Cost-effectiveness of water conservation measures and rainwater tanks in New Zealand houses

Installing water-saving fixtures in a new house can save significant volumes of water and reduce energy use where water is heated. Rainwater tanks can meet a large part of household water demand, but their cost-effectiveness depends on water supply charges (where meters are installed) and local rainfall levels.

THIS FACT SHEET covers the costs and benefits of installing domestic water conservation measures and rainwater tanks. The findings come from a larger BRANZ study on valuing sustainability and resilience features in New Zealand housing.

The overall project aims to provide an evidence base to help builders, designers and specifiers make better-informed decisions about investing in sustainability features. (For more details from the wider study, see the study reports listed in *More information*.)

Water efficiency

BRANZ looked at potential savings for installing in new houses appliances and fixtures that have a better-than-average WELS rating. Under WELS (the Water Efficiency Labelling Scheme), certain products must display a WELS label. The WELS label shows a star rating for relative water efficiency – the more stars, the better, up to a maximum of 6 (3 for showers) – and a water consumption or water flow figure.

The household products covered and the ways they are measured are:

- clothes washing machines (litres per wash)
- dishwashers (litres per wash)
- toilets (litres per half flush, full flush and average flush – the average of four half flushes and one full flush)
- showers (water flow in litres per minute)
- taps (water flow in litres per minute).

The specific fixtures considered in the study were:

- WELS 3-star showerheads
- WELS 4-star toilets
- WELS 5-star taps.

Table 1 shows potential savings from installing these fixtures in new homes compared to typical water use rates. The two types of cost included are:

- a council charge for the water supply
- heating costs for hot water use, assuming electrical heating.

Table 1. Water efficiency savings.

Water efficiency – potential savings for new houses

Typical total water use = 180 Lpd

					Typical (3)	Star rated	Household size (people)			
	Unit	Typical rate (1)	Star rate (2)		Lpd	Lpd	1	2	3	4
							Savings per house per day (litres)			
Shower	litre/min	8.0	6.0	WELS 3-star shower	53	40	13	26	40	53
Toilet	litre	8.0	4.0	WELS 4-star toilet	32	16	16	32	48	64
Taps	litre/min	12.0	7.0	WELS 5-star taps	25	15	11	21	32	42
					110	70	40	79	119	159
				Hot water energy savings kWh/year (5)			0	0	0	0

Water price c/litre including annual charge (assumes 270 Lpd) (4)									
People per house	1	2	3	4		**Savings per year water and water heating $**			
Auckland	0.34	0.24	0.20	0.19	Auckland	49	69	89	109
Tauranga	0.21	0.19	0.19	0.19	Tauranga	30	56	82	108
Wellington	0.30	0.23	0.20	0.19	Wellington	44	66	87	109
Nelson	0.41	0.31	0.28	0.26	Nelson	60	91	121	152
Christchurch	0.26	0.16	0.12	0.11	Christchurch	37	45	53	61
Dunedin	0.29	0.21	0.19	0.18	Dunedin	41	62	83	103

(1) Typical for new housing. Source BRANZ Water End-use and Efficiency Project (2007) and BRANZ Auckland water use project (2008).

(2) BRANZ assumption for WELS ratings.

(3) Assume 6.6 minutes per shower, one shower per person per day, four toilet flushes per person per day, taps are 14% total residental use. Lpd - litres per person per day.

(4) Price of water per litre is from schedule charges for the selected territorial authorities. The prices vary across household size due to the fixed component of pricing. Wellington prices are estimated by BRANZ electricity rate = 27.5 c/kWh.

(5) Allow 0.0348 kWh per litre heating from 16°C, and allow 10% for losses.

Geographically, there are no large differences. The difference comes with the number of occupants – the more people in a house, the greater the savings increase.

For the Auckland example in Table 1, the estimated annual saving ranges from $131–440 depending on the number of occupants. The cost of installing the water-saving devices has not been considered, as they are mostly standard items and dual flush is usually the default option with nil extra cost for toilet cisterns.

In most regions, households do not directly pay for water per unit used. However, Table 1 shows those cities where metering is compulsory or is available. The savings are significant considering that they come with little or no extra cost. The shower and taps require low-cost flow restrictors, and the toilet cistern needs to be specified as dual flush/low volume.

Rainwater tanks

Rainwater tanks are used in many houses around New Zealand, whether or not houses are connected to a reticulated system.

In rural areas, the homeowner has few choices, and most households have a tank system for supply.

However, in cities and towns, some owners and officials promote the merits of rainwater tank systems as a supplement to the reticulated supply. They are mandatory for new dwellings in Kapiti Coast District, a district with high per-person consumption and a significant cost to expand bulk supply. Rainwater is used for non-potable purposes such as toilet flushing and exterior taps for garden and other outdoor use.

The financial merit (or otherwise) of rainwater tanks is calculated using a unit price based on metering. Table 2 shows the water costs for selected councils. This includes the fixed annual cost spread over total consumption plus the charge per litre used.

Rainwater tanks are sized on the basis of the number of people in the household, roof areas and the likely rainfall in summer for the location. Payback is the number of years of water-saving cost to cover the initial expenditure on the tank, pump, electrician and plumbing.

Cities with metering commonly see use of 160–200 litres per person per day (Lpd). Unmetered cities use more, and up to 700 Lpd have been recorded in New Zealand.

Quite a small range from 180–360 Lpd was selected, as shown in Table 2. The payback years calculated are quite high, and a simple payback of more than 15 years is generally uneconomic.

In financial terms, 15 years represents a rate of return of about 5% on the initial cost, which is the minimum we would expect. The calculations do not allow for maintenance or for power to run the pump – likely to be a minor cost. A pump is usually necessary as gravity feed is incomplete with tanks on the ground.

In Table 2, Christchurch and Dunedin have long payback periods due to the low price of water and/or their lower rainfall than the other cities.

In many cases, the payback periods do not change significantly for bigger households, but for smaller households, the payback period becomes longer. See Study Report SR346 *The value of sustainability – costs and benefits of sustainability and resilience features in houses* for more details.

With domestic water supply, marginal costs can rise quite quickly as the lower-cost supply sites available to a local authority are exhausted.

Even though domestic water supplies in most areas are not metered, there is a cost to providing water that is paid for through local body rates. Where metering has been introduced, it has generally resulted in significant falls in consumption and is a valuable tool in situations where supply costs increase significantly with growth in demand.

Rainwater tanks in reticulated areas help to reduce demand. They are cost-effective in several locations where the supply cost is over about 0.15c per litre and summer rainfall is sufficient to replenish tank supply.

Table 3 shows the calculations for rainwater tank sizes and their costs for a 180 Lpd demand. (Study Report SR346 has data for higher Lpd.)

The calculations use the city summer and

winter rainfalls, house sizes and number of occupants.

The rainfall is assumed to occur on two occasions each month, which means the tank size can be smaller than if it was a single event. (However, note that some jurisdictions require a minimum tank size – for example, Kapiti requires a 10,000 litre tank for new dwellings unless greywater is used.) In this study, the maximum size was limited to 10,000 litres due to site restrictions on most redeveloped city housing sites. For example, in Table 3, for the 200 m^2 house, the tank supplies 44–87% of peak summer demand, depending on the location. The remaining summer water requirement is supplied from the city reticulation.

More information

BRANZ

Study Report SR159 *Water End-use and Efficiency Project (WEEP)*

Study Report SR333 *Valuing sustainability and resilience features in housing*

Study Report SR346 *The value of sustainability – costs and benefits of sustainability and resilience features in houses*

Bulletin 478 *Rainwater collection for domestic use*

www.level.org.nz – BRANZ website about sustainable housing

Other

Guidance on use of rainwater tanks. Australian Government Department of Health. Available online at: *http://www.health.gov.au/internet/main/publishing.nsf/Content/ohp-enhealth-raintank-cnt.htm*

Household water supplies. New Zealand Ministry of Health. Available online at: *https://www.healthed.govt.nz/resource/household-water-supplies*

Table 2. Rainwater tanks financial calculations. (Costs as at final quarter 2015.)

Rainwater tanks – cost effectiveness				170 m^2 house 3 people			
		180 Lpd	Payback	**270 Lpd**	Payback	**360 Lpd**	Payback
		Council charge	years		years		years
Location		cents/litre		cents/litre		cents/litre	
Auckland		0.24	14	0.20	14	0.19	13
Tauranga		0.19	16	0.19	14	0.19	13
Wellington		0.23	15	0.20	14	0.19	13
Nelson		0.31	11	0.28	10	0.26	10
Christchurch		0.16	28	0.21	36	0.11	42
Dunedin		0.21	17	0.19	19	0.18	21

The payback period is the cost of the tank, pump and plumbing divided by the annual savings in water costs. Lpd = litres per person per day. Water cost savings allow for the annual charge plus the per litre charge.

Table 3. Rainwater use details for 180 litres per person per day. (Costs as at final quarter 2015.)

Rainwater tanks – the financial case				Average use = 180 Lpd (moderate)	
House size m^2	100	120	170	200	250
People #	1	2	3	4	4
Required tank size (litres) to supply toilet, washer and outdoor use					
Auckland	2,000	3,500	5,500	5,500	10,000
Tauranga	2,000	3,500	5,500	10,000	10,000
Wellington	2,000	3,500	5,500	10,000	10,000
Nelson	2,000	3,500	5,500	5,500	10,000
Christchurch	2,000	2,000	3,500	3,500	4,000
Dunedin	2,000	3,500	3,500	4,000	5,500
% of summer demand met from rainwater tank					
Auckland	100%	91%	86%	76%	95%
Tauranga	100%	100%	98%	87%	100%
Wellington	100%	97%	91%	81%	100%
Nelson	100%	88%	83%	73%	92%
Christchurch	88%	53%	50%	44%	55%
Dunedin	100%	67%	63%	56%	70%
Cost tank + pump + plumbing + electrical $					
Auckland	2,550	2,750	3,050	3,050	4,250
Tauranga	2,550	2,750	3,050	4,250	4,250
Wellington	2,550	2,750	3,050	4,250	4,250
Nelson	2,550	2,750	3,050	3,050	4,250
Christchurch	2,550	2,550	2,750	2,750	2,850
Dunedin	2,550	2,750	2,750	2,850	3,050
Total annual water cost savings with a tank $					
Auckland	164	205	246	274	311
Tauranga	84	152	218	265	288
Wellington	143	196	243	275	313
Nelson	195	254	317	362	411
Christchurch	126	107	114	112	141
Dunedin	135	150	187	205	241
Simple payback period yrs					
Auckland	16	13	12	11	14
Tauranga	30	18	14	16	15
Wellington	18	14	13	15	14
Nelson	13	11	10	8	10
Christchurch	20	24	24	24	20
Dunedin	19	18	15	14	13
Cost of water cents/litre (for 3-person household and given Lpd)					
Auckland	0.43	0.29	0.24	0.21	0.21
Tauranga	0.22	0.20	0.19	0.19	0.19
Wellington	0.38	0.26	0.23	0.21	0.21
Nelson	0.52	0.36	0.31	0.29	0.29
Christchurch	0.36	0.21	0.16	0.13	0.13
Dunedin	0.36	0.25	0.21	0.20	0.20

Assume average water usage Lpd is = 180 of which about 58% can be supplied by rainwater for use in toilets, washer and outdoors. Tank size allows for the expected summer rainfall in each region.

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