Up-Spec: Background Research

Contents

What is Up-Spec?

New Zealand home designers, specifiers and sales agents are increasingly being asked for higher-performing new homes, but recommendations for comfortable temperatures, energy efficiency and water use improvements are often limited to general information rather than specifics on resource saving and costs. Up-Spec provides actual data for a range of performance improvements for new homes. They focus on practical and cost-effective measures across three themes:

- Comfortable temperatures
- Energy efficiency
- Water management

Figures are available for the following nine climate zones: Auckland, Tauranga, Hamilton, Napier, Wellington, Nelson, Christchurch, Dunedin and Invercargill.

Research

The performance upgrades are based on independent research by BRANZ and are region specific where possible. Only the most cost-effective improvements have been selected, based on homes consented in 2012. Figures take inflation and returns into account.

The information is based on the most recent information wherever possible and will be updated periodically. Although every care has been taken to provide accurate figures, they are best used to compare upgrade options, and house-specific quotes should be provided once a selection of upgrades has been shortlisted. All figures are estimates and should be seen as starting points for discussions. Once the upgrades have been chosen, the estimated extra costs figures will need to be more accurately determined and will vary depending on the specific design.

The information was developed in consultation with the homebuilding and environmental advisory community to ensure design solutions are practical and relevant and address key areas of concern.

Note that the focus of the research is on energy efficiency, water efficiency and personal financial considerations. Other issues, such as impacts on the environment or society, are not considered, but may be equally, if not more, important to clients.

Comfortable temperatures

Many opportunities are available for most new spec (volume-build) homes to improve their year-round comfort and reduce additional heating and cooling needs. Only the most practical opportunities have been presented here. The improvements are averages based on the careful computer modelling of many recently consented, stand-alone volume-built homes. Generally, the more money invested in thermal improvements early on, the better the return in terms of ongoing comfort.

The following options were explored:

- House orientation: facing the living areas to the north
- Ceiling insulation: upgraded from minimum Building Code levels
- Wall insulation: upgraded from minimum Building Code levels for 90 mm and 140 mm timber framing
- Windows: upgraded from standard (non-thermally broken) double glazed, aluminium framed with standard glazing
- Concrete slab floor: upgraded from standard (uninsulated) slab on ground
- Combinations of several thermal improvements

House orientation

Ideally, all living areas in homes should be north facing. Given that all the homes examined had at least one living area window facing in a northerly direction, many were close to their optimal thermal orientation already.

Ceiling insulation

Higher levels provide better comfort, but there are decreasing returns in terms of heat loss, with even less opportunity in double-storey homes, which have proportionally smaller ceiling areas and therefore less thermal influence.

Wall insulation

The most commonly installed wall insulation only just meets Building Code minimums, using bulk insulation in 90 mm framing. The implications of increasing wall insulation were explored but were found to be not financially viable even though thermally beneficial.

Window upgrades

Windows are a key thermal weak point, so there is a great opportunity to substantially reduce heat losses by upgrading the frames or the glazing.

Concrete slab

The perimeter of the slab is where most flooring warmth leaks out, so it should be insulated. Underfloor insulation must be continuous to minimise thermal weak points. The pod-style flooring systems have a base of non-continuous segments of polystyrene. Exposing uninsulated slabs internally increases heating costs when compared to the traditional slab construction, so is not recommended.

Combinations

A combination of several thermal improvements was explored that consider the whole thermal envelope (i.e. floor insulation, wall/ceiling insulation plus glazing). These more comprehensive upgrades result in the most thermal benefit.

Approach

Eighteen, 2012-consented group home builder specifications were sourced from three councils – six each from Auckland, Hamilton and Christchurch. The houses were then all ‘built’ virtually to thermally examine using a specialist computer program (AccurateNZ). Different combinations of the original 18 houses were then computer modelled in the remaining six climate zones (Tauranga, Napier, Wellington, Nelson, Dunedin and Invercargill) to ensure appropriate representation.

The computer model assumed sensible and identical occupant behaviour to ensure that a fair comparison between buildings could be made. For example, the heating schedule was modelled using the following comfort considerations. In winter, the thermostat is set to 20°C from 7am to 11pm in living, kitchen and bedrooms, with the remainder of the house being left unheated. In summer, when indoor temperatures are near 25°C, the windows are opened for cooling. All houses were assumed to be electrically heated with a 100% efficient space heater so that a fair and simple comparison could be made.

Each of the houses selected had the same thermal upgrades applied using available products and systems, while keeping costs in mind. The upgraded versions were then compared with the original (as consented) version to see what impact the upgrades really made for that particular climate zone and house configuration.

The economic viability of each upgrade was then assessed to ensure that the final suggestions would fall within a reasonable budget and have a positive new present value (NPV). The benefits (specifically, reduced heating costs) were thus assessed against the liability (i.e. higher initial purchase and installation costs), based on an electricity charge of 30 c/kWh. A discount rate of 5% over 25 years was applied, as suggested by BRANZ economists. Key costings reference sources were *QV costbuilder* and personal communications with BRANZ economists. Key thermal materials and buildings references were BRANZ experts and the BRANZ *House Insulation Guide* (5th edition).

The table below lists the complete set of upgrade options examined, whether they achieved a positive NPV or not. Figures are based on new, volume-built homes with an average floor area of 160 m^2, averaged for all New Zealand. For location-specific costings that are thermally beneficial, refer to the relevant climate zone.

Thermal variation	**Thermal benefit**
House orientation	
Living areas facing north, garage facing south	Good
Ceiling insulation	
R4.0 bulk ceiling insulation	Good
R4.5 bulk ceiling insulation	Very good
R5.0 bulk ceiling insulation	Very good
Wall insulation	
R2.8 bulk insulation to walls, with 90 mm timber framing	Good
R3.2 bulk insulation to walls, with 140 mm timber framing	Good
R4.0 bulk insulation to walls, with 140 mm timber framing	Good
Window upgrades	
Standard (non-thermally broken) double glazing framing, with low-E coating	Very good
Thermally broken framing; glazing with low-E coating	Very good
Thermally broken framing; double glazing with low-E coating	Very good
Timber framing, with low-E glazing	Very good
Concrete slabs	
Generic pod-style polystyrene insulation under concrete slab, with either carpet or vinyl floor coverings in the usual places	Marginal
50 mm expanded S-grade polystyrene insulation, continuous, under concrete slab (i.e. not pod style) with either carpet or vinyl floor coverings in the usual places	Very good
As above, but with 20mm around perimeter	Very good
Uninsulated (i.e. traditional) concrete slab with fully exposed and polished topping	None
Uninsulated (i.e. traditional) concrete slab with only living areas having exposed, polished topping; other areas carpeted	None*
Uninsulated (i.e. traditional) concrete slab with only living areas having exposed, polished topping; other areas vinyl	None
Uninsulated (i.e. traditional) concrete slab with only living areas having exposed, polished topping; other areas tiles	None*
Combinations	
50 mm expanded polystyrene insulation, continuous, under concrete slab + exposed slab in living areas	Excellent
As above, but with 20 mm insulation around perimeter	Excellent
50 mm expanded polystyrene insulation under slab + R2.8 walls + R4 ceiling + low-E glazing	Outstanding
As above but with thermally broken frames as well	Outstanding

*Auckland is the exception.

More information

- ALF, the free online thermal assessment and energy performance tool for New Zealand homes – www.branz.co.nz/alf
- BRANZ *House Insulation Guide* (5th edition)
- BRANZ Bulletin 568 *Low-impact homes*
- BRANZ Bulletin 571 *Thermal mass*
- Level: Passive design – www.level.org.nz/passive-design
- *QV costbuilder* – www.qvcostbuilder.co.nz

Energy efficiency

The following options were explored:

- Photovoltaic-ready house (installing cabling only)
- 3kW grid-connected photovoltaic system fully installed
- Correctly sized heat pump
- 4 Energy Star dishwasher and washing machine
- 4 Energy Star fridge/freezer
- All lighting is energy efficient

Photovoltaic-ready house (installing cabling only)

Electricity-generating photovoltaic (PV) panels are rapidly falling in price, making them increasingly affordable for domestic application. Homeowners who are interested in future proofing their new house – or wanting self-generation immediately – are advised to install the necessary electrical cabling from their roof to their fuse box (or similar) at the time of construction. This saves money later on, as internal wall access is simplified and no remedial work is required. Having a solar-ready house may also be beneficial in terms of future sales.

Approach

Installation cost estimates were based on estimates from several PV installers in late 2016.

More information

- BRANZ Photovoltaic Generation Calculator – www.branz.co.nz/PVcalculator
- EECA Energywise solar calculator – www.energywise.govt.nz/tools/solar-calculator
- Level: Photovoltaic (PV) systems – www.level.org.nz/energy/renewable-electricity-generation/photovoltaic-pv-systems
- Level: Sustainability fact sheet: Photovoltaic (PV) design – www.level.org.nz/fileadmin/downloads/Other_Resources/PV_s.pdf
- Solar photovoltaic quotes – www.mysolarquotes.co.nz
- Sustainable Electricity Association New Zealand (SEANZ) – www.seanz.org.nz

3kW grid-connected photovoltaic system fully installed

Photovoltaic (PV) systems are the most popular renewable-based technology for providing electricity to private residences in New Zealand. It is likely that they will only get more popular with time due to their wide applicability, falling price, low maintenance and high reliability. Grid-connected (i.e. grid-tied) installations are by far the most common PV system type in New Zealand, as they are considerably simpler and cheaper than alternatives. A fully set up medium-sized (i.e. 3kW) good quality system, which has the potential to generate about a third of a typical household's needs, cost around $10,000 in late 2016.

Ideally, renewably generated electricity should be used on site. This is due to electricity retailers paying considerably less for the excess electricity exported back to the grid than they charge for supplying. However, there is currently a lot of uncertainty about:

- what tariff electricity retailers will award for excess electricity produced (known as the buy-back or feed-in price)
- charge for supply
- just how much electricity can be used immediately on site, which will vary by individual household
- additional fees charged by some lines companies for households with grid-connected PV systems.

It is therefore very difficult to estimate the likely lifetime financial returns of installing a system. For a rough cost-benefit estimation for individual households, use these web resources to carry out an assessment for your circumstances:

- EECA Energywise solar calculator – www.energywise.govt.nz/tools/solar-calculator
- SEANZ Solar Optimiser – www.solaroptimiser.nz

More information

- BRANZ Photovoltaic Generation Calculator – www.branz.co.nz/PVcalculator
- EECA: Our renewable energy resources – www.eeca.govt.nz/efficient-and-renewable-energy/renewable-energy
- Level: Photovoltaic (PV) systems – www.level.org.nz/energy/renewable-electricity-generation/photovoltaic-pv-systems
- Level: Sustainability fact sheet: Photovoltaic (PV) design – www.level.org.nz/fileadmin/downloads/Other_Resources/PV_s.pdf
- Solar photovoltaic quotes – www.mysolarquotes.co.nz
- Sustainable Electricity Association New Zealand (SEANZ) – www.seanz.org.nz

Correctly sized heat pump

This is one of the easiest 'upgrades' of all and yet costs nothing to achieve! Space heating accounts for about a third of the energy needs of New Zealand homes, with heat pumps being the number one space heater specified. Correct heat pump sizing is critical to both efficiency and performance and results in quieter running and lower lifetime maintenance. In overseas studies, inefficiencies of up to 35% result from incorrect sizing.

Approach

A search for a robust, New Zealand-relevant method for sizing all heater types was carried out. Key influences such as local climate, number of external walls of the room being heated, building construction details and room volumes all had to be considered in the calculation method.

More information

- *Regional heat pump energy loads*. Page, I. BRANZ Report E528. Wellington. July 2009.

4 Energy Star dishwasher and washing machine

Although dishwashers and washing machines only account for about 2% of the energy use in New Zealand homes, this can be reduced even further. However, the extra price difference is considerable from the units sampled. At present, for the limited numbers of dishwashers and washing machines on the Australia-NZ Energy Star directory, it seems that it is not cost effective to buy 4-star energy rated appliances due to the price difference. However, purchasing the appliances in a sale may change this.

Approach

The comprehensive Australian energy-rating site was used to determine the performance of various appliances. For the dishwasher – assume that an inefficient 2 Energy Star dishwasher is being replaced by a 4 Energy Star dishwasher and it is used every day with 10+ settings. This upgrade will save around $70 a year to operate. The break-even price difference between the two dishwasher types is just under $300.

For the washing machine – assume that an 8 kg model is chosen and a 2 Energy Star washing machine is being replaced by a 4 Energy Star washing machine. This upgrade will save around $170 a year to operate. The break-even price difference is just over $700. Lifetime savings for all the examples are based on an electricity charge of 30 c/kWh.

More information

- Australia-NZ Energy Star – www.energyrating.gov.au
- EECA: Minimum energy performance standards (MEPS) and labelling – www.eeca.govt.nz/standards-and-ratings/minimum-energy-performance-standards-and-labelling

4 Energy Star fridge/freezer

Fridge/freezers are the biggest consumers of energy of all the household appliances, accounting for about 10% of household energy use. Their efficiency decreases as the surrounding temperature increases, so they should be located away from heat sources and direct sunlight. Choose a new fridge/freezer that is sized appropriately for the household. Ideally, they also should be placed so that they have a 75 mm gap all around for better ventilation.

Approach

It was assumed that only one fridge/freezer unit is replaced per house. An average-sized unit (at just under 400 litres in volume) was used for the comparison. A 2-door, 1.5 Energy Star fridge/freezer was compared to a 3.5 Energy Star fridge/freezer of a similar capacity. The Australia-NZ Energy Star directory was used to determine the standardised energy use of representative fridge/freezers to determine the average energy savings (of 43%). This saving was then reduced by 20% to better reflect actual performance as the standardised external temperatures are more representative of Australian conditions. The retail prices of 380-litre energy-efficient fridge/freezers listed on www.energyrating.gov.au were compared with a group of similar capacity low-efficiency fridge/freezers. No significant price difference could be found. Lifetime savings are based on an electricity charge of 30 c/kWh.

More information

- Australia-NZ Energy Star – www.energyrating.gov.au
- EECA: Minimum energy performance standards (MEPS) and labelling – www.eeca.govt.nz/standards-and-ratings/minimum-energy-performance-standards-and-labelling

All lighting is energy efficient

Ideally, all lighting installed in homes should be energy efficient, as well as meeting targets for appropriate colour representation, glare and utility. As nearly 10% of energy used in homes is from lighting, large ongoing savings are possible by shifting to more efficient lamps. BRANZ suggests that only lamps with an efficiency of greater than 40 lumens/watt is specified and used in homes. Thus, incandescent or halogen lamps should be substituted if possible in almost all situations, since very little of their energy use is converted to visible light. LED and fluorescent-style lamps are both more energy efficient and longer lasting and are dropping in price. In addition, they come in a wide range of styles and fittings to match the surrounding decor.

Approach

There have been no recent New Zealand studies on what is specified in homes in terms of lamp type. Building consent documentation is seldom specific enough to determine this either. The NZ Rightlight website (now EECA Energywise: Lighting) was used to establish the total lifetime costs of a wide variety of lamps (i.e. the initial purchase price plus running costs plus replacements).

Using the BRANZ/CRESA report *Lighting in New Zealand homes*, a model house representing a more traditionally set-up house was developed then upgraded to an energy-efficient version providing the same amount of lighting over the same period of time.

The traditional house was artificially lit by incandescents (46% of the total lighting energy) and halogens (42%) but also CFLs (10%) and fluorescents (2%). The upgraded house was lit by CFLs (80%) and LEDs (20%). The upgrade resulted in a 51% reduction in energy use as well as a 50% reduction in total costs. Lifetime savings are based on an electricity charge of 30 c/kWh.

More information

- EECA Energywise: Lighting – www.energywise.govt.nz/your-home/lighting
- *Lighting in New Zealand homes*. Burgess, J., Camilleri, M. and Saville-Smith, K. Wellington. Sustainable Building Conference SB10. 2010.

Water management

The following options were explored:

- 4.5 star WELS dishwasher and washing machine
- 3 star or better WELS showerhead
- Greywater recycling for WCs and garden
- 4 star or better WELS toilets
- 5 star WELS kitchen + bathroom tapware
- Rainwater tanks

4.5 star WELS dishwasher and washing machine

There is no relationship between cost of appliance (whether dishwasher or washing machine) and standardised water use i.e. Water Efficiency Labelling Scheme (WELS) rating. There are only a few 2 and 3 WELS star rated washing machines available, with most being 4 or 5 stars, on average. A 4.5 star will use about 69 litres. The minimum WELS rating for dishwashers is 3. Together, a water savings of about 19,000 litres per year could be expected, the majority of savings coming from the washing machine upgrade.

Approach

Assuming one 8 kg load per day, a 3 star washing machine will use about 43,000 litres while a 4.5 star will use about 25,000 litres over a year. Thus, about 18,000 litres is saved a year on this washing regime. For the dishwasher, assuming 14 settings, a commonly available 3 star WELS dishwasher uses just under 17 litres per wash, while a 4.5 star uses just under 13 litres per wash. Assuming one wash per day (following AS/NZS 6400:2005 *Water efficient products – Rating and labelling*), this equates to 1,460 litres per year saved. Harvey Norman and Noel Leeming online were used to establish prices and water WELS ratings.

More information

- Water Efficiency Labelling Scheme (WELS) – www.mfe.govt.nz/fresh-water/we-all-have-role-play/water-efficiency-labelling-scheme

3 star or better WELS showerhead

The ordinary showerhead typically makes up the largest percentage of indoor water use, accounting for about 30%. A number of showerheads are available that provide a very comfortable flow, although their water usage is modest at around 8–9 litres per minute. It is unknown how efficient the average showerhead is in new New Zealand homes. Given their significant contribution to water use in the home and the ease with which they can be substituted for something considerably more efficient, it makes sense to specify a high (3 or higher) WELS rated showerhead if possible in ALL bathrooms. Note that the showerhead must be matched to the home's water pressure/plumbing – check with your plumber.

Approach

A best estimate of the common flow rate of showers being installed is about 14 litres per minute. A 3 star WELS rated showerhead will provide a flow of 8.5 litres per minute. Using the Upper Hutt City Council How much is your shower costing you? calculator based on three showers per household per day for an average time of 7.8 minutes, this equates to a savings of around 47,000 litres per year – enough water to fill the average sized home over seven times!

Bunnings and Plumbing World NZ online were used to acquire retail prices in February 2014. Prices for the extra stars are hard to determine because of the mix in quality but probably marginal extra costs.

More information

- Level: Water – www.level.org.nz/water
- Smarter Homes: Collecting and using rainwater – www.smarterhomes.org.nz/water/collecting-and-using-rainwater

Greywater recycling for WCs and garden

Greywater systems can take advantage of the wastewater from the shower, bath and some taps, which typically makes up about half of all the water used in the house. This water can be reused either for flushing the toilet or watering the garden. Greywater cannot be used for cooking, bathing, swimming or drinking. The system must be properly installed and maintained and kept from direct human contact if used in the garden. Also, untreated water should be used within 24 hours. Various types of greywater systems are available. Before investigating the options, make sure that your local/regional council permits their use.

Approach

Supply and wastewater charges were sourced (using Water New Zealand figures from their 2015/16 National Performance Review online resource). Where there was an option for both metered and unmetered water, it was assumed that all new connections in metered areas would be metered.

2015/16 local authority charges associated with supply and wastewater based on 200 m³/yr

	Supply water	Wastewater
Auckland	$1.41 per kL	$2.88 per kL
Hamilton	$1.15 per kL	$0.985 per kL
Tauranga	$1.97 per kL	$1.9 per kL
Napier	$1.23 per kL	$1.23 per kL
Wellington		
Nelson	$3.045 per kL	$1.95 per kL
Christchurch		
Dunedin		
Invercargill	$306.07	$201.11

Based on a whole household of 600 litres a day water use, a 50% savings equates to saving 300 litres a day or some 109,000 litres a year. Using a popular wastewater system model, the costs work out as: base unit ($3,400), bracing ($120), irrigation system for garden ($300), freight ($150) and extra plumbing work ($200) – $4,200 in total. Cost-benefit calculations were based on these figures.

More information

- BRANZ Bulletin 485 *Domestic on-site wastewater systems*
- Level: Water – www.level.org.nz/water
- Water Efficiency Labelling Scheme (WELS) – www.mfe.govt.nz/fresh-water/we-all-have-role-play/water-efficiency-labelling-scheme

4 star or better WELS toilets

It is estimated that toilets use about 18% of total house water (including that used outside for gardening), with the average person flushing the toilet about five times daily. This water is treated and pumped – both before and after use – requiring lots of resource use. Toilet water efficiency is standardised using the WELS system.

Although dual-flush toilets are becoming the norm in new houses, most seem to go for the standard 6 litre/3 litre flush (i.e. 3 star WELS). These can be simply substituted with the considerably more efficient 4.5 litre/3 litre flush (i.e. 4 star WELS) toilet, with no loss in utility.

Approach

The yearly savings from the upgrade are based on the following calculation process. For dual-flush toilets, daily flow rates are calculated from the average of 4 half flushes and 1 full flush per person. Thus, the flow rate for the standard toilet is 3.6 litres while the more water-efficient toilet requires only 3.3 litres, effectively equating to a reduction of 8%.

For a three-person household, assuming 5 uses per person per day, the original water usage is 19,710 litres versus efficient water use is 18,067 litres per year. This equates to a savings of 1,642 litres per year.

No obvious differences in purchase costs between the more commonly specified 6/3 toilets and the more water efficient 4.5/3 toilets was found, using a variety of bathroom and plumbing retailers.

More information

- Water Efficiency Labelling Scheme (WELS) – www.mfe.govt.nz/fresh-water/we-all-have-role-play/water-efficiency-labelling-scheme

5 star WELS kitchen + bathroom tapware

There are good water savings to be made from reducing the flow rates of tapware – mainly due to lower water wastage. There doesn't seem to be significant purchase price increases for the more efficient tapware.

Approach

The method is based on information obtained from the WELS site www.waterrating.gov.au. A tap is turned on full three times a day for 3 minutes by each household occupant, and half the water used is heated to 23°C. It is assumed that the tapware is upgraded from an inefficient 2 star WELS to a more efficient 5 star WELS. The energy saving is from the resulting reduction in necessary heating water, knowing that it takes about 5.5 Wh per litre of heated water (starting from 10°C). Note that 6 star WELS tapware is also available.

The purchase cost information was provided by a JASMAX study carried out in 2013 as part of an investigation into the cost implications of having new houses environmentally assessed.

More information

- *Homestar Cost-Scoring Appraisal for Auckland Council (Draft Unitary Plan)*. February 2013 Revision 1.0. JASMAX.
- Water rating – www.waterrating.gov.au
- Water Efficiency Labelling Scheme (WELS) – www.mfe.govt.nz/fresh-water/we-all-have-role-play/water-efficiency-labelling-scheme

Rainwater tanks

The following options were explored:

- 1,000 litre water tank, with feed pump to garden
- 5,000 litre water tank, with feed pump to laundry and toilets
- 25,000 litre water tank, with feed pump to whole house

Rainwater tanks are becoming increasingly popular to supplement reticulated supplies as people are becoming more aware of resource use, independence and increasing council charges and requirements. A good deal of use can be gained from even a tank of smaller capacity – say 1,000 litres – if used well. About 11% of water use in homes is for the outside, changing with season.

The usefulness of a rainwater tank is dependent on the size of the rainfall resource, the collection (usually roof) area, the size of the tank and the actual demand. There are decreasing returns by increasing storage tank size.

Approach

In terms of determining the water saved, the following approach was used. It was assumed that the roof collection area equates to 140 m^2 with the home occupied by three people year round who use an average 600 litres a day combined. The nine locations were divided into three rainfall climates: less than 800 mm/yr, 800–1,100 mm/yr and 1,100–1,400 mm/yr of rainfall.

Appling a rainwater calculator, these variables provided an estimation of the average yearly percentages of water supplied, by climate (location):

- The 1,000 litre tanks provide between 63,000 and 93,000 litres, depending on climate, for garden-only purposes.
- The 5,000 litre tanks provide between 76,000 and 120,000 litres, depending on climate, for laundry and toilet-only purposes.
- The 25,000 litre tanks provide between 83,000 and 134,000 litres, depending on climate, for laundry and toilet-only purposes.

These figures are indicative, based on average rainfall events, standardised occupant behaviour, and so on.

In terms of costing the rainwater storage solutions, two main sources were used – Abbott's 2010 article 'Estimating the cost benefits of rainwater tanks', adjusted for inflation, and the Greater Wellington Regional Council's resource *Rainwater tanks*. Polyester (plastic) tanks were used for each solution, and costs included the tank, pump with protective housing, delivery, installation, trade labour and all plumbing. No earthwork was assumed to be required. Individual city cost differences were not explored, as they were expected to be much the same. In only those councils that currently meter water by usage (instead of a charging a flat rate) were savings calculated.

More information

- Estimating the cost benefits of rainwater tanks. Abbott, S.E. (2010). *Water New Zealand*, 164, 26–31.
- Greater Wellington Regional Council: *Rainwater tanks*
- Smarter Homes: Collecting and using rainwater – www.smarterhomes.org.nz/water/collecting-and-using-rainwater
- Water Efficiency Labelling Scheme (WELS) – www.mfe.govt.nz/fresh-water/we-all-have-role-play/water-efficiency-labelling-scheme

Further advice

For independent and knowledgeable advice, contact the free, award-winning, Eco Design Advisor service www.ecodesignadvisor.org.nz

Feedback

We welcome constructive feedback. Please contact up-spec@branz.co.nz