Future Living Skills

LearningGuide: Eco-Building and Renovation

How to build and renovate for better health, comfort and the environment

This building topic in the Future Living Skills series is designed to give you two hours of useful insights on environmental aspects of the siting, thermal design, materials and fittings involved in building and renovation.

This *Learning Guide* fits alongside topics on food, water, waste, energy, gardening, transport and community resilience which are also available at www.sustainableliving.org.nz (free to download in member council areas of New Zealand).

The reading and activities aim to show some basics of sustainable design so that you can approach your suppliers, builder, architect or design professional with the aim of making your house more healthy, comfortable and resource-efficient. As the consumer or client, you need to know what to ask for and to be confident in asserting your needs.

Work through the readings in this left column in sequence, and print the activity sheets ready to work through with others. The column on the right is for extra information and references. There are a lot of links to other websites if you need more detail, but don't get lost! Remember to come back to the learning guide – you should be able to complete all the exercises in under two hours. They are designed to work best with groups of 8 to16, but are still interesting for a couple to tackle together.

Let's start with exploring what you want and what you need from your home, and why you should prioritise the best sustainability outcomes when deciding on what goes in and what comes out of your budget.

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SUSTAINABLE Aotearoa New Zealand LIVING

Sustainable Living Education Trust is a registered charity, supported by council members across NZ.

www.sustainableliving.org.nz

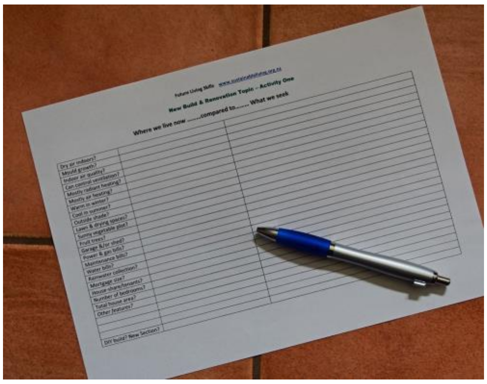
This Future Living Skills Learning Guide was written for the Trust by Eion Scott, Rhys Taylor, Verney Ryan, Richard Popenhagen and Dave Bryce.

Are solar panels or a green roof a desirable option?
This solar integrated 'green roof' not only collects sunlight directly for hot water, it provides native plantings for wildlife, has less stormwater run-off, and also contributes to home insulation. The adjacent north facing veranda supports solar PV panels (Photo Rhys Taylor).

What do you want in your new or updated home?

You probably know – if only by spotting what is right (or wrong?) with your current house or one you visit. Try this activity before reading further:

Activity One. What to look for in a home: Print off the sheet available at the downloads page (shown in photo below), ready to write-in good or bad features of your existing home and what you'd like in a new or altered home. If in a group, you could either use one house example (perhaps that where you are meeting, if your host agrees) or have a sheet printed ready for each participant to complete, based on their own home. Aim to gather words and phrases describing what would be "a comfortable and more sustainable home".



Then discuss, or think through: How does the house or flat you live in now compare for comfort, with a checklist of sought-after features? (see ideas at right)

Is it chilly in midwinter and poorly ventilated, perhaps with condensation on some walls or window surfaces? Are there draughts blowing under doors or in through cracks? In summer, do rooms overheat? Older houses also tend not to have extractor fans or high level window vents installed to take steamy air away from the kitchen and bathroom, and also have more cracks and gaps to let in draughts and rain. Some of them have enough leaks or condensation into cupboards, or through walls, to grow toxic black mould *Stachybotrys chartarum*. (photo shows this, on wallpaper)

You may have identified in the first activity some of these aspirations:

☐ North facing, sunny and warm living areas in winter, sheltered from predominant cold winds

☐ Easy to heat (insulated), not draughty and provided with fixed, effective and efficient heating sources, whether radiant (sunshine, log-fire, radiator), or convection heaters (heat pumps, air transfer fans). More on heating choices in the **Energy Topic** in this set.

☐ Cool living areas and bedrooms in summer (shaded, maybe a ceiling fan)

☐ Healthy air – plenty of openable windows to provide fresh air and extract fans to expel stale, damp air from bathroom and kitchen.

☐ Clean and mould-free walls and window-frames.

☐ Some garden or yard space outdoors – access to sunny private space, vege garden, clothes drying line.

☐ Day-lit throughout and effectively lit by energy-efficient lighting at night

☐ Weathertight, low maintenance structure and non-toxic paints.

☐ Walking distance to community services, schools and local shops and access to public transport

Fashion or performance?
There is more to house building and renovation planning than applying guesses about fashion trends that may boost resale values! Some recent 'trends' of conspicuous consumption have included ensuite bathrooms on all bedrooms, showers with multiple heads, large open plan living rooms, and double or triple garages, plus outdoor living spaces with lighting and even heating. Are these fashions where *you* wish to head, even if it's affordable?

Aspects of sustainability, comfort and efficiency are influenced both by the design and use of the house. Some are closely related to its age: New Zealand houses built before the 1980s were not required to be insulated and will cost a lot of money to heat each winter (and may also need help to cool in summer) unless they have been retrofitted with insulation in the roof and under the floor. Houses built in the 90s and even in the early 2000s may not meet today's insulation standards, though they are likely to have *some* insulation in the walls and ceiling. Most were built on un-insulated concrete slabs, which are difficult but not impossible to retrofit (see slab insulation detail below).

After discussing what you want (Activity 1) you are ready for a new activity.

How well insulated is your current home?

Activity 2: Investigate existing insulation in your current house (or if you are studying at a friend's place, see if they can show you)**.** The easiest first place to look is in the roof space, by finding a hatch in one of the ceilings and standing on a firmly-secure step-ladder, holding a torch (or using one on a headband – do be careful when climbing ladders, it's one of the most frequent causes of serious accident and you will need to keep your hands free). Try to measure what thickness of insulation sits above the ceiling. Old insulation often flattens, trapping less air.

If you are to meet as a group, consider one person taking a look in advance, armed with a cellphone or camera and lamp or flash, so that the photos of the insulation type, location and thickness can be shown to others, rather than all of you climbing up a stepladder to look!

What does that tell you? How new/well installed is the insulation, if any? Is there space for more? You may be able to add an extra blanket layer over the old insulation, or maybe it's just dust now, and needs to be removed? Old loose fill insulation can be a fire hazard if down-lights have been added later. Check that any existing or new insulation doesn't come up against or cover down-lights, unless they are designed to allow that (would be labelled CA, IC or IC-F – check here for what each does). Old down-lights act like a chimney venting warm air out of the room, so are very energy inefficient and can reduce the insulation effectiveness by half. See Insulating around Heat Sources on the Energywise website for more information on efficient, safe lighting.

You may also be able to look under the house, if it is a timber structure supported by piles, but not if it sits on a concrete floor. Be careful of touching any foil insulation. It's now illegal to install foil, because of risk of electrocution from accidental staple connection with cables, and foil should be removed and replaced with bulk insulation by a professional if you are considering upgrading (also, if it was installed more than 10

See which type of New Zealand house, and from what era, you are living in, by comparing with the pictures at this BRANZ website or this page from Beacon Pathway. (BRANZ is the government owned building research centre, while Beacon is an independent public-private research consortium).

1970s house, from BRANZ Renovation Guide

Why insulate? Insulating a South Island pre-1980s wooden house to the current NZ Building Code minimum level can cut daily winter heat demand from 17kWhr to 4.5kWhr and save hundreds of dollars on heating bills. Read more in this pdf advice sheet from Eco Design Advisors.

To compare costs and check out grants and insulation installers, see this EECA page. Without grants you'd need to find about $4,000 investment. Even in warmer areas of the North Island, insulation still helps significantly, as you can see in this pdf advice sheet.

Always buy insulation on R-value – this is the standard way to measure resistance to heat flow - and allow enough space within designed roof and wall cavities for the thickness required by that material (consider 140mm walls, instead of standard 90mm, and avoid cathedral or "skillion" ceilings, because flat ceilings with attics above are much easier to upgrade).

For new or replacement insulation, aim for between R1.5 to R1.9 under floors, R2.5 to R3.0 in walls and R3.3 to R5.0 in ceilings – larger numbers are better insulators.

Different materials require varying thickness to achieve similar insulation R-values.

years ago, it will be largely ineffective now, as dust will have gathered on top and reduced its ability to reflect heat back into the house).

If you have a concrete floor, the options for retrofit are limited. As up to 80% of the heat lost through a concrete slab is through the edge, you could consider fitting polystyrene to the slab edge, though this will require digging down to the footings and providing a protective sheath to the outside of the insulation (often a plaster finish). That process is detailed in the latest insulation retrofit standard, NZS4246:2016, which can be downloaded free from the MBIE Tenancy Services webpage.

Finding out what insulation is within the walls is harder, but you'd know if they felt warm or cold to touch in winter, and if condensation forms on wall surfaces. You could also unscrew a power point (after switching them off at the fuse-board) and see if there's any insulation behind. Either way, it's a tricky job to retrofit, and will often require a Building Consent, especially if using a blown or pumped insulation product.

Window insulation and reducing condensation

Windows are the weakest point in the "thermal envelope" of the house, and they can be easy and not necessarily expensive to upgrade. Secondary glazing is the addition of a new transparent glass or plastic layer within or across older window frames, and can be as simple as a window insulation kit that costs only $30 from a hardware store. It helps to trap air (stopping convection heat loss) as well as providing a warm inner window pane, reducing conductive heat loss and thereby eliminating condensation. Multi-layer blinds or lined curtains are also very effective window insulation at night but need to be as closely fitting to the frame as possible (and for curtains, full length to the floor, which can also help to insulate a half wall below a window).

In new houses, installing double-glazed windows is now Building Code in New Zealand. EECA also includes windows in its EnergyStar scheme, just like your new refrigerator or television, with more stars for the best performing glazing and frames. Window fixings are critical to ensuring effective ventilation, particularly in bedrooms – get burglary stays on at least one window in each room, and consider insect screens to deter mosquitoes and flies if it's a problem to leave the window open on those warm summer nights.

Read more on windows in a pdf from Eco Design Advisors, who provide this useful comparison chart of approximate insulation values:

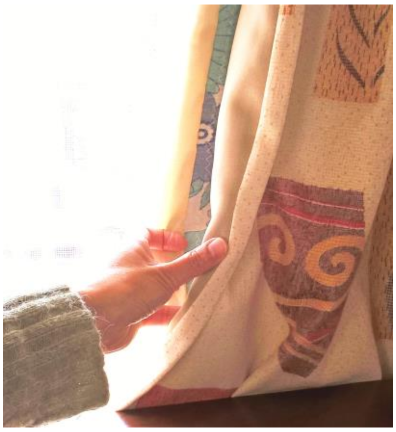
	Worst			Best
Window type & framing	Single glazing	Double glazing	Double with LowE glass	Double, LowE, Argon gas fill
Aluminium framed	R 0.15	R 0.26	R 0.31	R 0.32
Thermally broken (insulated) aluminium	R 0.17	R 0.31	R 0.39	R 0.41
Timber or uPVC frame	R 0.19	R 0.36	R 0.47	R 0.50

Dryer, healthier air

Now let's consider indoor air quality, too. If you get condensation on window frames and glass panes in winter, then ventilation as well as the

100mm of fibreglass or mineral wool blanket or segment is a better insulator than 100mm of natural wool or polyester, so you'd need a thicker layer of the latter two for the same R-value.

If you are taking off wall linings in an older house for renovation, do put in insulation at the same time. See Christchurch example (with 5 minute video, which also shows under floor insulation plus the use of a plastic groundsheet under a wooden floor – it gets rid of rising damp, to make heating easier). Read more about the why and how of ground moisture barriers here.



You can never have too many layers! Auckland resident Helen has sewn these multi-layer curtains for her home (photo Eion Scott)

Seek an end to overnight window and frame condensation such as this, by installing double glazing on insulated frames and ensuring moisture source areas are well ventilated.

window construction could be at fault. If steam from the use of the kitchen and bathroom is not being removed already by a fan, or at second-best (because it is draughty) by an open window, then you could consider installing an above-range hood and a bathroom extractor fan.

Bathroom fan timers are a great add-on; they switch on the fan with the bathroom light and continue for 10 minutes or so before turning off automatically. Even better are humidity detector switches. Clothes dryers should also be vented directly outside by flexible hose unless they have a built-in condenser, which collects the moisture from the dryer (at an increased running cost).

If one room gets too hot from its main heat source, such as a large wood stove, you could consider installing a duct in your ceiling to move surplus heat directly to one or more bedrooms. These heat transfer systems are fairly simple and cheap to install. They use a low-pressure fan on mains power and can be thermostat controlled so that they only work when the source air is warm enough to move.

Different to these are so-called “positive pressure” systems that collect air from the roof-space and pass it into the house, largely for the purpose of ventilation. They are less effective at recovering waste heat and sometimes have the opposite effect of moving cold air into the house. Nevertheless, these systems are very popular and can have good outcomes for people such as city commuters who don’t or can’t ventilate their homes during the day by opening their windows.

High performance new houses sometimes include a balanced ventilation system which does have a heat (or in summer, cooler temperature) recovery function, keeping the temperature within the home even despite the constant swapping of stale indoor air for fresh air from outdoors. They are an important feature of a “passive house”, which is so efficient and airtight that it needs a mechanical ventilation system in order to allow occupants to breathe! More information on passive houses here.

Getting the orientation right

The directions that your rooms and their windows face – whether you are planning a new build or altering an existing dwelling – will make a big impact on your home’s performance. Focus on maximising the amount of light coming into the building in winter, not on the extent of the views, particularly if they are to the west (where you risk overheating on long summer evenings) or south (freezing in winter from large heat sucking windows!) The Building Code pushes you in the right direction by limiting glazing to 30% of the east, south and west walls, but allowing the north wall to be 100% glazed (for more on this, you can download the acceptable solution NZS4218: 2004 from here).

The consequence of this is that your living areas will also face north and get the most sunlight – and as you spend the most time there, you will get the most benefit. Keep the south end of the house for the garage, bathrooms, laundry and maybe a shady study for computer screen time. Bedrooms should get some sunlight, but again not too much in the summer evenings or you will find it difficult to sleep. Making the house long in the east west direction means you’ll have more ability to site bedrooms with north and/or east facing windows, as well as allowing the mid-day winter sun to reach as far back into the house as possible.

Target temperatures for best adult health are 20°C in living areas and 16°C in bedrooms, says the World Health Organisation (higher if there are children or older people in the house). Get a maximum-minimum thermometer (as used in greenhouses) to see what the 24 hour range is in your rooms. Also, if it reads the relative humidity, try to keep it in a 40-60% range.

Taylor Griffiths house, sun facing north side, shows PV panel installation on veranda (right) and nearby woodsheds. East wall of house is cut into hillside, waterproofed and insulated. (photo R. Taylor)

What makes a good new house site? Bear in mind distance from the grid affects the cost of mains power, water and sewer connections, as well as telephone and broadband fibre lines. Consider neighbours and their impacts (e.g. noise, animals, weeds, privacy, electrical interference); sun all day; prevailing winds and shelter; hazards - of geology, landslips and quakes, possibly contaminated soils, river or sea flooding, upwind forest fire sources, bridge failure or road-slip vulnerability; distance from workplaces, schools, public transport and shops…

Interior layout

Group all rooms that need plumbing close together, to minimise pipe runs and loss of heat in water from the hot water cylinder. If hot water is required occasionally at a distant point, consider using instant electric or gas heating there on a cold piped supply instead of creating a long hot water route. If you are thinking of installing solar hot water, locate the tank centrally between the bathrooms and kitchen, or better still in the ceiling above (if you have an attic).

Activity 3 – Concept Plan. If you or some of the group are considering a new build project or house extension, this activity will be useful. In preparation, get Activity notes from our building topic download page.

Flesh out details like the slope contours and neighbouring houses or trees to see if they will shade the site. Where is the prevailing wind coming from, and where would you plant trees to shelter the house from it? Is there a long east-west building platform? Or would you build a more compact two-storey house? If off-mains, where would the septic tank or onsite wastewater management system go? What about the rainwater tanks (you might want them even if you have mains freshwater). Is there sufficient north oriented roof space for solar without winter shade from surrounding buildings or trees?

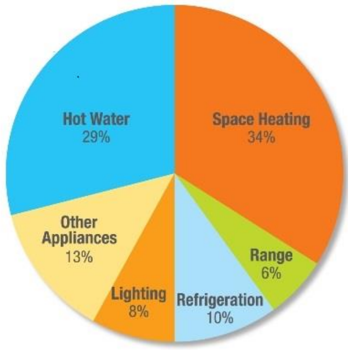
Now flesh out the layout of the house. On the outline plan, draw the location of two or three bedrooms, a bathroom, a kitchen, a living area, a laundry and decide whether there's still room for a garage. (Hint, an average single bedroom is 2mx3m, a double bedroom 3mx4m, and a lounge 4mx6m. Kitchens, bathrooms and laundries can be squeezed in around these building "blocks".) Work out the best location to get living areas in the sunniest spot and avoid west-facing bedrooms.

Getting the footprint right

The 'elephant in the room' is the size of the room! We have become used to wanting more and more space, but this comes at a cost. With the growing floor areas come larger resource use and thus higher cost to build and furnish, more construction waste, higher maintenance, lighting and heating costs (and, in town, less garden space within the section).

Larger houses consume more scarce resources per person, both to build and to run. Buildings contribute about 35% of New Zealand's greenhouses gas emissions (in materials, plus construction and use) so this is an area where new approaches could make a significant difference. A smaller house may save more than your money.

There has been a trend for the number of people per household to fall while the amount of living space per person (footprint) has gone up, accelerated by rising prosperity. Fewer people live in larger houses, often single-storey bungalows or villas that are especially hard to heat. You might decide that your next house could be smaller rather than larger? Perhaps even an apartment above ground or a higher density row-house, if gardening is not your passion (or you are not a dog owner!)



Energy uses in typical New Zealand homes – data from the 2010 final report of the 10-year BRANZ HEEP Study.

Energy efficiency at home is good at reducing carbon footprint because it reduces domestic power demand at the after-work/early evening peak time, when power generators are most likely to burn coal and gas. Read more about electric power in our Energy learning guide

AUCKLAND DESIGN MANUAL
TE PUKA WHAKATAIRANGA I A TĀMAKI MAKAURAU

Check out the design tips and trends in the Auckland Design Manual, an online resource for architects and designers aiming to build compact, quality, affordable housing as promoted by the Auckland Council Unitary Plan

and the Christchurch "Build Back Smarter" campaign.

Thinking about impact of room sizes on the amount of materials required as well as how to heat and cool them once in use, is an example of how house design is influencing a system. Many aspects are interconnected. Read more about Beacon Pathway's Higher Standard of Sustainability here.

Town section sizes have tended to get smaller as there is less demand for large gardens once land is expensive. The consequences are large areas of roofing on not much larger sections of land, where each roof intercepts rainwater and diverts it straight to the storm drains (potentially flooding the rivers). Urban land is much drier without the benefit of rainfall soaking in, so it is worth diverting some of the rain water into a storage tank by the house, ready for gardening use. See our **water topic** for how to capture and use rainwater.

Using the sun – passive solar design basics

Activity 4. Some Questions to discuss:

This section begins with a quick quiz.

Q1. How much heat does the sun deliver into a home, per square meter of sun-facing window?

a) Similar heat to a 100watt filament light bulb
b) Similar heat to that given off by a person's whole body surface, 400watts
c) Similar heat to a 1 bar (= one kW) radiant electric heater
d) Similar heat to a small pot belly stove, perhaps 4 kW

Discuss, before selecting an answer. (see page 8, right column)

Q2. Which is usually the sunniest region of New Zealand?

a. Far North
b. Bay of Plenty and Gisborne
c. Marlborough and Nelson
d. Central Otago

Q3. How many hours of sun does the sunniest region get per year?

a. 2400
b. 2100
c. 1800
d. 1500

Q4. Which is the least sunny and most cloudy region?

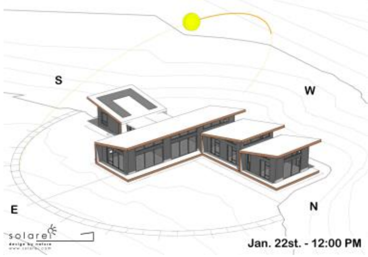
a. West Coast
b. Southland
c. Wellington
d. Taranaki

Q5. Which side of a house overheats most easily in summer, and why?

a. North
b. South
c. East
d. West

Keeping your cool

In winter, a well-designed home will catch and retain the sun's heat. In summer, shading will keep the higher angle sun out, and breezes will keep air in the building cool. This is known as 'passive' heating and cooling. As the climate gets warmer, houses in the north of New Zealand are suffering more and more from overheating. This has been recognised in the latest version of Homestar which includes a cooling



Here's a graphical representation of a sunpath (the inclination of the sun in relation to a property across the year) and you can check access to sunlight at various times of the year on your own building site, by registering for NIWA Solarview. For more information about maximising the benefits of your site, go to the excellent home renovation website SmarterHomes (developed by MBIE, the Ministry of Building Innovation and Employment) or BRANZ's in-depth sustainability website Level. Both websites have a wealth of information and deserve checking for any question you have on building or renovating. Also check that your architect or builder uses them.

homestar

Future proof and prove value. Will overall environmental performance and in particular the energy efficiency of homes become a key aspect of their attractiveness to builders and renovators and add value at the time of sale? NZ Green Building Council thinks so, and manages a rating tool for houses called **Homestar™.**

By 2016 approximately 6,000 houses had been registered for the tool. Check it out. See how the description changes from 1 to 10 stars. If renovating, you might aim for 6 star, if new build for 8+? You can conduct a free on-line self-assessment, or you can pay a Homestar qualified assessor for an assessment of design and 'as built' certification.

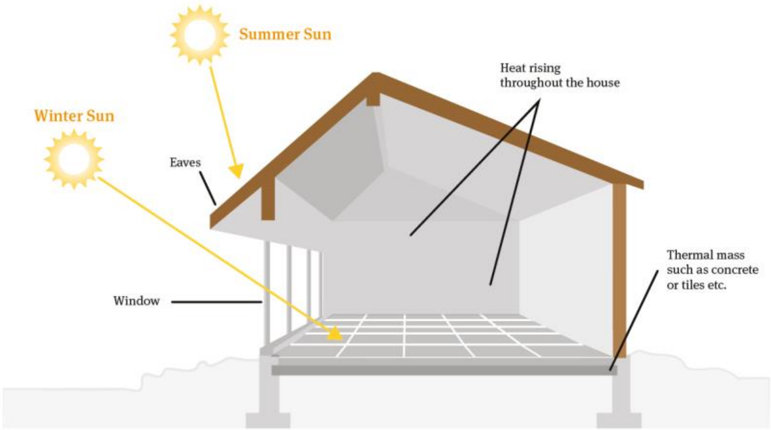
calculator.

Cooling can be expensive – new houses can expect to spend as much as 50% more on energy bills, if the house is not designed to keep cool passively. Good design reduces costs.

You can achieve significant benefits from small alterations to an existing home, such as thicker insulation, shading north-facing glazed rooms or installing external shading (which could be as simple as a pergola with a grape vine, conveniently leaf-less in winter).

Thermal mass also helps to moderate the sun's heat in summer, as well as storing it in winter. Tell your builder or designer you wish to maximise the use of the sun on site, including using some mass, and refer them to the level website for passive solar design guidelines. If you have a floor slab, make sure it is as exposed to as much sunlight as possible in winter, but shaded in the warmer months; that it is insulated (see above) and uncarpeted (rugs are OK if only partially covering the floor, and kept away from the windows).

Activity 5: Passive solar design. Using the diagram below, discuss how these features do or could work in your existing house, or apply to a new house or extension design. Consider the difference in angle of the sun in summer and winter and how the house has allowed for sunlight to enter or be excluded from the building (hint – look at the length of the eaves). Consider what happens to the sunlight when it hits the floor – is it reflected or absorbed? If absorbed, will the heat release once the sun has gone down? Why? Look at the heat rising through the house. Can that be reused? What would you need to install to move that back down to where you can get a benefit from it?



Using the Sun (source: Christchurch City Council, New Build Design Guide)

Material selection for safety and sustainability

Choose materials that promote the health and safety of the occupants as well as reducing the energy "embodied" in the material for lower overall carbon emissions.

It's a complex decision, as some materials have high "embodied energy"

Alexandra example of thermal mass provided by earth brick walls inside and out, with a central insulation layer, creating a thick wall. Window openings are timber lined and windows are double glazed, in timber frames.

This house is cool in summer, warm in winter and operates at stable temperatures between day and night.

Answers to Activity 4:

Q1: c. Direct sun provides about 1kW heat per m^2

Q2: b. Marlborough and Nelson, followed by Gisborne and BOP.

Q3: a. 2400 sunshine hours (compared to 1600 in Invercargill).

Q4: b. Southland, followed by West of Alps.

Q5. d. West facing windows in summer afternoon/eve when air temp is high and sun angle low.

While discussing **Activity 5,** be sure to consider the way that light passing through glazing is transformed into heat once it hits the inside floor and furniture. Any heat inside the house is less easily transmitted back out if the windows are insulated (e.g. double glazing) and the same in reverse, warmer outside air is less likely to transfer through the glazing to overheat the house. Double glazing also reduces solar heat gain (the invisible energy from direct sunlight that accompanies light), but not nearly as much as through tinted windows.

(energy in manufacture) but promote lower energy in use. For example the energy used in creating concrete, particularly its main binding ingredient, cement, is high because concrete is so heavy (the actual measure of embodied energy, MJ/kg, is actually low for concrete compared to most materials). But this is compensated by the fact that concrete is extremely durable and long-lasting, and because it is a heavy material can be used as thermal mass to store heat and moderate internal temperatures in the house in summer and winter. Therefore it reduces overall energy once in use, given a long lifespan.

Understanding how long it takes for the energy savings in-use to outweigh the embodied energy is part of a science, called LCA or Life Cycle Analysis. Level has a series of webpages about materials used in a range of constructions (e.g. cladding, roofing, flooring). Not only does it give you a figure for each material's embodied energy, but it shows the impacts on health and the environment at each stage of the material's life cycle, from mining, or harvesting, through to manufacturing, installation and recycling after its useful life has finished.

Buying local 'heavy' materials when available and suited to design, such as stone, bricks or rammed earth, will reduce the transport component of the material's embodied energy compared to imported materials. The bonus is that it will reflect the colours and character of your area. For example, consider Oamaru limestone if house cladding in South Canterbury and North Otago, but schist if in Central Otago or Lakes.

Alternatives to common toxic materials

The Building Code requires framing timber to be water and insect resistant, which can mean treating softwoods like pine with the (relatively) harmless bromide chemical preservative, or the far more toxic chromated copper arsenate (CCA). Chrome and arsenic are classified as dangerous chemicals, exposure to which could potentially harm the occupants but will pose a much greater risk to mill workers and carpenters.

There are alternatives that can meet the code, such as macrocarpa, cypress, cedar, larch, Douglas fir and some laminated plywood. Native hardwood timbers like totara, kauri and matai may also be salvaged from demolition yards, or even pulled out of old swamps, and reworked for furniture or a special feature exposed beam, door or flooring. Imported bamboo has also become a popular flooring and internal lining material due to its fast growth and strength when laminated. But be careful if you are growing it, as it can turn into a weed!

Be aware if using imported hardwoods used in decking and outdoor furniture, that they are not sourced from rainforests. Look for the FSC Forest Stewardship Council symbol to prove that the wood has been harvested sustainably and without endangering wildlife (the habitat for species like the orangutan has been reduced alarmingly by clear felling of rainforests in South East Asia, often for plantations of palm kernel oil, byproducts of which are used in our dairy industry as cattle feed.)

Cabinets in the kitchen, bedrooms and living areas may be offered in composite wood fibre products such as MDF or plywood, which use glues containing formaldehyde, a major cause of toxicity in the home through off-gassing VOCs (volatile organic compounds) for months after

Read more on passive solar design:

consumer. now you know

SMARTER HOMES

Eco Design Advisor

As an aside, the first New Zealand company to gain certification that its products were environmentally acceptable (called an Environmental Product Declaration) was a concrete company, Allied Concrete Ltd. For more about EPDs (which are becoming more readily available for many products) see the Environmental Product Declaration page on Level.

All window glass is imported, and it is heavy, which means it has high embodied energy and very poor energy saving in use (heat escapes almost as fast as light comes in!) Another reason to reduce the size of windows & double glaze.

For more information on sustainable material sourcing and toxicity, see the Eco Design Advisor building materials factsheet or click on the logos below to see their certification benefits.

FSC

ENVIRONMENTAL CHOICE NEW ZEALAND Cert.TM construction. This is the characteristic "new car" and "shoe shop" smell!

Most carpets have glued backing, so it's a good idea to have new carpet, whether synthetic or wool, unrolled to air at the warehouse for a week or two, or at least to have it laid while you are away on holiday. Alternatively choose lino, tiles, cork or wooden floors with low-emission water-based sealants (try to avoid turpentine-based polyurethanes, and vinyl flooring which has a particularly bad reputation for off-gassing – though any glued-down flooring will suffer the same initial problems).

Similarly for paints, choose low-VOC products, which are largely water-based now (even for enamels). Look for the Enviro-choice symbol, or if you are undertaking a Living Building Challenge, you will need to ensure none of your materials are on the Red List of the *Declare* certification.

Declare.

Seal your solid wood kitchen units, utensils and furniture with linseed oil, beeswax or tung oil, all being better alternatives to high-VOC polyurethane sealants and varnishes.

Correct sizing, prefabrication, separation

The average new home built in New Zealand produces 6 tonnes of waste – that usually ends up at the tip. Not only does this harm the environment (about 40% of waste comes from construction) but it also costs the owner, both in tipping fees and in needless over-ordering of materials.

Avoid construction site waste by specifying quantities accurately (a quantity surveyor can help here) and so minimising offcuts. Materials like plaster board lining come in standard sizes to match standard wall stud widths. Walls, windows and door openings can be designed to fit within these dimension to reduce waste and project cost.

While using non-modular construction materials gives greater flexibility on dimensions and scope for artistic variations in wall widths, curves and surface textures, it takes longer to implement (labour is the biggest cost in building) and reduces the potential for prefabrication. So design simply and consider modular or prefabricated sections that could be manufactured offsite, with resulting material and cost efficiencies.

Check out the materials, including paints, macrocarpa weatherboards and recycled beams (were from an old boat) used in the Zero Energy House in Auckland's Pt Chevalier. The owners also encouraged good waste management practices, including separate bays for different types of waste, to enable easy recycling.

Set aside offcuts of timber for use later, or for firewood (but only if untreated). In some parts of New Zealand treated timber offcuts can be collected by a specialised service and used to fire industrial furnaces, such as cement plants, where emissions are scrubbed. In Timaru such wood can be turned into charcoal. Set aside and recycle any packaging (using labelled storage areas instead of chucking it all in one skip). Have contract conditions and worker incentives to minimise waste. Even so it's often left to the enthusiastic waste reduction expert (probably you!) to monitor and record and ensure that everyone plays by the rules.

Adopt the seven 'R's to cut waste in construction:

- Respect people and environmental limits/systems
- Reflect and spend time planning, design to be resourceful
- Reduce materials ordered, order in good time and thus minimise delivery vehicle trips
- Repair before replacing, seek durable products and avoid throw-away items
- Recover materials, salvage, de-construct and store
- Re-use materials on site before buying new
- Recycle if not reusable – above all, avoid landfill.

Activity 6: Materials and waste. Print (preferably in colour) and cut out the set of cards available at our downloads page, to re-order according to the sustainability of each building material, from low to high. When doing so consider the following criteria:

1. The healthiness of the material (i.e. does it off-gas or is it likely to house dangerous chemicals or promote toxic moulds)
2. The durability of the material, how long will it last, is it prone to damage from the environment (flooding, earthquakes, weather)
3. Can it be locally sourced, and so reduce embodied transport energy?
4. Does resourcing the material damage the environment or habitats for wildlife?
5. What are the life cycle costs of using the material – does energy reduction in use outweigh the material's embodied energy?
6. Can it be deconstructed at the end of its life and reused, or will it end up in landfill?

If playing this game in a group, you can play judge and jury by awarding points according to the above criteria numbers (so team A might get 1 point for healthiness and 3 points for local sourcing, but maybe gets 2 points taken away because the material would fail in an earthquake!).

Have fun, and argue the toss over a final nightcap for the evening…

Space here and overleaf for your notes and sketches.

Info on minimising construction waste, including templates for waste management plans and details of recycling locations, is on the REBRI website

A slide set is available in support of this building topic, from the downloads area at www.sustainableliving.org.nz