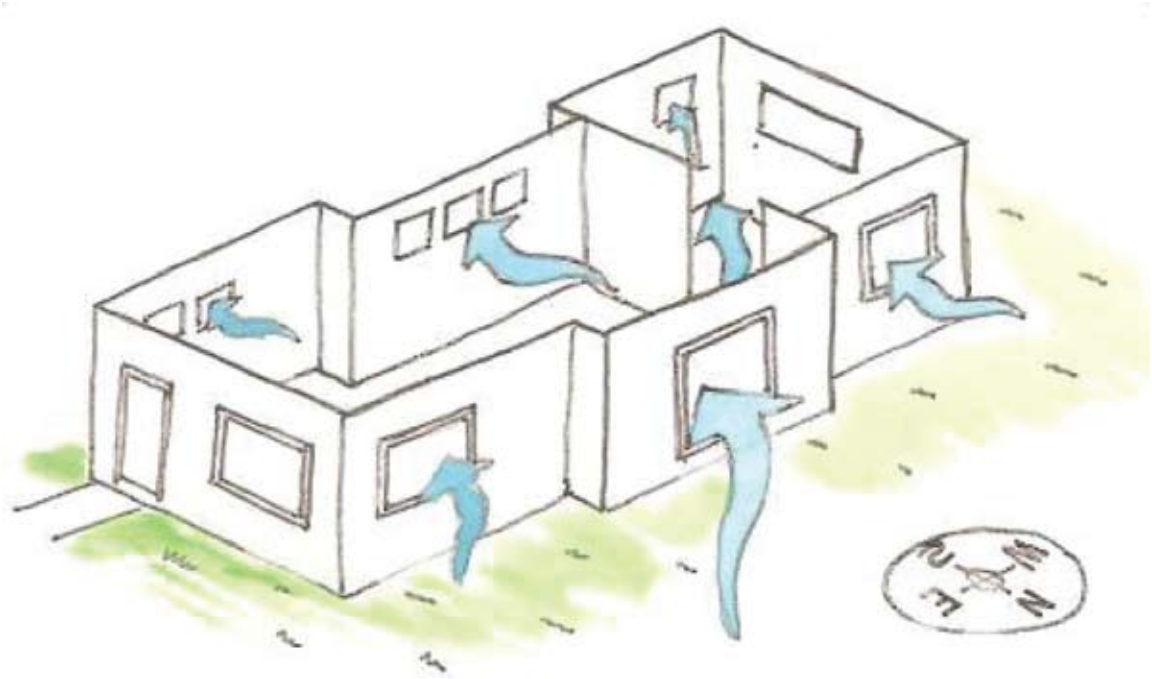
One of the most effective ways of cooling your home in summer is to leave windows open overnight. Try and take advantage of the natural draughts flowing through your house – by leaving open internal doors, higher windows, and windows on the opposite sides of the house. Opening windows on opposite sides of the house will also allow you to take advantage of cooling breezes. When designing a new home or undertaking renovations, include larger windows opening to the breeze and smaller, higher windows on the walls on the opposite side of the house.

Allowing air to escape through higher windows is known as **passive stack ventilation** and gives you a cooling up-draught. In hot climates, it's also useful to ventilate the roof spaces as otherwise the heat gets trapped in the cavity. Many older homes were designed with roof vents to take advantage of passive stack ventilation and get rid of this hot air.

If you are concerned about security, there are easy-to-install security stays available from your local hardware store.

You can also include passive ventilation in the form of vents in your window frames or louvres, or by installing a solar powered ventilation system. If you have these, make sure they are on or open over the summer.

The aluminium window frames in the Waitakere NOW Home® included passive vents that allowed air flow even when the windows were closed.



Source: www.smarterhomes.co.nz

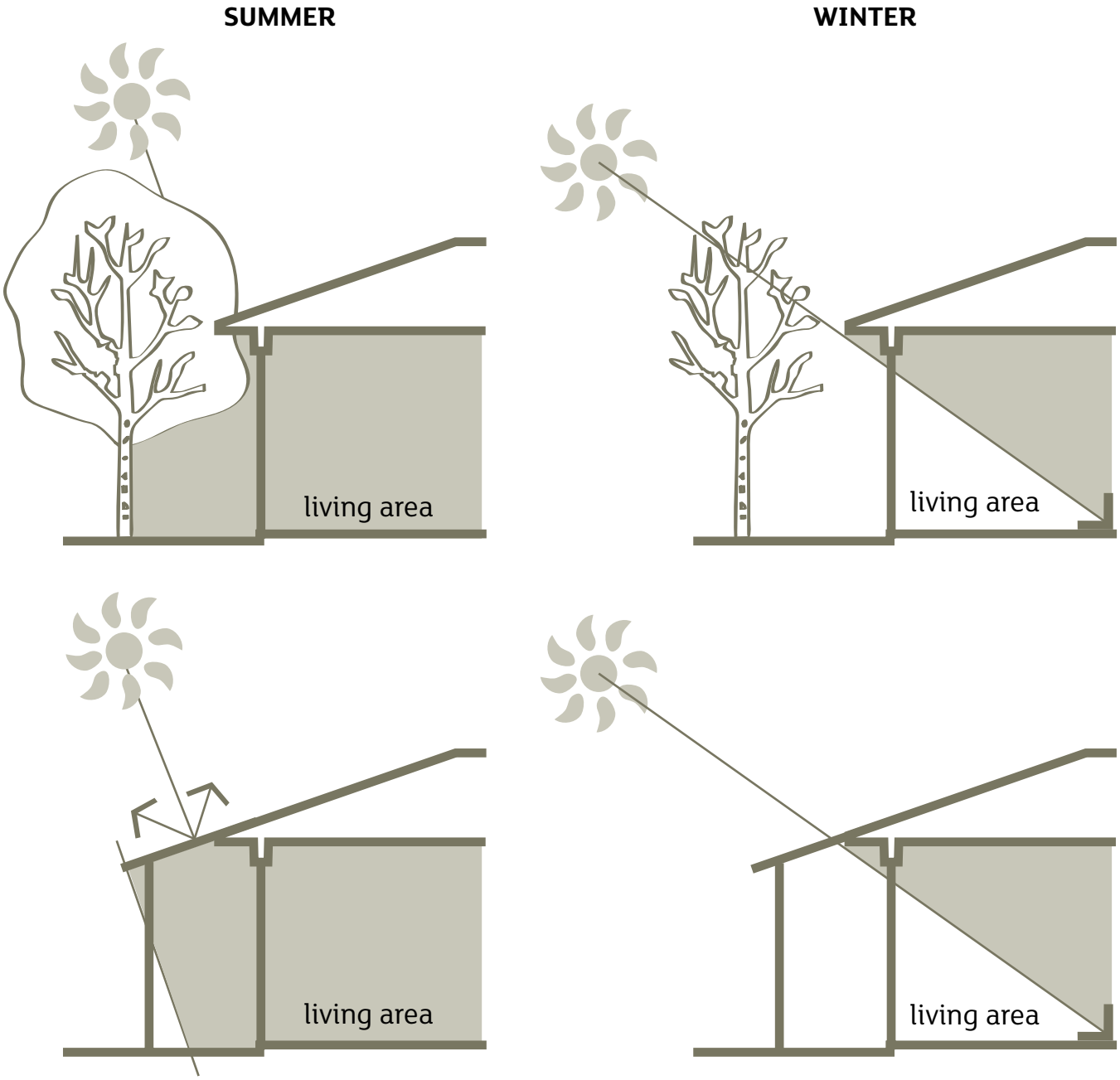
Shade

With a well-insulated house facing north, you may still need to actively control shading. In general, you'll need some form of shading above doors and windows on the east, north and west side of the house. The size and type will depend on your circumstances.

Window shading helps to reduce glare and keep indoor temperatures at comfortable levels by minimising the amount of late afternoon sun falling on your windows. Ideally you should not have large areas of western-facing glass, but if you already do, then shading these areas (with an awning or deciduous trees) to block out late afternoon sun is a good idea.

Shading options include:

- Eaves
- Pergolas
- Fixed louvres
- Covered balconies or deep verandas (e.g. a balcony on the north side of your home could block winter sun)
- Awnings
- Shutters



Source www.yourhome.gov.au

Curtains and blinds

If you can't shade from the outside, then the next best option is to install thick thermal curtains or blinds – as well as keeping your home warm in winter, they help to stop the sun getting in and overheating your house. In summer, it's a good idea to adjust the east-facing and west-facing curtains daily to block out unwanted sun. You may want to adjust east-facing curtains to keep out all morning sun but open them in the afternoon to let in some light. You may want to leave west-facing curtains down all day to keep out sun that might otherwise cause overheating.

If you'll be out all day in summer, it can be a good idea to leave the curtains closed all day.

Active cooling

If you still feel that you need to cool your house, then the most energy efficient option is to use fans – either ceiling mounted or portable fans you can move around the house as needed. If you have a heat pump, try not to use it as an air conditioner – but if you do, make sure your doors and windows are closed, and only use it to cool spaces you are using.

Top tips to keep cool

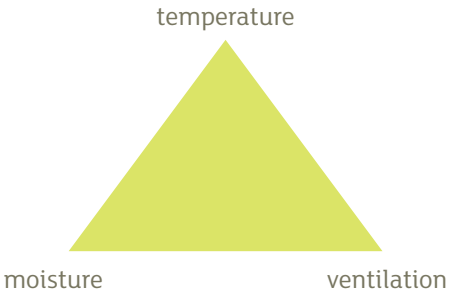
- Shut curtains on the western side of the house in the afternoon to keep the sun from overheating the house.
- Plant deciduous trees or install shades on the northern and western sides to keep the sun out in summer, but let it in over winter months.
- Open windows on both sides of the house to let a breeze through.
- Use security stays on windows to leave windows open overnight and through the day.
- Include higher windows or roof vents to let hot air out of the house.
- Use portable or ceiling fans rather than air conditioning.

Section Three:
Keeping healthy indoors

We spend most of our lives indoors, especially if we are very young, ill or elderly. Evidence is increasingly showing the link between indoor environment and health, and it is not just about cold living conditions, it is about the air we breathe and the fact that we are 1000 times more likely to breathe pollutants indoors.

Achieving a healthy indoor environment is a balance of temperature, moisture and ventilation.

Addressing some simple principles will bring healthier living conditions inside your home.



Typical Home*Smart* features

- Rangehood in kitchen vented outdoors
- Bathroom fan vented outdoors
- Solar powered, roof-mounted ventilation systems
- Opening windows, with top windows able to be left open
- Passive vents such as window inserts
- Under-floor vapour barrier
- Clothes dryer vented outdoors
- Clothesline outside
- Low toxicity materials e.g. Environmental Choice certified paints
- Good drainage and management of stormwater runoff so it keeps away from the house
- Good maintenance of roof, gutter and downpipes to keep water out of the house

Temperature

We've already covered keeping warm in winter (see Sections One and Two). Beacon recommends that living areas should be above 18°C between 5pm and 11pm in winter and that bedrooms should be above 16°C between 11pm and 7am. New Zealand's homes are often below this. Recent New Zealand research on insulation and health has shown that internal air temperatures below 12°C can have a significantly detrimental impact on health.

And it's not just a matter of warmth. Cold air holds far less moisture than warm air. In cold temperatures the moisture naturally in the air settles on cold surfaces such as un-insulated walls, ceilings and windows as condensation. Condensation and cold are the perfect conditions for growing mould which thrives in humidity greater than 70% on cold surfaces with condensation potential.

Mould, with its tiny spores, is at the root of many respiratory illnesses and asthma as well as some forms of gastroenteritis. Fungi growth affects about 40% of New Zealand homes and can cause adverse health effects such as respiratory illnesses, asthma and allergies. Dust mites also thrive in humid environments, exacerbating asthma and allergies.

This is why our first priority for renovation is keeping your home warm. Follow the advice in Sections One and Two to achieve this.

Our second priority is to reduce indoor moisture and ventilate your home.

Moisture and dampness

Dry your house out and keep it dry

Eliminate unnecessary moisture sources such as unflued gas heating (see page 37). Check for drainage problems, badly fitting windows, and plumbing and gutter leaks in and under your house – get them fixed. This may seem basic but it can make a big difference. In the Home*Smart* Renovation project:

- 23% of homes had dampness under their floors.
- 6.3% had leaking roofs.
- 16% had water coming in through windows and door.
- 22% had leaking gutters.

Up to 30kg of water can be released by damp soil under a house every day. This phenomenon, known as rising damp, is a major cause of mould growth in homes. Remove any soil in contact with the cladding and remove anything blocking under-floor vents.

You can minimise ground-sourced moisture by laying a sheet of polythene on damp ground beneath the house. This is sometimes called a moisture or vapour barrier. Available from most hardware stores, about $120 will cover the cost of polythene and tape needed for a medium-sized house or flat. Here's how to do it:

- Fold the polythene out away from you to provide a smooth clean surface.
- Lap and tape joints.
- Tape around piles.
- Run a few centimetres up the edge of the walls.
- Weigh down with bricks or stones.

Some people use a dehumidifier to remove moisture from the air, but we suggest that you eliminate moisture sources (as above) and improve ventilation in wet areas (see p.45) **before** considering a dehumidifier. If you do use a dehumidifier, ensure the water collected is emptied frequently and close your windows and doors when running it.

Mould a major concern

Most homeowners that Gary Robertson, of Community Energy Action in Christchurch, visited as part of the Home*Smart* Renovation assessments were concerned about mould in their bathrooms – it is a visible sign of damp homes. Mould caused by dampness underneath homes is a common problem in Christchurch.

"A lot of people are surprised to find that the dampness under their home is not caused by a plumbing leak but by a high water table and that this won't 'dry out' necessarily in summer," says Gary. This dampness can be easily solved by installing a polythene vapour barrier.

Many homeowners also don't realise that activities such as drying washing inside make the air in the house damper and contribute to mould growth. Gary finds most people are relieved to hear that, rather than just cleaning off or putting up with the mould, they can actually take action to stop or reduce the growth.

Top tips for reducing indoor moisture

- Fix any leaks or stormwater drainage problems.
- Make sure your windows and doors are weather-tight.
- Regularly air your home - open windows and doors to replace stale air with fresh.
- Cover pots when they're boiling on the stove.
- Dry clothes outside – not inside.
- Avoid over-watering indoor plants.

Ventilation

Ventilation is important because it:

- lowers humidity and reduces mould.
- makes homes easier to heat.
- makes home healthier.
- reduces over-heating in warmer weather.
- dilutes pollutants (although it is always better to avoid them in the first place).
- provides fresh air.

Ventilate to remove moist air

Passive ventilation, as described in Section Two, p.39, will also contribute to addressing condensation and dampness in your home. Window vents or louvres will help bring fresh air into your home. Equally, a solar powered ventilation system can be useful to control airflow through your home to maintain comfortable temperatures and get rid of moisture.

Control moisture at its source with mechanical ventilation. Install and use bathroom extractor fans and kitchen rangehoods when showering or cooking. Vent your clothes dryer outside the house. Make sure all extractor fans and rangehoods are not vented into the roof space as that will allow moisture to accumulate and damage your internal roof structures.

You can also take action to ventilate your home. All houses need to be aired so open the windows regularly during the winter to remove stale air. Consider security stays so the house can be ventilated when you are not at home.

Control indoor pollutants at source

Building and home interior materials may contain solvents and chemicals that can release fumes for years after construction. Some of these chemicals have been linked to asthma and skin conditions. Others - if breathed or ingested - may have more harmful effects.

Indoor pollutants are 1000 times more likely to be inhaled than outdoor ones. Pollutants include volatile organic compounds (VOCs), respirable particulates, gases, fungi, bacteria and dustmites.

VOCs are commonly found in paints and varnishes, carpets and vinyl floors, fabrics, adhesives and cleaning products. They are highest after a home has been built or renovated. While many are in low concentrations, together they can form a potent cocktail of harmful compounds, causing nose and throat irritations, respiratory problems and also cardiovascular disease.

When renovating or building, look for products and materials that:

- Are pre-dried or quick drying.
- Are breathable.
- Use water as the solvent. Water-based products have lower solvent emissions and are less harmful to use and dispose of.
- Use natural, plant-based ingredients.
- Are classed as having zero or low VOCs.
- Are Environmental Choice certified. Such products have low levels of VOCs and hydrocarbon solvents; and no heavy metals, formaldehyde or harmful solvents. See the Environmental Choice New Zealand website - **www.enviro-choice.org.nz.**

ENVIRONMENTAL CHOICE NEW ZEALAND
Cert.TM

Top tips to reduce indoor pollutants

- Don't use paint as a sealant.
- Choose Environmental Choice certified products.
- Let new furniture and carpeting air in a well-ventilated and dry area outside the home before installing and using it. This is known as off-gassing
- Ventilate your home following renovations, especially if they include painting, redecorating or installing new flooring, such as pressed wood or carpeting. Don't use rooms which have just been painted. Ideally renovations and redecoration should be conducted in summer to enable plenty of ventilation with outdoor air. Especially consider airing babies' rooms before your baby arrives.
- Ventilate while you are redecorating or doing any hobbies that can produce VOCs. Close doors to other parts of the home to avoid dispersing contaminants to other areas.
- Maintain sure your living areas are always well-ventilated and ventilate kitchens, ensuite, laundry and bathrooms when these rooms are in use. Ventilate most when outdoor air temperature is within the range of 16°C – 25°C.
- Avoid using cleaning products, such as floor polishes, that can contribute to VOCs.

Renovating in baby steps: Lisa's story

It's amazing what we're prepared to put up with; then along comes baby and the same conditions are no longer acceptable. Set on the south side, our small office (soon to be baby room) was sweltering in summer and arctic in winter.

We added floor, ceiling and wall insulation stripping out the room, fitting battens and building paper for ventilation, installing insulation, re-lining, plastering and painting. Finishing touches included a low VOC acrylic paint and draught-stopping the windows. We ventilated the room for a couple of weeks before moving baby in so she didn't breathe any fumes produced by all the new materials.

The little heater now warms the room, even on the coldest night. And the under-floor insulation has stopped the musty, damp earth smell coming through the floor boards. We're now happy to tuck our new addition into her cot at night, confident that she's sleeping in a warm, dry, healthy environment.

Considering a whole house mechanical ventilation system?

Whole house ventilation systems are increasingly being promoted as the solution to house performance problems such as dampness and cold. However, very little research has been done to show what sort of houses, climates and situations they work in. They're also a very expensive item to install for an uncertain outcome. Research done by Beacon shows they are often being installed in homes where ventilation is not a problem, as most New Zealand homes are quite draughty. In the homes Beacon has looked at, condensation problems were caused by:

- Lack of insulation
- Not enough heating
- Uncontrolled moisture sources (leaks, ground water, unvented wet areas)

Our research shows that during the day in winter there is more moisture in the roof space than in the house. Operating a ventilation system during the day actually brings more moisture into the house, making it more expensive to heat your home. At night the air in the roof space is drier but much colder. Operating a ventilation system at night replaces warm air with cold.

When it comes to moisture removal, the actions we do recommend (getting rid of moisture sources by extractor fans, vapour barriers under the house, drying clothes outside and making sure dryers are vented to the outside, getting rid of unflued gas heaters, insulating, and regularly airing your house) are cost effective and proven methods for reducing moisture in all houses. These actions should be undertaken before considering a whole house mechanical ventilation system.

Heat or energy exchange ventilation systems pre-warm the incoming air from the heat or energy in the outgoing air. These systems are most effective in very airtight, new, well-heated homes in very cold parts of the country. Most existing homes are not airtight enough, even if they have full wall insulation and window replacement.

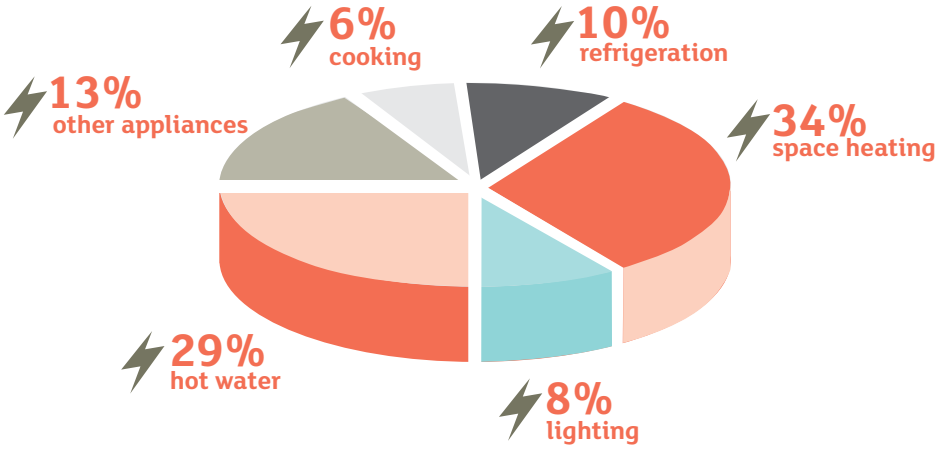
Our recommendation: If you are thinking of installing one of these systems, address moisture sources and insulation levels in the home first. Get your house tested for draughts (often called a blower door test) and only consider one of these systems if your house is quite airtight.

More information:

- Read our research at **www.beaconpathway.co.nz /further-research/article/testing_ventilation_systems**
- EECA have recently produced a research report on roof space systems, which you can read at **www.eeca.govt.nz/sites/all/files/home-ventilation-systems-09.pdf**

Section Four:
Energy saving

Here's where your energy is typically used:



The changes you have already made by keeping the heat in your home and selecting efficient heating will also reduce your energy use. You can further save on your power bills by making more energy-efficient choices in appliances and lighting, and by changing your habits. Keen energy savers can also consider generating their own energy via photovoltaic systems.

Typical Home*Smart* features

- Energy monitoring device
- Energy-efficient washing machine
- Energy-efficient dishwasher
- Energy-efficient fridge/freezer
- Energy-efficient light bulbs

For energy generation:

- Photovoltaic solar power system

For hot water savings

- A solar, heat pump or wetback hot water system
- Water-efficient washing machine (3 star rated under the Water Efficiency Labelling Scheme)
- Water-efficient dishwasher (3 star rated under the Water Efficiency Labelling Scheme)
- Water-efficient tap mixers and shower heads (3 star rated under the Water Efficiency Labelling Scheme)

Managing your energy use with an energy monitoring device

Energy monitoring devices such as a Centameter are designed to help you save power by being able to constantly monitor how much you are using and spending on electricity.

You clip the sensor over the main power feed into your house, and then put the monitor somewhere where you will notice it. You can programme the meter with your own per-unit power charges, so you can track how much it is costing to you to run your house.

A useful thing to do is to watch the meter as different appliances are working, so that you can see what the biggest power users in the house are. For example, generally a microwave will use a lot less energy than an oven. The Centameter also has a temperature display on it, so that you can see what the temperature is in the room which it is located.

You can buy a Centameter on **www.centameter.co.nz/**

Choosing energy-efficient appliances

When you are replacing your appliances, check the Energy Rating label – this uses a simple star rating. The more stars on the label, the more energy efficient the appliance is compared to similar models.

The labels also give you an energy consumption figure. This tells you how much electricity the appliance typically uses to run in a year, in kilowatt hours (kWh). The lower the number, the less the model will cost to run and the lower the environmental impact.

You can use the energy consumption figure to work out how much it will cost you to run the appliance. Multiply the consumption figure by your electricity tariff (including GST). You'll find this tariff, or unit cost, on your electricity bill.

Also look for the Energy Star mark. This is a global mark of energy efficiency, typically awarded to the top 25% most energy efficient products in a category. You can find a list of Energy Star products on the Energywise website (**www.energywise.govt.nz**)

Appliances that use electricity when you think they are off

This is called standby electricity. Most appliances that you can switch off with a remote keep using electricity, slowly but steadily, often without you realising. If your appliances' lights and clocks are on, they're using electricity. The average household could save around 4% on their electricity bill if appliances on standby were switched off.

Home entertainment products account for around half of standby electricity use in the home. These include:

- Televisions (especially large rear projection, flat screen or plasma TVs)
- Audio equipment
- DVD players
- Games consoles
- Set-top boxes

Other products that could be wasting electricity in standby mode could include:

- Computers
- Home office equipment
- Microwaves
- Washing machines
- Dishwashers

Turning off appliances at the wall when you're not using them will make a noticeable saving to your energy bill over a year. Alternatively, devices are now available to allow you to switch off the power to multiple devices with just one click of the remote control. The Conserve Surge Protector, for example, cuts off or activates the power that flows to devices plugged into Switchable outlets, while devices such as DVRs or routers can be plugged into the Always-On outlets, since they require a continuous power supply.

Using energy-efficient lighting

A good starter is to maximise natural lighting – it will not only save you money, but natural daylight is better for your health and productivity. You should aim not to need electric lighting between 9am-4pm all year round (except on overcast winter days). If you have an area without access to windows, you can bring natural light in using a Solatube skylight.

There are two main types of energy-efficient lighting currently available – compact fluorescent bulbs (CFLs) and LED lighting.

Light emitting diode (LED) lamps are extremely efficient and have a very long life (approximately 50,000 hours). You should be able to fit-and-forget them. They cost little to run as they use less electricity than any other lighting option.

Compact fluorescent lamps (CFLs) use about 80% less electricity than standard incandescent bulbs which turn only about 5% of the electricity they use into light. Although standard incandescent bulbs are cheap to purchase, the equivalent CFL will cost you far less money in the long run. Not only will it use less electricity, a quality CFL will last between 6,000 and 15,000 hours. CFLs now come in a wide range of colours, shapes, sizes and with increased functionality and choice.

Avoid using downlights unless it is on a bottom storey, as they allow heat to escape from your home. See page 24 for more information.

To find out more on efficient lighting options, visit **www.rightlight.govt.nz**

Visitors to the Waitakere NOW Home® are impressed at the light provided for the kitchen by a Solatube skylight.

Top tips for energy efficient lighting

- Maximise the natural light you get into your rooms.
- Switch off any lights that you're not using and take advantage of natural lighting whenever possible.
- Use energy-efficient lightbulbs. Modern CFLs deliver as a high a quality light as traditional incandescents and last longer as well.
- Clean your lights and lampshades regularly to get the maximum light.

Energy saving tips

Top tips for energy-efficient fridges and freezers

- Check the temperatures with a fridge thermometer. Freezers should be between -15°C and -18°C, while fridge compartments should be around 2°C to 4°C.
- Check your fridge door seals properly – if not, your fridge will be using more energy than it needs to. You can check it by turning a torch on, putting it inside your fridge and closing the door. If you can see the torchlight, your seals need replacing.
- Notice if your fridge or freezer is running continuously or nearly all the time - it may be faulty and costing you a lot of money in wasted energy.
- Defrost your fridge or freezer regularly – it will be more efficient to run. You can reduce ice build-up by keeping food covered and wiping moisture from bottles and other containers before you put them back in the fridge.
- Avoid opening the fridge doors more than you need to.
- Leave space around the back of your fridge or freezer for air to circulate.

Top tips for energy-efficient cooking

- Defrost food naturally instead of using the microwave.
- Use a microwave or toaster instead of the oven or stovetop whenever you can. If you are using your oven, cook several things at once.
- Avoid opening oven doors too often - each time you do, the temperature drops by up to 15°C.
- Keep lids on the pots when you are cooking and match the size of pot to the size of element.
- Keep oven seals clean and fitting.

Top tips for energy-efficient appliance use

- Use the power options on your computer to save electricity when you're not using it. You can choose the amount of time after which your computer does simple tasks like turning off the monitor and hard disks.
- Turn off chargers at the wall when batteries are fully charged e.g. cellphones and laptops.
- Wait until the dishwasher is full before you use it - and use the economy cycle.
- Don't overload your washing machine (although it's better to wash full loads than half loads) and don't forget to adjust your wash cycle to match the load. Use shorter wash cycles if possible.
- Dry washing on your clothesline as often as possible. Relocate your line if it is not in a sunny place
- If you're using the clothes dryer, fill it - it's more efficient to dry a full load.
- Use the low heat setting on your dryer whenever you can.
- Clean your dryer's lint filter every time you use it.

Generating your own energy

Solar modules (known as Photovoltaics - PV) generate electricity for your home using the most abundant energy source on the planet, the sun. They are silent, consume no fuel and generate no pollution. They also contribute to the reduction of greenhouse gas emissions; a 2kW PV system on a house will prevent the emission of about 40 tonnes of CO_2 during its projected 30 year lifetime. Furthermore, the use of PV will reduce your electricity bills and exposure to fluctuating and steadily rising electricity prices. It can be connected into the electricity grid, so when you aren't using all the power, you can sell it back to the grid.

A photovoltaic system consists of solar panels, an array frame to hold the panels, and an inverter. The inverter is necessary because most household appliances use alternating current (AC) electricity, which is what comes out of the power point of a mains-grid connected house. However, the batteries used in a stand alone system supply (DC) electricity. To make conventional appliances run in a stand alone system, this DC electricity must be converted to AC. This conversion is done by an inverter. The inverter is connected to the battery bank, and provides mains-type AC electricity to the system. The inverter needs to be sized to suit the system's electrical requirements.

A photovoltaic system will require some monthly and annual maintenance; check your instruction manuals.

Photovoltaic systems can be expensive and are likely to be an option only for the most dedicated renovator. Consequently we have only included limited information here. You can find more information about photovoltaics at:

- **www.energywise.govt.nz/how-to-be-energy-efficient/generating-renewable-energy-at-home/solar-electricity-generation**
- **www.smarterhomes.org.nz/energy/generating-your-own-electricity/photovoltaic-cells/**
- **www.level.org.nz/energy/renewable-electricity-generation/photovoltaic-systems/**

Photovoltaics used in first Home*Smart* Home

The first home built by the New Zealand Housing Foundation to Home*Smart* Home specifications include photovoltaic energy generation.

The house features a grid linked solar power system capable of producing in excess of 2100 kilowatt hours per annum:

- The solar modules comprise 8 Sharp 175W 24V panels, and are fastened onto the roof using a solar array frame.
- The DC power produced by the solar panels is fed into a SMA Sunny Boy 1700 inverter which "inverts" the energy from DC to 240V AC.
- The resulting energy is connected to the switchboard in the house and then either used to meet the power needs of the home, or "fed" into the grid for a credit on the power bill.

This home is being monitored over a year – results of the monitoring will be available at **www.beaconpathway.co.nz**

Saving with hot water

Hot water heating typically uses a third of the energy needed to run a home in New Zealand. Using renewable and energy-efficient hot water systems is one of the easiest ways to make substantial improvements in energy efficiency in your home – and save money off your power bill. If you are able to make use of the free energy from the sun to heat your water, it's also a great way to future proof your home – regardless of energy price increases.

29%
of your total power bill will be for heating water

Because the electric hot water cylinder was invented here, they are still very widely used. However, electric and gas hot water cylinders are not a very efficient way to heat your water - that's because they have what are called standing losses where heat is being lost from the cylinder.

Old hot water cylinders are un-insulated, and their standing losses are very high, meaning you use a lot more energy to keep the water hot. More modern (post 2005) hot water cylinders are quite well insulated, but even these have standing losses. Beacon recommends that all electric hot water cylinders have a hot water cylinder wrap and that hot water pipes (which also lose heat) are lagged with thick insulation (see p.56). If your cylinder is more than 10 years old, you should plan to replace it, preferably with a more efficient hot water system such as solar, a heat pump hot water system, or a wetback.

Wrapping your own hot water cylinder and lagging the pipes

Hot water cylinder wraps and pipe lagging are widely available from hardware stores. First check what size hot water cylinder you have. Most electric hot water cylinders are either 135 litres (small) or 180 litres. New cylinders may be larger than this. It is worth wrapping even new hot water cylinders.

To install a cylinder wrap, you need to have good access to the cylinder. You will need at least 5 cm all around the cylinder - more will make the installation easier. If you have easy access to the cylinder, installing a wrap is not difficult and takes about two hours.

To lag pipes, you can buy foam tube pipe insulation from your local hardware store or plumbers' merchants. It's important to wrap the first metre of the hot water pipe from the cylinder as this is where most heat loss occurs.

Top tips for wrapping your hot water cylinder

- Lag your hot water pipe first.
- Check for leaks and that connections are in good condition - if there is a problem, get this fixed first.
- If you need to cut your wrap down to size, mark it up first using a knife, and cut over a timber surface.
- If it's tricky to get the wrap around, you can tie a cord to a bottom corner of the wrap to help pull it round the cylinder.
- Tape the join together near to where the thermostat and element control box are, so they can be accessed in the future if you need to.

Important: Gas hot water cylinders should not be wrapped as they need ventilation to be safe, but you can still lag the hot water pipes.

Case study: Hot water cylinder wraps are a great energy efficiency measure

In terms of value for money, hot water cylinder wraps and pipe lagging remain a fantastic investment. Nine houses in Beacon's Papakowhai Renovation project, with cylinders ranging in age from 1970s to 2005, had their pipes lagged and cylinders wrapped.

This proved worthwhile in all cases, boosting efficiency between **11%** and **30%**. In fact, the cylinder wraps appear to be worthwhile even on modern A-grade cylinders, particularly if only low volumes of hot water are used.

Types of hot water system

Hot Water System Type	Description
Low pressure electric cylinder	• Widely installed – most older hot water cylinders (more than 10 years) are of this type. • Are often small (135 litres). If you regularly run out of hot water, this is probably what you have. • Low pressure hot water systems also often can only run one tap at a time at a good pressure of hot water. There are some low pressure cylinders which give you high pressure delivery (indirect mains pressure cylinders); however, these are less energy efficient as they are often operated at high temperatures. • Electric hot water cylinders are very energy inefficient, and older systems are poorly insulated so have a lot of heat loss. • If you are replacing your electric hot water cylinder with another one, then you can get better insulated (and larger) low pressure hot water cylinders, but even a new cylinder will benefit from a hot water cylinder wrap. • Modern hot water cylinders last 12-20 years.
High pressure electric cylinder	• Most modern electric hot water cylinders are high pressure/mains pressure cylinders and most are 180 litres or bigger. • Generally mains pressure systems can cope with several hot taps being turned on at once without a drop in pressure. • These systems are more expensive than low pressure cylinders. • Sometimes, when upgrading, the change (from low pressure to high pressure) can put stress on your plumbing, and leaks can develop, or even pipes blow. • Like low pressure electric hot water cylinders, these are energy inefficient and even new, better-insulated cylinders will benefit from a hot water cylinder wrap. • Modern hot water cylinders last 12-20 years.
Instant electric hot water	• These are relatively uncommon in homes, though can be used for small systems. • They heat the hot water at the time it is required, rather than leaving it to sit around all day, so are more efficient than electric hot water cylinders. • However, they generally require heavy duty electrical wiring which is not normally used in residential situations. • Because they heat at the time you want it, the electricity will often be charged at peak rates, so they can be an expensive way of heating your water. • They are best used as a supplementary system where the outlet is a long way from the main hot water system.

Hot Water System Type	Description
Gas cylinder	• These systems are slightly more energy efficient than an electric hot water cylinder. • They also have high heat losses but, because they need to be ventilated, they can't have a hot water cylinder wrap installed. • They need to be located in a well-ventilated area (e.g. a basement) and so can often lead to long pipe runs – with associated heat losses. They also need to be flued to remove exhaust gases. • They have a quicker heat recovery time than a comparable electric hot water cylinder. • If you have several gas appliances, a gas cylinder will likely be cheaper to run than an electric cylinder; however, if you only use your gas for hot water, it will be more expensive – gas daily connection fees are high.
Instant gas hot water	• Water is heated when you turn on the hot tap. • Some systems have controllers which enable you to choose the delivery temperature, e.g. 41°C for shower, 38°C for bath. This reduces the waste of heating water to high temperatures, and then cooling it by adding cold water. • Having no hot water cylinder means no standing losses. • Most efficient systems can have a COP of 0.95 – where 95% of the energy you put into the water is turned into heat. • If you have several gas appliances, will likely be cheaper to run than an electric cylinder; however, if you only use your gas for hot water, it will be more expensive – gas daily connection fees are high.
Wetback	• Wetbacks generally provide a boost to the water heating system, particularly in the winter when most required. • They can be used in conjunction with wood burners or pellet burners. • They are most useful in areas with a cold climate and a long heating season, and where the wood burner heats the house well, so there is surplus energy to heat the water. • In areas with low winter sunshine (e.g. Dunedin/Southland), wetbacks can be a good combination with solar hot water to get year-round hot water. • They are also very useful in areas with low security of energy supply and abundant wood, enabling a greater degree of self sufficiency and resilience. The wood heating component is generally regarded as carbon neutral. • If retrofitting a wetback, generally they should be within 5 metres of your hot water cylinder, or plumbing costs can be high. • Modern wetbacks are more efficient than older ones, and have fewer air emissions. • If you live in an urban area, your burner and wetback must comply with National Environmental Standards for emissions (see **www.mfe.govt.nz**).

Hot Water System Type	Description
Heat pump hot water	• These are relatively new type of efficient electric hot water system. • An all-in-one system has the heat pump as part of the hot water cylinder. These are normally located outside so it's important that hot water pipes are lagged, and they are located near to where the hot water is needed. • Split systems have the heat pump part located outside and the hot water cylinder (which can be a modern electric cylinder) located inside the house. • The outside unit can be quite noisy – so think of your neighbours and your own night time comfort when locating them. • They work most efficiently at warmer temperatures (above 6-7°C) at which they are up to 2-3 times better than standard electric hot water cylinders; however, they may not be suitable for very cold climates. They are particularly suitable for temperature to warm climates where solar is not appropriate (e.g. where there is a shaded roof or installation of solar would be difficult). • Although they are a lot more expensive to purchase than a standard electric hot water cylinder, their efficient operating costs mean that they are a good investment. • Not all systems are created equal – Consumer New Zealand (www.consumer.org.nz) has looked at their efficiency and recommended some systems ahead of others. The cheapest system could be a lot less efficient than one that costs only a little bit more.
Solar hot water	• These are the type of hot water system most commonly recommended by Beacon. • A good installation should be able to deliver 75% of hot water heating for free, throughout the year, in most of the country. • There are two types of systems – one where the solar panel and cylinder is on the roof (a thermosiphon system) and one where the hot water cylinder is inside the house (an active system). Beacon generally does not recommend thermosiphon systems because there can be a lot of heat lost from the hot water cylinder being placed outside on the roof. • Solar hot water cylinders are larger than conventional hot water cylinders (normally around 300 litres) but, in colder areas, it is recommended that you get a system with the cylinder inside, or there will be more need for boosting. • Boosting can either be done by gas or electricity, and in areas with low winter sunshine, a combined solar/wetback system can give year-round hot water. • Because of the energy and greenhouse gas emission savings from using solar hot water, there are government subsidies available for their installation. Subsidised systems are listed on the EECA website (www.solarsmarter.govt.nz). • Solar hot water is most easily incorporated into a new house, and they can be expensive to retrofit.

Table 6: Types of hot water system

Wetbacks

A wetback is a useful way to heat water in winter if you have a wood burner and a reliable source of dry, untreated wood. You can also use a wetback with a pellet burner. If you live in an urban area, the burner and wetback must meet Ministry for the Environment National Environmental Standards for emissions. See **www.mfe.govt.nz** for a list of authorised wood and pellet burners. A building consent is required when installing one.

Wetbacks can complement solar water heaters since they are used in winter when the sun is weaker. This is a particularly good option in areas with low winter sunshine (Dunedin and Southland) giving year-round hot water and good security even in the face of power cuts.

Some types of burners-wetback combinations produce a high proportion of their output as hot water. These are best suited to houses where space heating demand is lower (e.g. warmer climates – and well insulated houses).

Case study: Wetback and solar in a Papakowhai renovation

One home in Beacon's Papakowhai Renovation project had its B grade wrapped hot water cylinder replaced by a combined solar hot water system, wetback and new 300 litre cylinder.

Monitoring showed a significant saving in hot water energy bills of ~70% over winter. During May-September, almost all the hot water heating energy was being supplied by the wetback and solar connections.

Heat pump hot water

Heat pump hot water systems are a relatively new form of efficient hot water heating, with 2-3 times the efficiency of an electric hot water system, depending on the system. There is a subsidy from the government for installing heat pump hot water systems – see **www.energywise.govt.nz** for more information.

Heat pump systems work best when:

- You live in a warmer climate. They operate best when temperatures are greater than 6-7°C - and some of the more commonly installed systems have very poor efficiency at low temperatures.
- Solar hot water isn't feasible, either because your roof is shaded in winter, you don't get enough sunshine hours, or it is too expensive to install in your existing home.
- You are low hot water users.
- You mainly use hot water during the day.

There are two types of systems – all-in-one (e.g .Quantum, Seibel Eltron) or split systems (e.g. Econergy). The all-in-one systems are a combined heat pump hot water cylinder which is installed outside. These systems can be noisy so think of yourself and your neighbour's night time rest when locating them. Split systems have the heat pump box outside and the cylinder inside, and can be installed on an existing modern electric hot water cylinder.

It seems to be common practice for systems to be installed without hot water pipe lagging. However, we recommend you make sure your hot water pipes are lagged or you will lose heat and efficiency.

Because, on average, about a third of your electricity bill is hot water costs, you should see a reduction in your electricity bill. However, with the larger hot water cylinder size, it's easy to end up using more hot water – and therefore losing any electricity savings.

Because these are a relatively new technology, it's worth choosing your system carefully as they are not all as good as each other. Consumer New Zealand (**www.consumer.org.nz**) has tested some of the main systems available and found that the most efficient clearly outperformed the other systems. This was particularly the case at lower temperatures.

Solar hot water systems

Solar hot water systems are the first choice of hot water system from a sustainability perspective. A good installation - well sized, well installed, with a good controller - should deliver up to 75% of your hot water, for free, year round. New Zealand is a sunny country, and even our less sunny areas (Dunedin and Southland) have more sunshine hours than countries like Germany, where solar hot water is commonly installed. Because of the energy and greenhouse gas emissions saved, there is a subsidy from the government for installing solar hot water – see **www.solarsmarter.org.nz** for more information.

This display in the Waitakere NOW Home showed the homeowners exactly what temperature their solar system was providing

Solar hot water is not suitable for everyone – it works best when:

- You have a sunny location with year round sun and you live in a high sunshine area (this includes most of New Zealand).
- There is sufficient area of roof exposed to northerly sun year round. South facing houses, or those shaded by trees, buildings or hills might not get enough sun to make solar hot water worthwhile.
- There is a high demand for hot water. Generally the more people in the house, the more cost effective solar hot water is. It's particularly good for high hot water users or houses with four or more people.
- You mainly use hot water during the evening.
- Quiet operation is important.

Visit **www.beaconpathway.co.nz/further-research/article/choosing_the_right_renewable_energy_source_for_your_site** for a checklist which will help you decide if your site is right for solar hot water.

When choosing a system you will need to decide on:

- The system type – thermosiphon or active. Thermosiphon systems have the hot water cylinder on the roof, active systems locate the cylinder inside. In colder climates, active systems are better as there are high heat losses having a cylinder on the roof. Thermosiphon systems also require a more complex building consent to ensure that your roof can the take the weight of the cylinder.
- The installer. Make sure that your installer is well qualified and has a lot of experience in installing solar hot water systems. Research shows that the quality of installation is the biggest factor in how well your system will perform.

Top tips for getting the most from your solar water heater

- Control your supplementary heating using timers and control to exclude electric supplementary heating in the morning. Solar water heaters allow for electricity to kick in and heat the water if there is not enough sun. But if your system immediately re-heats your water with supplementary electric heating after early morning water use, you miss out on using solar energy to re-heat the water during the sunny parts of the day.
- Look for a system that provides information about how your system is operating to get a better understanding of when your household needs hot water and when the sun provides it.
- Ensure your solar panel (collector) is installed at the same angle as the latitude of your location to get the best year-round performance.
- Ensure that the collector area is sufficiently large for the demand required.
- With a larger collector area, you will also need a larger hot water cylinder (300 litres) to ensure you can store the water heated during the day for later use when hot water is required.
- Ensure that insulation levels on cylinders are appropriate for New Zealand conditions and that pipe run lengths are kept short and well-insulated to minimise heat loss.

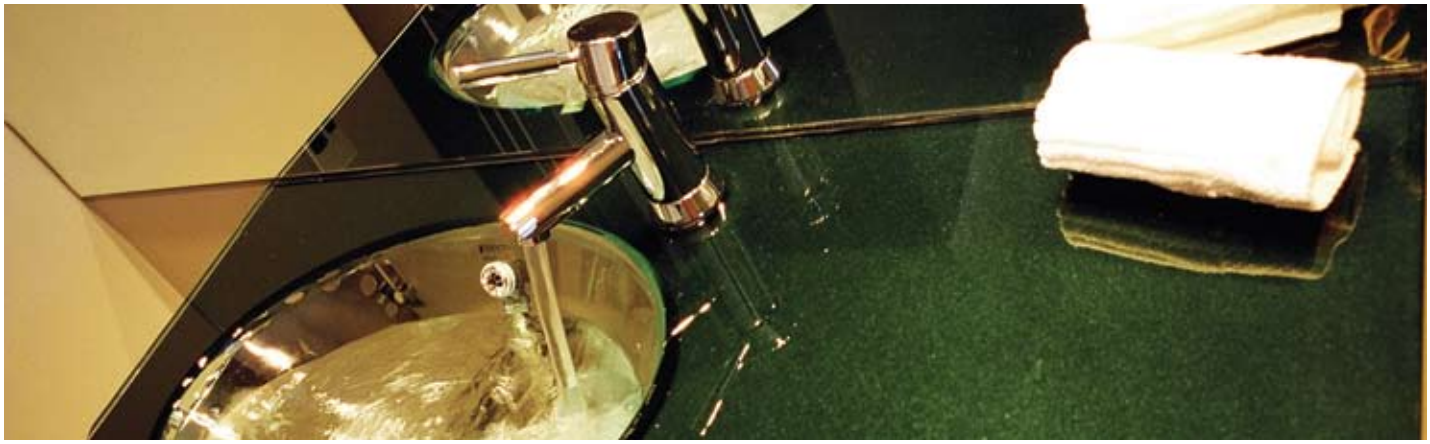
Case studies: Three examples of solar water heater installation

As an example from Beacon's earlier research projects, two of our solar water heating systems (the Waitakere NOW Home® and the Rotorua NOW Home®) were installed at shallow angles. They provided only 45% and 36% of hot water energy, compared to 75% from the well-angled Papakowhai panels.

The Waitakere NOW Home panels were only installed at 20° in line with the roof. It should have sat at 37°. This system provided only 45% of water heating.

The Rotorua NOW Home panel was limited to 30° by the framing that it came with. It should have been at 38°. This system provided only 36% of water heating. The outdoor cylinder also had the most heat loss.

The Papakowhai panels sat at 41° to match the latitude of the site. Two twelve-tube panels formed a large collection area, and were matched with 300 litre indoor cylinders. These systems provided 75% of hot water.



Saving water means saving on water heating

The less hot water you use, the less water will need to be heated. That's why the water saving devices such as low flow shower heads and taps will also save you on power bills.

Top tips for saving hot water

- Adjust the thermostat on your hot water cylinder so that is at 60°C – higher temperatures waste a lot of energy.
- Switch off your hot water cylinder if you're away for more than two weeks.
- If designing a new hot water system, aim for short pipe runs by locating your hot water source close to the kitchen, bathroom and laundry.
- If you change hot water systems from a low pressure to a mains pressure system (this is normal if you replace your hot water cylinder), install a water-efficient shower head and taps at the same time.

Section Five:
Water saving

In New Zealand, we're surrounded by water. It's easy to think of it as a free resource - one that will never run out. But that isn't entirely the case. Increasingly, towns and cities are facing water shortages. Some will have to invest in costly new infrastructure in coming years to ensure that supply can keep up with demand.

Already, many New Zealanders pay directly for the water they use. That trend is set to continue. The good news is that reducing your demand for water can be simple. Something as basic as fixing a leaky tap can make a difference. The costs of reducing water use can be minimal, yet the benefits are significant.

Typical Home*Smart* features

To use less water:

- Water-efficient washing machine (3 star rated under the Water Efficiency Labelling Scheme)
- Water-efficient dishwasher (3 star rated under the Water Efficiency Labelling Scheme)
- Water-efficient tap mixers
- Dual flush toilets (4.5/3 litre flush)
- Water-efficient shower heads

To use free water:

- Rainwater tank for the garden (2000 litres)
- Rainwater tank plumbed to the toilet and laundry (4000 litres or larger)
- Greywater system for toilet flushing and/or garden watering

Using less water

Water-efficient appliances

When buying appliances, tap and shower ware, and toilets, check their star rating under the Water Efficiency Labelling Scheme – the more stars the more water efficient the appliance is. Currently WELS ratings are under the Australian system and can be accessed at **www.environment.gov.au/wels_public/searchPublic.do**. However, New Zealand is joining the scheme and, from 1 April 2011, all imported and manufactured appliances and fittings will need to be rated.

Low flow taps and showerheads

You can save a lot of water by simply changing your showerheads and taps to more water-efficient, low flow models. A tap aerator will deliver 6 litres per minute, compared to 12-20 litres per minute delivered by many taps. A standard showerhead uses about 15 to 25 litres of water per minute. A 3 star rated water-efficient showerhead uses as little as 9 litres per minute – without compromising quality of the shower – saving about 14,500 litres per household each year.

In-sink waste disposal

While it's tempting to use in-sink waste disposal units, it's best to try not to. They waste a lot of water and can overload sewerage systems. A better option is to compost your food waste.

Top tips to save water

Your actions can also reduce your water usage. In areas where water is metered, this will directly reduce your water bills. However, because electricity is used to heat your water, many of these steps will also reduce your electricity bills.

- Check for leaks inside and outside home. Use your water meter to check for leaks:
  - Turn off all your taps and water-using appliances and make sure that the toilet cistern has stopped filling. Now read your water meter - it is generally close to the street. Read it again after an hour - without using any water in the meantime. If the reading has changed you are losing water somewhere.
- Fix all dripping taps.
- Use the plug rather than running water, when you're washing, doing dishes or cleaning vegetables.
- Use modern dual flush toilets to reduce the amount of water used in each flush.
- Only wash full loads in dishwashers and washing machines.
- Washing your car with a bucket of warm water and only use the hose for rinsing.
- If you need to water the garden, choose water-efficient irrigation. There is more information about this in a Waitakere City Council brochure on Gardening With Water (**www.waitakere.govt.nz**)
- Choose native and drought-resistant plants for your garden.

If there is a water meter in your home, you can use it to gauge your daily water use and make changes accordingly.

Using free rainwater

A rainwater collection system collects rain from the roof (via gutters and pipes). This water flows through screening devices to remove dirt and debris. The water is then stored in a tank outside the house. There are two main types of rainwater systems – where the rainwater tank provides water for the garden, and where rainwater is used for both indoor and outdoor water uses. Read more at **www.smarterhomes.org.nz/water/collecting-and-using-rainwater/**.

The average household can use untreated rainwater for about 65% of usage - toilet flushing, washing machine, and garden taps. If adding a rainwater tank to an existing home, the actual percentage you will achieve, and the cost, will depend on how practical it is to access the relevant pipes.

Case studies: Saving water with rain tanks

In the Waitakere NOW Home®, a 13,500 litre rain tank was installed to supply all except drinking water. Monitoring showed the tank supplied 47% of the home's water needs in year 1, and 52% in year 2. As their water supply is metered, this represents a considerable savings on water bills.

Beacon's second research home was in Rotorua where the year-round rainfall meant a smaller tank (4000 litres) supplied 72% of household needs for garden taps and toilet flushing. A controller proved to be effective at optimising when rainwater was used as opposed to mains supplies.

It is possible, and legal, to use rainwater for potable supply where the city supply is available -- however, you must treat it to potable standard, you need building consent, the initial cost is higher because of filtration and sterilisation, and you will be committed to more maintenance.

Installing a rainwater tank or barrel for outdoor use

You can install either a rain barrel (generally about 240 litres) or a rainwater tank (500 litres +) for garden watering. Gravity-fed systems (without need for a pump) will need the barrel or tank on a stand. Because a litre of water weighs a kilo, a rainwater tank stand needs to be fairly robust, and should be concreted into the ground. It will need to be over 30cm and less than 1 metre high.

Ideally you should include a mesh grate to prevent leaves from entering the barrel or tank (this can be fitted in the guttering) and you will need down-pipe fittings. You might need to get these from a specialist plumbers' store; though in the provinces, they are also available at your local hardware store.

It's best to locate the tank in a cool place, out of sunlight, to stop algal growth. An overflow outlet and access for cleaning is also important.

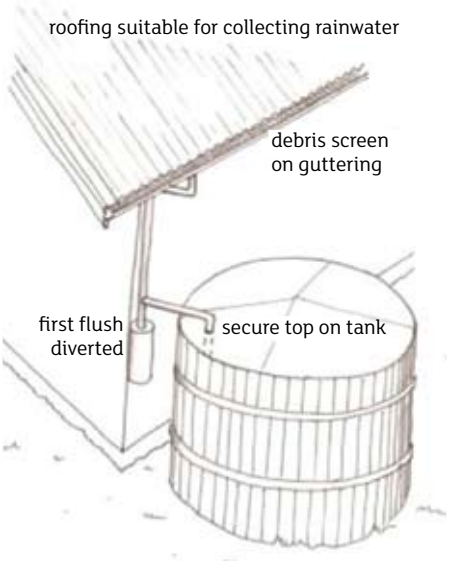
Installing rainwater tanks for indoor use

If you are connected to town water supply, then you can only use rainwater for some indoor uses – toilet flushing and doing your laundry. Other household uses such as drinking, bathing and use in the kitchen should continue to be supplied by town water. If you are connecting your rainwater system to household plumbing then you need a building consent. You may also need a building consent to install the tank.

An indoor-outdoor rainwater system will also need a pump to operate. You will also need a larger tank than for an outdoor only system. In areas with year-round rain, a 5000 litre tank will provide a good proportion of your water use. In areas with dry summers, a much larger tank will be required.

Include leaf catchers and a first-flush diverter. These reduce the need for maintenance - especially if there are trees nearby. Pruning any tree branches overhanging the roof is a good idea.

Again, it's best to locate the tank in a cool place, out of sunlight, to stop algal growth. An overflow outlet, and access for cleaning is also important.
Source **www.smarterhomes.org.nz**



Treatment of rainwater

There are two types of system which can treat rainwater to drinking-water standard. Many of both sorts are installed and successfully operating in the Auckland region.

1. **Ultrafiltration** removes everything down to 0.2 microns (which includes viruses). An example of such a system is at **www.homespring.co.nz/main.cfm?id=29**. The advantages of ultrafiltration are low maintenance and low energy consumption. The disadvantage is regular automated backflushing which uses more than 40 litres of water per day.
2. **Ultraviolet treatment systems** use UV light to kill contaminating micro-organisms. The disadvantages of UV treatment are the need for pre-filtering down to 1 micron (meaning filter maintenance) and slightly higher energy consumption. There are several suppliers of such systems, for example, **www.idswater.com/water/australia/taylor_purification/water_filter_units/2987_0/directory_listing.html**, and **www.contam.co.nz/**.

Maintenance of your rainwater system – non-potable supply

Regular maintenance is important to keep the supply clean. It will save time and frustration in the long run. You should:

- Keep the roof clear of overhanging vegetation, particularly before the autumn leaf-fall
- Regularly check the roof and spouting for debris, especially before and after a storm.
- Make sure your roof remains clean, especially from bird droppings. When cleaning the roof and spouting, ensure the wash water doesn't go into the tank.
- Check your gutters and downpipes for obstructions every few months, and clean out any leaves or mess.
- Regularly check and maintain leaf screens and filters.
- Wash out first-flush diverters every three or four months – this only takes 10 minutes.
- Drain and clean your tank every five years if your maintenance is optimal, more often if you do not regularly remove sludge and sediment.
- Inspect your tanks for any cracks and leaks, particularly before it gets dry over summer.
- Check the condition of pipes, fittings and structural supports.

Maintenance of your rainwater system – whole-of-house supply

If you use rainwater for whole-of-house use, regular maintenance is vital for health, even if you have sterilisation equipment. Maintenance will save costs and time, and prevent bad odours, tastes, and frustration in the long run. First-flush diverters seriously reduce bacterial contamination: do include them in the system.

Maintenance should include the maintenance needed for non-potable supply (listed above) plus:

- Service sterilisation equipment as recommended by the supplier
- Regularly check for sludge build-up in the tank

Using greywater

Greywater is the wastewater from the shower, bath, washing machine and taps (not including the kitchen). Just over half of the water used in your home ends up as greywater. In homes without greywater systems, this water ends up in the sewer. Your greywater system will collect this wastewater for use in the toilet or for underground garden irrigation. Mains supply is still used for drinking, bathing, cooking and other uses requiring treated water.

Installing a greywater system

If you are thinking of installing a greywater system, check with your local council first. If you are on town sewerage, then some councils won't allow you to install a greywater system. You will need a building consent.

There are two main types of systems – those that use greywater for toilet flushing (e.g. EcoPlus) and those which use greywater for garden irrigation (e.g. Watersmart). Because the water must be used within 24 hours (or it starts to smell), you will need to have a bypass system which enables you to send the greywater to the council sewer.

In general, a garden greywater system will divert water from your washing machine, shower, bath or basin so that solids such as lint and fats are filtered out. Care needs to be taken when cleaning and maintaining systems (e.g. avoiding contact with solids that can be composted or disposed of). After filtering, the water then flows to a storage tank or directly through an irrigation system to your garden. Whatever type of system you use, the greywater should be discharged below ground, not directly onto the surface of the soil to avoid the risk of people being exposed to bacteria in the greywater. There's also a risk of the greywater pooling on the ground.

Maintenance of greywater systems

Greywater systems require a regular schedule of weekly, six monthly, and annual maintenance. Check your instruction manual carefully and keep up the maintenance.

Top tips for using a greywater system

- Make sure faecal matter - for example, from children's baths or from washing nappies - is diverted to the sewer or on-site sewage system.
- Use appropriate soaps and detergents - avoid washing powders that whiten or have enzymes, and avoid detergents or cleaners containing boron.
- Don't use too much greywater on your garden - if water ponds, harmful microbes can multiply, creating a potential health hazard.
- You may want to divert the first flush of water from your washing machine into the sewer to reduce the amount of chemicals you are putting on your garden
- Take advice about planting - some plants do not thrive in alkaline conditions and greywater tends to be alkaline. You may need to change plants or avoid watering such plants with greywater.

For more information, visit:

- **www.waitakere.govt.nz/CnlSer/wtr/wstewater.asp#alternative**
- **www.waitakere.govt.nz/AbtCit/ec/bldsus/pdf/water/wastewtr.pdf**
- **www.smarterhomes.org.nz/water/on-site-sewage-systems/**

Section Six:
Waste, maintenance and project management

Reducing your household's waste

Typical Home*Smart* features

- Under-sink waste bins
- Plenty of room for compost or worm bins

Waste is one thing every home and household produces. It is what you do with it that makes the difference to our landfills and environment.

Kitchen/garden wastes

First, try not to use a in-sink waste disposal unit. They waste a lot of water and can overload sewerage systems. A better option is to compost your food waste.

Have a look at your rubbish bin in the kitchen. Is there space to separate your waste? Ideally, you should have three bins: "general recyclables", "decomposables/ organics", and finally one for "landfill". You can buy bins which are already split into compartments, or you can just adapt your existing bins.

Organic waste

A significant amount of household rubbish is organic waste such as food scraps and garden waste. You can use it to fertilise your garden. The best way to decompose this waste is by using worms or having a compost heap.

If you are interested in making a **worm farm**, it is best to use Tiger worms, which quickly transform scraps into compost. They can be bought at garden centres and environmental centres. Purpose-built worm farms can be bought – or you can make your own.

Make sure the worm farm is in a sunny spot.

Worms will eat food scraps (cooked and raw), tea bags, coffee grounds, bread and other organic waste. However, limit the quantity of citrus product, onions and garlic. Do not include meat scraps, dairy products or oils.

If you are interested in making a **compost bin**, you will need about 1m^2 area in your garden. You have the option of making one yourself or buying one from a garden centre.

Make sure the compost bin is in a sunny spot.

You can add food scraps, tea bags, coffee grounds, bread, citrus, onions and garlic. Do not include meat scraps, dairy products or oils.

Recyclables

You can find out more about recycling through **www.plastics.org.nz** and **www.reducerubbish.govt.nz**. Check your local council website for information about recycling collections in your area.

Waste to landfill

Once you have composted all your food scraps, set aside hazardous waste for collection and separated your recyclables, there will still be some waste left. This is what gets sent to landfill with your usual collection.

By doing all of the above, you will probably find that your general waste volume is much smaller: a real saving if you are paying for collection. The environment will benefit as less waste means each landfill will last longer, with fewer valleys being filled in. Reducing how much of your waste goes to landfill is a great way to help the environment.

Hazardous wastes

Hazardous wastes include: waste oil, petrol, batteries, fluorescent light bulbs, pool chemicals, petroleum-based solvents, storage containers from paints, adhesives and varnishes, acidic cleaning products, garden sprays etc. Hazardous wastes should be stored in a secure (i.e. lockable) outside space such as a garden shed or garage.

Hazardous wastes need to be disposed of carefully as they can be very dangerous if they are not contained properly. Check on your local council website for information on hazardous waste collection in your area.

Never dispose of hazardous materials with ordinary wastes, and never tip paint, oil or other chemicals down a stormwater drain – they'll end up in your city's streams and waterways.

Construction waste

One major contributor to our landfills is waste from construction, renovation and demolition, which forms up to 50% of all waste generated in New Zealand. One study calculated that building an average three-bedroom home generated six tonnes of construction waste, of which up to 85% could be reduced, re-used or recycled.

You can help to reduce this by encouraging your builder and other trades to have a waste management plan and to reuse or recycle building materials and construction waste where possible.

Your builder should follow REBRI (Resource Efficiency in the Building and Related Industries) guidelines for waste management (see **www.branz.co.nz/rebri**). These provide information and advice on:

- What materials can be recycled or salvaged.
- How to find markets for your recycled material.
- How to design and select products to minimise waste.
- How to develop a waste management plan.
- How to set up a waste management system.
- How to separate and store waste.

Reducing construction waste in the Waitakere NOW Home®

Every effort was made during the construction of the Waitakere NOW Home® to reduce the amount of waste sent to landfill. The waste both generated and recycled was weighed to find out how successful those efforts had been.

Careful design and accurate quantity surveying were the first steps toward minimising waste. The room sizes in the Waitakere NOW Home® were based on standard GIB® wall lining sizes to reduce plasterboard waste. Framing timbers were pre-nailed off-site to reduce timber off-cuts.

The waste that was generated on-site was sorted and, where possible, materials were re-used, or recycled.

- Timber off-cuts were used for noggins, jack studs and blocking, and any untreated timber was used as firewood.
- Excess polystyrene insulation was delivered to a recycling company.
- Plastics (coded no. 1 and no. 2), and aluminium cans, were recycled using the local kerbside recycling scheme.
- Clear plastic wrap and ferrous metals were also separated for recycling.

Only the remaining materials were sent to the landfill.

Maintaining your home

Regular maintenance will make your home last longer and increase its value. Through regular maintenance, you can identify work that needs to be done in advance, whether the job is small or large. Maintenance is also important for the performance of your home. Small problems, such as leaks or draughts, can affect how well your renovations to improve your home are working. Leaky roofs, for example, will undo the good your ceiling insulation does, as well as damaging your home in the long term.

The good news is that a lot of maintenance is quite easy to do yourself. Much of it we have already covered, so this serves as a reminder to do it regularly.

We suggest you keep a maintenance log cataloguing what was done, by whom and when. Keep the log somewhere all the adults in the home know about, and hand it over when you sell the house.

Maintenance	Why it is important?	How often?
Clean your gutters of leaves and silt.	Make sure your gutters can carry away rainwater without overflowing into your home.	Beginning of winter.
Prune any trees away from your roof.	Reduce leaves in your gutter and rainwater system. Get winter sun into your home.	
Check your roof for popped-up nails, loose tiles and cracks in cement.	Prevent leaks into your home.	Get these fixed before winter.
Have your chimney/flue swept regularly.	Get maximum warmth in a safe environment from your wood or pellet burner.	Beginning of winter.
Check and repair your stormwater drains. Clean out any sludge.	Ensure they work efficiently to get water off your property.	Before winter.
Wash your roof and walls and treat any moss and lichen.	Prevent damage to your roof and walls which lets in water	
Check doors and windows for draughts. See Section One, p.24 for more information on how you can do this.	Keep the heat in your home to be warmer and make more efficient use of your heating.	Before winter – ideally when it's still warm and dry.
Check all your windows to make sure they shut securely. Replace catches if necessary.	Keep the heat in your home to be warmer and make more efficient use of your heating.	
Clean and check all aspects of your rainwater tank system. See Section Five, p.69 for more information on this. Any water treatment systems will need more regular care.	Prevent leaks and overflows of water into your home or property. Ensure clean water for use.	Yearly.

Maintenance	Why it is important?	How often?
If you have a greywater system, this will need regular maintenance. See Section Five, p.70 for more information.	Ensure your systems work as efficiently as possible.	Some systems need weekly maintenance such as using chlorine tablets.
Replace filters in heat pump and ventilation systems.	Ensure your systems work as efficiently as possible to use less energy and be more effective.	Yearly or more frequently as per your system instructions.
Clean outlets and intakes in ducted and heat transfer systems.	Ensure the systems work effectively and avoid spreading dust.	Every few months.
Clean outlets and intakes in extractor fans and rangehoods.	Ensure they work effectively to take moisture out of your house.	Every few months.
Clean any solar panels for solar hot water or photovoltaics.	Maximise the solar gain your systems can get.	Yearly.
Check in your ceiling and under your floor to make sure your insulation is still in place. Rearrange it if it has been shifted. See Section One, p.20 for more information on how to do this.	Keep as much warmth in your home as possible.	Yearly, and after you have had any work done in these areas.
Clean materials and finishes, both inside and outside the building.	Materials will last longer, especially to prevent corrosion in metals which are not rain washed.	Yearly.
Clean any mould off walls, ceilings and windows. See the infobox below for tips on how to do this.	For better indoor health.	As soon as you notice it.
Check the battery in your smoke detectors.	Safety	Every six months.
Emergency first aid/food kit.	Safety	

Top tips for cleaning off mould

Many of our homes suffer from mould and damp. A tip for cleaning mould off walls, ceilings and windows is to use a solution (about half and half) of white vinegar and water, and sponge off the mould. This actually kills the mould spores - much more effective than a commercial mould cleaner, which just bleaches them.

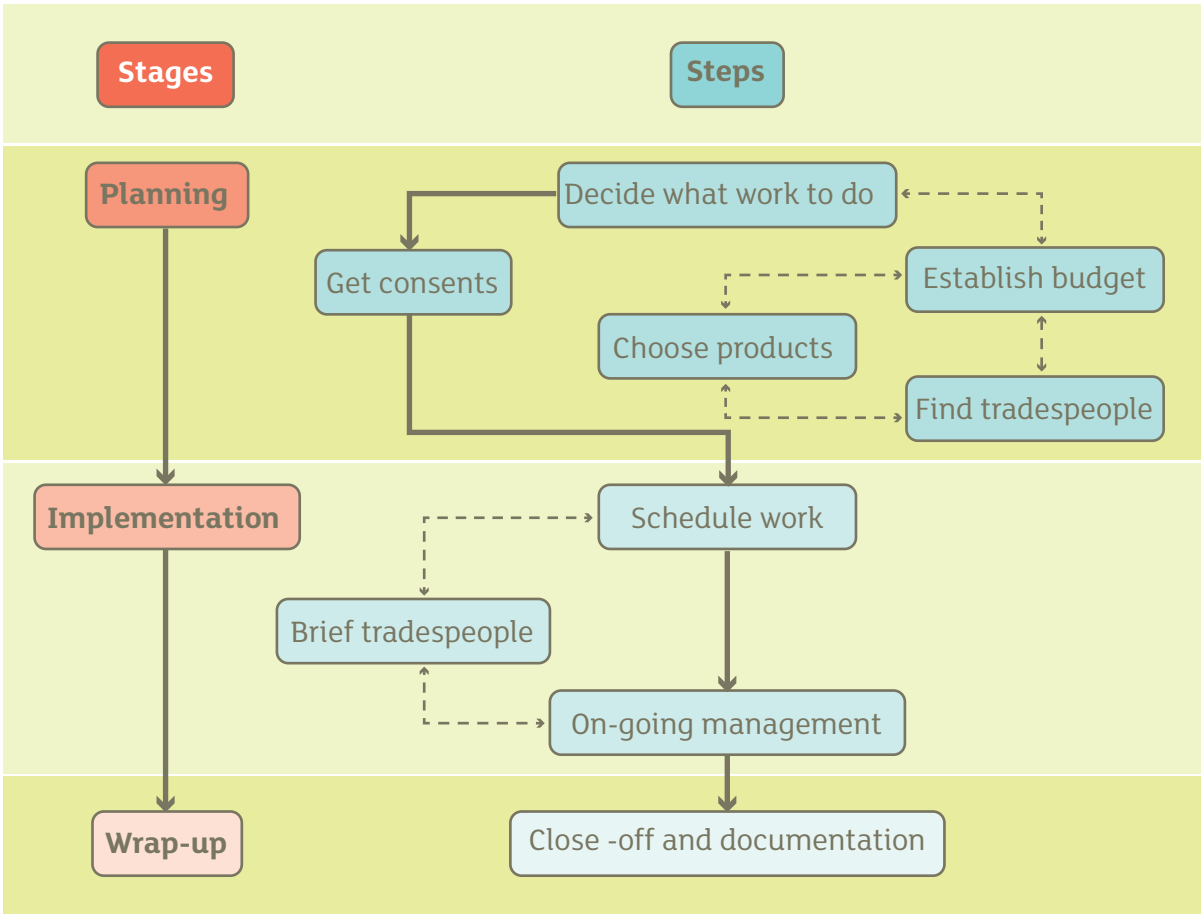
If you are cleaning mould off curtains or soft blinds, then a teaspoon of oil of cloves in a litre of water – applied with a sprayer – will work well. Put your curtains outside to dry in the sun (sunlight is a great steriliser) and then beat off the mould.

Project managing your renovations

Project management is the art of organising, running and completing a piece of work. You can be the project manager or you can hire someone else. To a certain extent, the scale of your renovation will influence who project manages the work; a small project such as insulating the walls or ceiling could by managed by you or the main tradesperson. However, for a large project, such as a full-scale renovation of your home, it may be better to use a specialised building project manager.

Managing any project runs through three stages: planning, implementation and wrap up. You'll notice that the flow chart below is not linear. Often you may need to revisit earlier decisions in order to get the results you need from your renovation. For example, you may have set your budget and, on receiving quotes, find that you can't afford to complete everything as originally planned.

Project Management Flow Chart



Decide which renovations are priorities for you. We have recommended an order of priorities which will bring the greatest improvements to your home's performance (p.11)

There is a natural order to some renovations. Take advantage of opening your walls for insulation to also check your wiring and plumbing. Similarly, it is better to do plumbing or wiring work in the ceiling cavity or under the floor before laying down insulation. Depending on your priorities, you may choose to work first on certain parts of your home, like the ceiling cavity, or certain areas such as the front rooms.

Top tips for finding a tradesman

- Word of mouth is still the best way – ask your family, friends or neighbours for any recommendations.
- Look for membership with reputable associations such as Registered Master Builders, Certified Builders Association, or Master Plumbers. Electricians should be registered with the Electrical Workers Registration Board, and plumbers and gasfitters with the Plumbers, Gasfitters and Drainlayers Board. Solar water heater installers must be accredited by the Solar Industries Association and wood or pellet burner installers must be accredited by the NZ Home Heating Association. Heat pumps use refrigerants and therefore installers should have both electrical and refrigerant certification (HVAC engineer). The Department of Building and Housing has just started a Licensed Building Practitioner Scheme which has a list of all registered tradespeople. Under new building laws, tradespeople must be registered with this scheme by 2010 in order to do certain kinds of work.
- Ask for examples of their work or references for you to contact.

A full Project Management Guide is available at
www.beaconpathway.co.nz/existing-homes/article/homeowner_manual_get_the_best_from_your_home

Important: If you are considering DIY for parts of your renovation, you must be aware of some legal restrictions around what you can do. Consumer Build (**www.consumerbuild.co.nz**) provides a clear description of what you can and can't do. Otherwise contact the Department of Building and Housing.

Make sure you get a quote or estimate in writing and make sure you understand what the clauses mean. An estimate is a guess only, and is not binding. The more detail you can provide, the more accurate any quote or estimate will be. This reduces the need for variations later. Ask at least three tradespeople for quotes so you can compare for accuracy, but beware: the cheapest quote is not always the best! Think about qualifications, reputation, guarantees and when they can do the work.

Any time a tradesperson is working on your home, you will need insurance cover. Often a tradesperson will have their own insurance – you should check this and understand the level of cover before you sign any contract. If they don't have sufficient insurance, make sure you organise your own. In any case, you should always advise your own house insurer before any work begins.

Don't assume that you are covered by any trade guarantees. Specifically ask the tradesperson and find out if you need to apply or pay a fee. Check carefully the level of cover and understand how the complaints procedure works.

Project management checklist

The following checklist helps you to identify the tasks and responsibilities of the project manager. If you are the project manager, make sure you understand each task. If you are hiring a project manager, go through the tasks with them and confirm who will do what.

Project management task	Who is responsible
Confirm what work will be done	
Confirm budget	
Confirm contingency amount, and the rules about when it can be used	
Advise insurer of house renovations	
Research tradespeople	
Research products	
Obtain estimates and quotes for tradespeople and products	
Check on tradesperson qualifications, work history and insurance	
Obtain building and resource consents	
Confirm tradespeople, contracts, insurance and guarantees	
Brief tradespeople	
Confirm products and any warranties or guarantees	
Manage contractor schedules	
Develop and maintain a Health & Safety plan	
Develop and maintain a site security plan	
Oversee and record work quality	
Collect and safely store all documents and records	
Arrange building inspector visits and confirm sign off	
Arrange any resource consent inspections and confirm compliance with any conditions	
Confirm quality finish (use a “snagging” list if appropriate)	
Arrange contractor payment	
Obtain Code Compliance Certificate	

Where to find more information

www.homesmarts.org.nz
Developed by Beacon and based on our research, Home*Smarts* gives people individualised advice on how to make their home warmer, healthier, cheaper to run and kinder to the environment. It's a quick, easy way to find how a particular home measures up to recommended standards and what simple steps you can take to improve your home.

www.energywise.govt.nz
This EECA-run website is the centre of information on Government programmes to encourage energy efficiency, solar water heating and space heating options. Visit here to find out what the options are and what Government subsidies exist to help you. Visit here to find out about Energy Star products, the mark awarded to the top 25% most energy efficient appliances.

www.energyadvice.org.nz
An independent, not-for-profit service, the Home Energy Advice Centre provides free, impartial advice to help you decide on energy efficient options and upgrades for your home.

Call their toll-free number **0800 388 588** to speak to an advisor.

www.smarterhomes.org.nz
Run by the Department for Building & Housing, Smarter Homes is a comprehensive guide to making your home perform better. It covers energy, water, indoor environment, design, materials, construction, siting and landscaping, with good general advice on what to think about. You can download two key publications: *Your Guide to Smarter Living* and *Your Guide to Smarter Insulation.*

www.consumer.org.nz / www.consumerbuild.org.nz
Visit the Consumer website for independent testing and evaluations of appliances and heating/energy products and systems. Find out which brand is rated as giving the best performances and what issues to watch out for. The Consumerbuild website has independent advice on buying, building, renovating and maintaining homes.

www.level.org.nz
Developed by BRANZ (an independent building research company) in tandem with Smarter Homes, Level gives more detailed advice on building and renovating for the construction industry. Expect to find more technical detail here.

www.rightlight.govt.nz
Find out more information on how to reduce household power bills through efficient lighting options.

www.mfe.govt.nz
Go to the Ministry for the Environment website to find lists of wood and pellet burners which meet National Environmental Standards for emissions.

www.accreditedsolar.org.nz
Find out which solar water heating products comply with the New Zealand Building Code and find an accredited supplier and installer who has a proven competence to install the systems.

www.enviro-choice.org.nz
The Environmental Choice tick tells you that a product has been made with the environment in mind. Find out what products you should select.

www.wanz.org.nz
WERS is a star rating system for windows - five stars is the highest rating, one the lowest. WERS assessment covers performance on winter heating, summer cooling, and prevention of fading. For advice on selecting the most energy efficient windows and glass.