BRANZ

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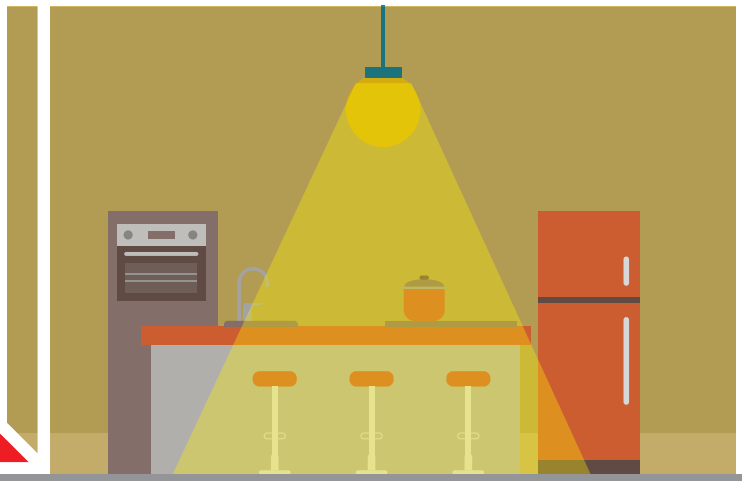

ENERGY EFFICIENCY IN NEW ZEALAND HOUSES

December 2019

- BRANZ collected data on energy and appliance use in homes as part of the last House Condition Survey.
- The survey found big opportunities for improving the energy efficiency in New Zealand houses.
- Improving energy efficiency has numerous benefits, from financial savings for households through to reduced greenhouse gas emissions.

1 INTRODUCTION

1.0.1 BRANZ has carried out a House Condition Survey (HCS) of New Zealand houses approximately every 5 years since 1994. The 2015 sample of 560 houses was broadly representative of the national housing stock and included both owner-occupied and rental houses. The houses were surveyed between September 2015 and June 2016. The survey comprised an on-site physical house assessment, a telephone interview with the occupants and an appliance use questionnaire completed by the occupants. The questionnaire was a new addition to the HCS, commissioned by the Energy Efficiency and Conservation Authority (EECA).

1.0.2 The findings of the HCS have been widely used by industry, government and non-government bodies.

1.0.3 One of the key findings – that there are considerable opportunities for improvements in energy efficiency in the existing housing stock – is supported by other work. In its 2018 Statement of Intent, EECA estimated that more than $470 million could be saved each year by improving the quality and energy efficiency of New Zealand's houses.

1.0.4 In addition to consumer savings from reductions in energy consumption, there is another specific benefit that comes from residential energy savings – reduced energy generation costs. Households account for a considerable amount of peak electricity use – on winter evenings, for example, when electricity is particularly expensive to produce. EECA has calculated that investing more in heat pumps, LED lighting and other efficient appliances in houses "could deliver thousands more GWh of extra renewable electricity capacity at a lower price than investment in new renewable generation alone".

1.0.5 The growing body of evidence of the risks posed by climate change have added an urgency to this issue. It has been estimated that buildings are directly and indirectly responsible for up to 20% of New Zealand's energy-related greenhouse gas emissions, contributing to climate change. Achieving improvements in energy efficiency is an important part of addressing this.

2 SPACE HEATING SYSTEMS AND APPLIANCES

2.0.1 Space heating typically accounts for around a third of the energy use in an average New Zealand house.

2.0.2 The most common types of heating appliance found in the HCS were, in approximate order of popularity:

- portable electric heaters (such as oil column heaters) in around half of all houses
- solid fuel heaters (typically wood burners) in 49% of owner-occupied homes and 36% of rentals
- heat pumps in 46% of owner-occupied houses and 27% of rentals
- fixed electric heaters (such as panel heaters) in 25% of owner-occupied homes and 18% of rentals
- fixed gas heaters in 22% of owner-occupied houses and 16% of rentals – overall, around 70% were flued.

2.0.3 Heat pumps, enclosed wood burners and flued gas heaters are among the more cost-effective heating appliances. These were more common in owner-occupied homes (88%) than rental homes (62%).

2.0.4 One in every five rental properties had no fixed heating system, relying solely on less-efficient portable heaters (Figure 1). This is almost three times the

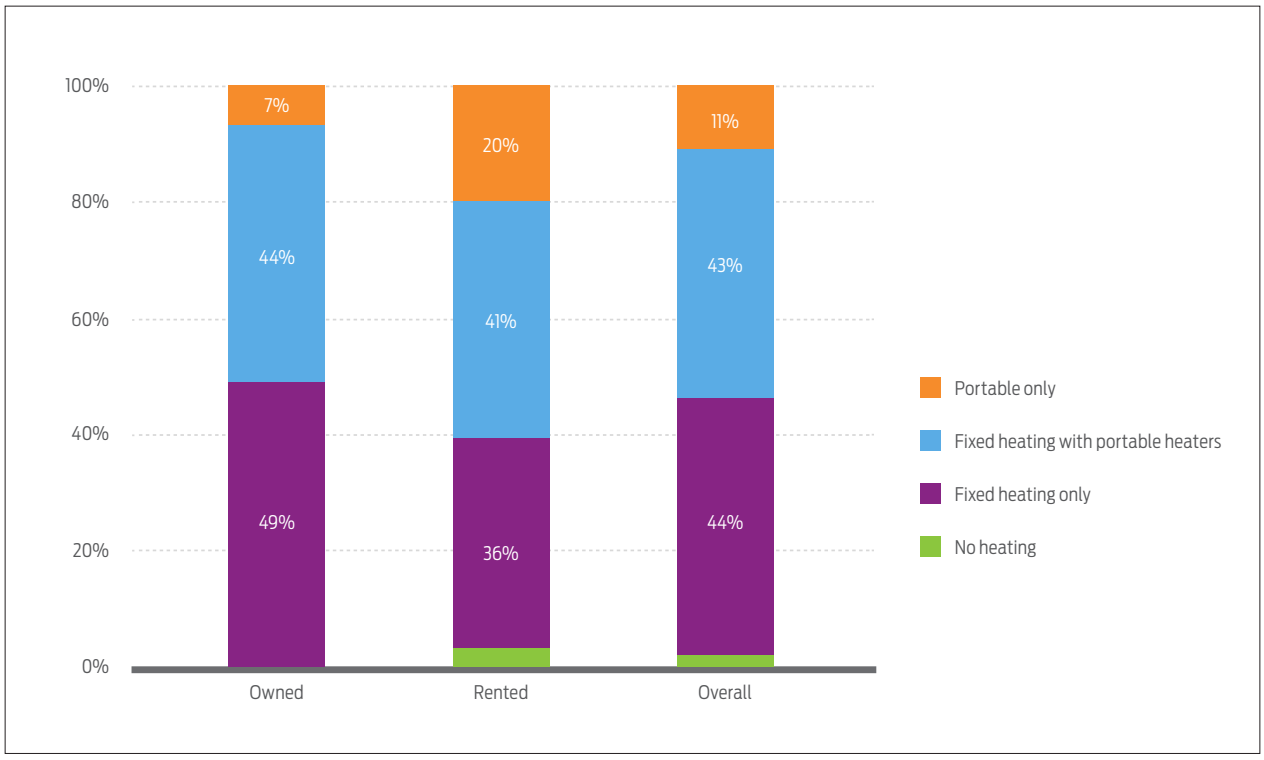

Figure 1. The presence of different heating types by tenure.

proportion of owner-occupied homes. The healthy homes standards are likely to change these figures – see section 9.

3 SPACE HEATING HABITS

3.0.1 While this bulletin focuses largely on energy efficiency and the reduction in energy use that can come from that, the health and wellbeing of occupants always needs to be considered. This is especially relevant in domestic space heating – a considerable amount of research has found many New Zealand houses to be unhealthily cold.

3.0.2 While the HCS recorded the presence of heaters in houses, the existence of a heater does not necessarily mean it is used. The appliance use survey therefore asked when householders usually heated living areas and occupied bedrooms in winter and the type of heater used most in each room:

- Overall, 5% of households did not usually heat living areas at all in winter.
- In 32% of households, all occupied bedrooms were usually heated at some time in winter (Figure 2).
- In 22%, some occupied bedrooms were heated in winter.
- In 46% of households, no occupied bedrooms were heated in winter, even where those bedrooms were occupied by children or older adults.

3.0.3 Without any heating in winter, it is unlikely the indoor temperature would consistently achieve the World Health Organization's minimum recommendation of 18°C.

4 THERMAL INSULATION

4.0.1 For ceiling insulation, EECA recommends a minimum depth of 120 mm across at least 80% of the accessible roof space. In the HCS, just 39% of houses (which works out to 610,000 homes) had ceiling insulation that met this requirement (Figure 3) while 41% had insulation less than 120 mm thick. Around 3% had no insulation at all in the roof space – across New Zealand, this works out to 52,000 houses. There was little difference in ceiling insulation levels between owned and rented houses, although a slightly higher proportion of rentals had less or no insulation in the roof space.

4.0.2 Around half of houses with ceiling insulation had at least one defect such as gaps in insulation (31%) or insulation settling (22%), not fitted properly (16%) or displaced (11%).

4.0.3 Underfloor insulation (at 80% coverage or more) was present in 43% of houses that had a subfloor cavity (450,000 homes).

4.0.4 Just over a quarter of rental properties with a subfloor cavity (26%) had no insulation (110,000 homes, 20% of all rentals). A further 9% had some insulation, but it covered less than 80% of the area. Overall, approximately 150,000 rentals have suboptimal subfloor insulation. Most of these (120,000 or 22% of all rentals) had an accessible subfloor that could in theory be retrofitted. The figures around subfloor insulation in rental houses are changing as a result of law changes – section 9 addresses this further.

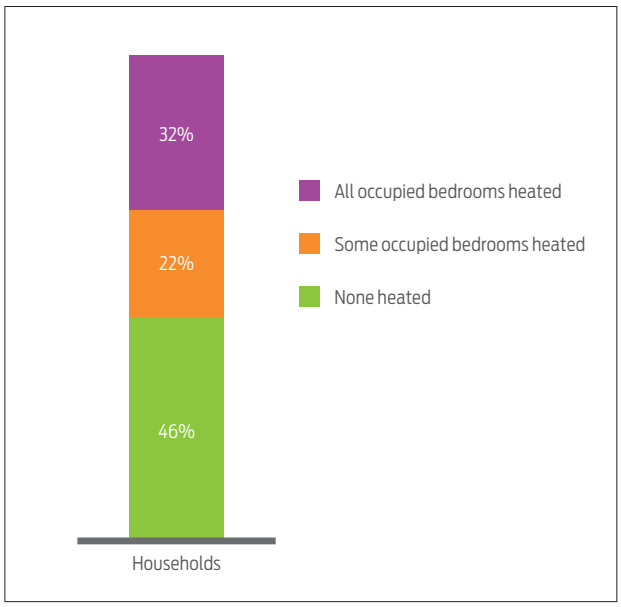

Figure 2. The proportion of households heating occupied bedrooms.

4.0.5 Of owner-occupied houses, 17% (180,000 homes) had an accessible subfloor and suboptimal subfloor insulation and could therefore benefit from retrofit.

4.0.6 Overall, the findings suggest that around 47% of houses (740,000 dwellings) could benefit from additional insulation in the roof space, and 28% of houses with a subfloor cavity (290,000 dwellings, 19% of all houses) could benefit from additional insulation of the subfloor. Combined, over half the housing stock (53% or 830,000 houses) could benefit from retrofitted roof or subfloor insulation or both. (Percentage figures do not always add to 100% because some roof or subfloor areas were not accessible to assessors.)

5 GLAZING

5.0.1 Windows may constitute only 8–10% of the thermal envelope of a house yet can account for up to 40% of heat losses if the home is built to little more than the minimum New Zealand Building Code requirements.

5.0.2 The HCS found that only 10% of all houses had double-glazed windows throughout. A further 8% had a mix of double and single glazing. In 81% of all houses, there were only single-glazed windows (climbing to 90% for rentals).

6 WATER HEATING SYSTEMS

6.0.1 New Zealand residential hot water systems are electric by a very wide margin, with the HCS finding that almost half were low-pressure electric cylinders (Figure 4).

6.0.2 With domestic water heating, energy efficiency is related to the grade of cylinder (where there is storage heating) and cylinder/pipe insulation, the temperature the water is heated to and delivered at, the length of

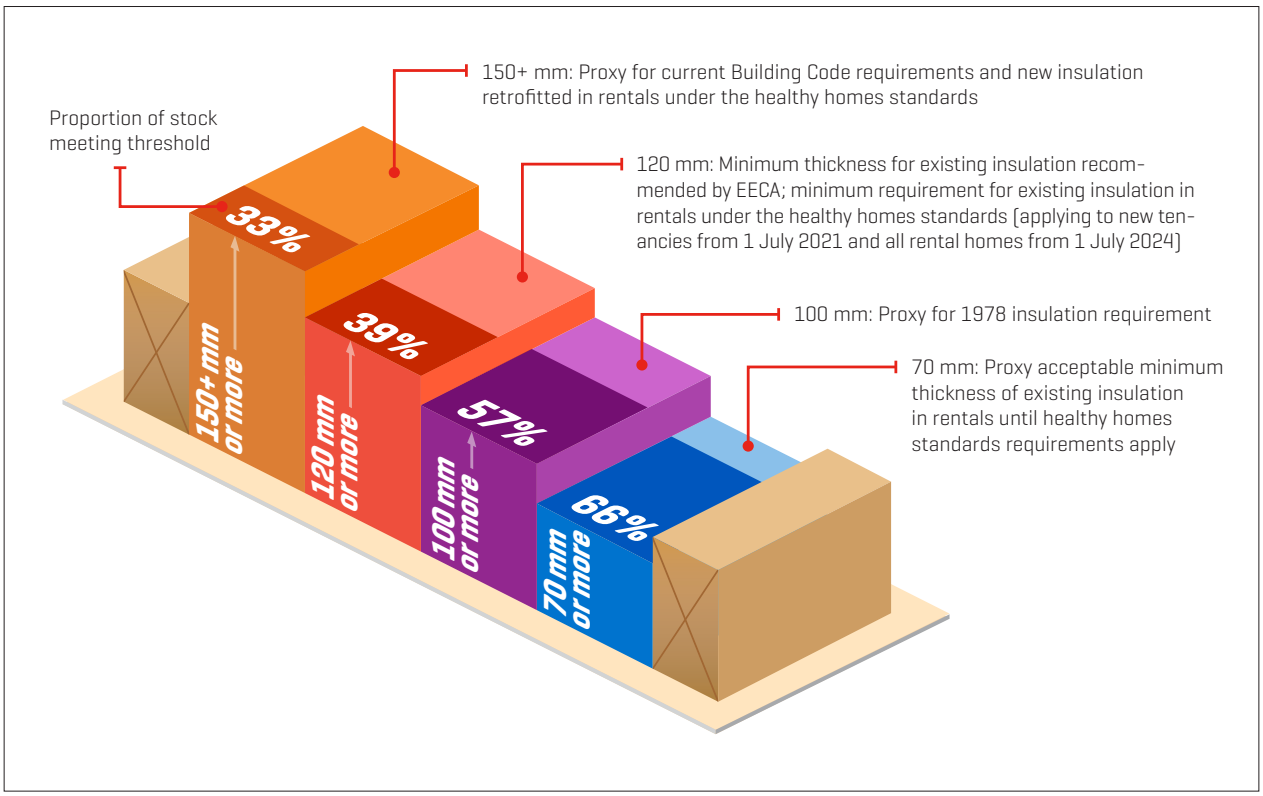

Figure 3. The proportion of houses where ceiling insulation depth meets a particular requirement.

hot water pipe runs, the flow rate of showers and the absence of leaks.

6.0.3 Hot water cylinder grades were not always accessible or available in the HCS, but the data that is available indicates that 38% were grade A (the most energy efficient), 30% grade B and 16% grade C or D. In houses built after 2000, 74% of cylinders were grade A.

6.0.4 EECA recommends adding a thermal wrap around cylinders from before 2002. Overall, 79% of cylinders that pre-dated 2002 (34% of all cylinders) had no cylinder wrap. This equates to just under half a million houses.

6.0.5 Two-thirds of hot water pipes were not insulated – this equates to over 1 million houses.

6.0.6 Hot water temperatures must be set for safety, with a cylinder thermostat setting of 60°C required to avoid the growth of dangerous *Legionella* bacteria. Higher temperatures put householders at risk of risk scalding and also waste energy.

6.0.7 The average temperature of all cylinder thermostats in the HCS was 62°C. While some settings were lower than 60°C, 25% of houses had a cylinder set at 65°C or higher and 11% set at 70°C or higher. These proportions of unnecessarily higher temperatures represent 400,000 and 170,000 houses respectively.

6.0.8 New Zealand Building Code Acceptable Solution G12/AS1 gives a maximum water temperature at the tap for home showers, baths and hand basins of 55°C

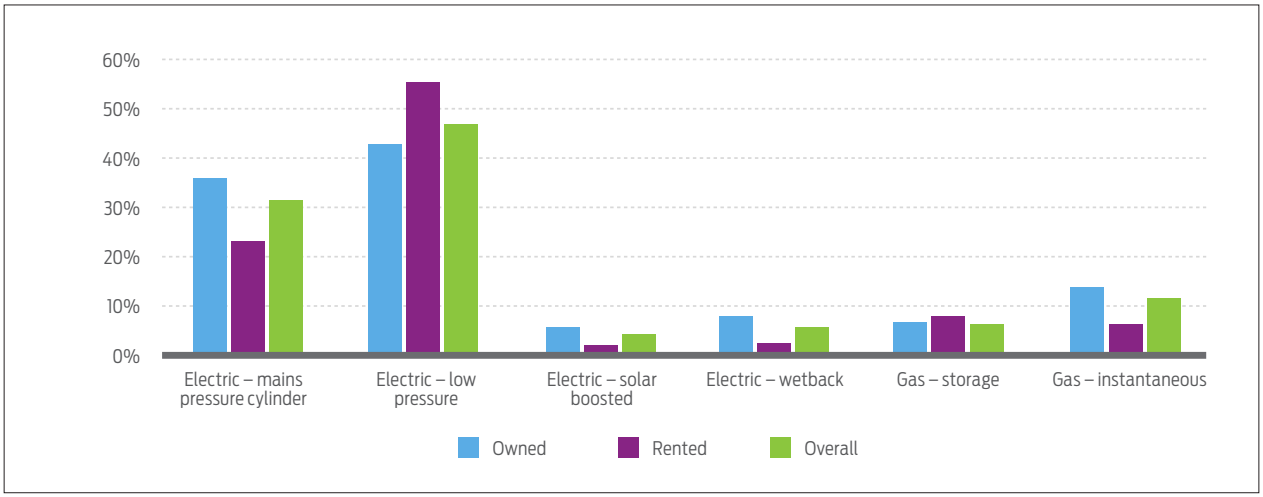

Figure 4. Water heating systems by type.

to prevent burns and scalds. The HCS found that just over one-quarter of taps (26%) were over 55°C. These were found in 31% of the houses, with a slightly higher proportion of rentals having a tap over 55°C.

6.0.9 The HCS gives an indicative measure of hot water pipe run distance from heater to kitchen tap. Distance is descriptive: 'reasonably close' is up to one room away, 'medium distance' is two rooms away and 'long distance' is more than two rooms away. In general terms, the longer the run distance, the greater the risk that heat energy will be lost, so shorter runs are preferred.

6.0.10 Owner-occupied houses were more likely to have longer distances between the hot water source and the kitchen tap, possibly because they were typically bigger houses. Overall, 42% of runs were reasonably close, 42% medium distance and 16% long distance.

6.0.11 EECA recommends a shower flow rate of 9 litres per minute or less, but in the HCS, 46% of houses had at least one shower with a flow rate greater than this (Figure 5). Higher flow rates were more likely in:

- owner-occupied houses
- houses built since 1990 – 55% of houses built in the 1990s and 79% of houses built from 2000 onwards had a shower with a flow rate greater than 9 litres per minute
- houses with a mains pressure or instantaneous gas hot water system.

6.0.12 Leaking taps or leaking showerheads were found in 7.5% of owner-occupied bathrooms and 5.6% of rental bathrooms. The numbers can be extrapolated to 147,000 houses across New Zealand. A leak of 10 drips per minute from a single source is a loss of 3 litres per day or 90 litres per month.

7 LIGHTING AND APPLIANCES

7.0.1 The householder appliance use questionnaire asked occupants to count the number of different bulb types in different rooms in the house (fixed lighting only). The most common form of light bulb was incandescent (Figure 6). These are a highly inefficient form of lighting – there are 9.5 W LEDs available that will produce the same amount of light as a 60 W incandescent bulb. If these lights are used for several hours every day, the incandescent can use around $14–15 more electricity each year than the LED.

7.0.2 Owner-occupied houses had an average of 27 fixed light bulbs, rental properties an average of 15. This extrapolates to over 35.1 million bulbs in New Zealand houses.

7.0.3 The appliance use questionnaire asked occupants about the use of a range of household appliances. Of the appliances not discussed so far, clothes washers and dryers and refrigerators are among those that typically use the most power.

- Top loaders are by far the most common type of washing machine in New Zealand, regularly used in 80% of houses. The more energy efficient front loaders are used in 19% of houses (22% of owner-occupied homes and 12% of rentals).
- Clothes dryers are used regularly in 50% of households.
- The most common type of refrigeration appliance (accounting for 35%) was the vertical fridge/freezer with a bottom freezer. Where estimates of the age of the fridge/freezer were provided by occupants, the average (mean) age was just over 10 years. Nearly one-third (32%) were up to 5 years old and a further third (33%) between 6 and 10 years old. EECA recommends replacing fridge/freezers when they are over 20 years old. This applies to 7% of refrigeration appliances in the survey.
- Most houses (55%) had one flat-screen television that was used regularly and 30% had two. The average (mean) screen size of all flat-screen TVs recorded

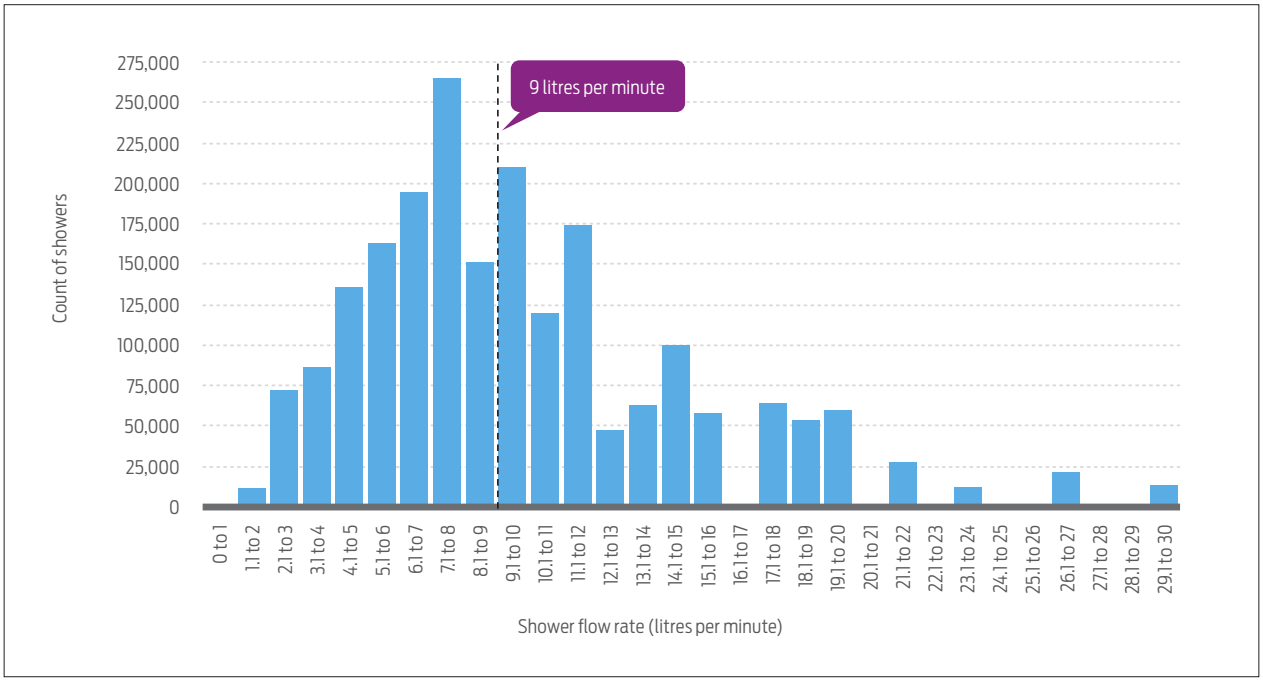

Figure 5. Shower flow rate (litres per minute) showing the recommended 9 litres per minute.

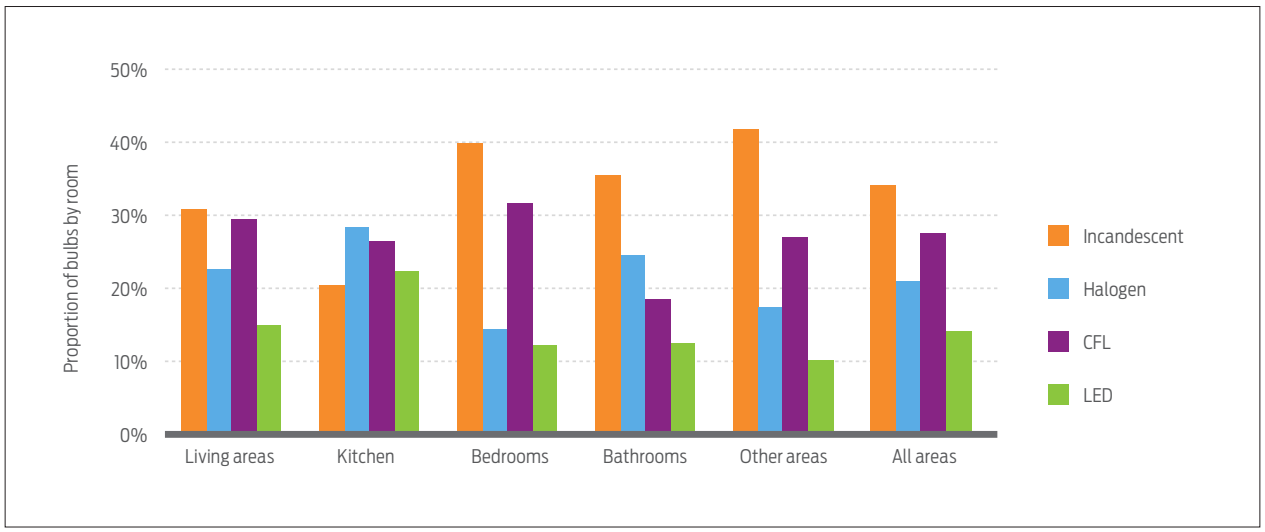

Figure 6. Proportion of different types of light bulb by room.

was 38 inches, with no difference between owned and rented houses.
- Dishwashers are used regularly in 68% of owner-occupied houses and 34% of rentals (56% overall).
- Rangehood/extractor fans are used in 62% of houses (68% in owner-occupied homes and 51% of rentals.)

8 RESIDENTIAL ELECTRICITY CONSUMPTION

8.0.1 New Zealand residential consumers are using less electricity. In 2019, The Ministry of Business, Innovation and Employment (MBIE) reported that, over 2009–2019, the amount of electricity used per capita had fallen by 15%. This is a faster fall than other advanced OECD countries. MBIE forecasts the downward trend to continue at around 0.8% per annum until 2030.

8.0.2 Part of the drop comes from consumers buying more energy-efficient appliances, and part comes from efficiency improvements in the appliances themselves. There was a 26% improvement in the overall efficiency of heat pumps sold in New Zealand between 2004 and 2014, for example.

8.0.3 The Warm Up New Zealand campaigns under different governments have also contributed. Since 2009, governments have spent $465 million to retrofit insulation into nearly 300,000 houses.

8.0.4 There is considerable evidence that consumers themselves are paying greater attention to energy consumption, particularly the cost of it. Each year, over 400,000 households switch their energy provider and over 100,000 households switch plans within their existing provider.

9 REGULATORY CHANGES AROUND ENERGY EFFICIENCY

9.0.1 A requirement for ceiling and underfloor insulation in rental homes where it is reasonably practical to install it came into effect on 1 July 2019. Ceiling insulation must be at least R2.9 in the North Island (excluding the Central Plateau) and R3.3 in the South Island and the North Island Central Plateau. (Insulation installed before 1 July 2016 complies if it was minimum R1.9, or R1.5 in masonry construction.) Underfloor insulation must be at least R1.3 (R0.9 if installed before 1 July 2016.)

9.0.2 New requirements for rental properties announced in February 2019 – the healthy homes standards – will apply to new tenancies from 1 July 2021 and to all rental homes from 1 July 2024.

9.0.3 The healthy homes insulation standard says that the minimum level of ceiling and underfloor insulation must either comply with the 2008 Building Code, or where there is existing ceiling insulation, it must have a minimum thickness of 120 mm.

9.0.4 There are other requirements in the healthy homes standards that directly relate to energy efficiency:
- Providing a fixed heater that can heat the main living area to 18°C in winter. In medium-sized and larger homes, this will likely be a heat pump or wood burner. Inefficient options such as open fires or unflued gas heaters will not comply.
- Preventing draughts that make a home harder to heat – blocking off open fires and draught-stopping gaps wider than 3 mm.

10 KEY OPPORTUNITIES FOR IMPROVEMENT

10.0.1 The 2015/16 House Condition Survey findings point to significant potential for energy efficiency improvements:
- The HCS findings suggest that around 47% of houses (740,000 homes) could benefit from additional insulation in the roof space, and 28% of houses with a subfloor cavity (290,000) could benefit from additional insulation of the subfloor. The insulation requirements in rental housing implemented in 2019 and in the healthy homes standards being implemented in 2021 and 2024 are addressing this in rental stock, housing

over one-third of New Zealand households, but big gains can also be made in owner-occupied housing.
- Replacing portable heaters with more energy-efficient space heating options such as heat pumps and efficient enclosed wood burners can provide big gains. The healthy homes standards will drive this in rental stock, but there is considerable room for this to be carried out in owner-occupied housing too.
- Significant savings can be made by changing to showerheads that have a flow rate of 9 litres per minute or less. The HCS found that almost one in two houses had at least one shower with a greater flow rate than this.
- While domestic hot water must be heated to at least 60°C to kill bacteria, the HCS findings suggest that half a million households have settings higher than 65°C – a waste of energy.
- Just over a third of existing hot water cylinders pre-date 2002, and over 80% of these had no insulating wrap (which EECA recommends). This equates to just under half a million houses. Two-thirds of hot water system pipes were not lagged – this equates to over 1 million houses.
- The HCS found that 34% of light bulbs in surveyed houses are incandescent and only 14% are LEDs. The gains available from switching light bulbs is considerable.

10.0.2 While there are many opportunities for improving energy efficiency in existing houses, of course the most cost-effective way of creating an efficient housing stock is to build efficient houses in the first place. This does not require a large amount of additional spending.

10.0.3 In one research project, for example, BRANZ examined 210 randomly selected new detached houses that met Building Code minimum requirements but did not take advantage of passive solar design. Using computer modelling, BRANZ found that the average house required two to three times the amount of heating energy to maintain comfortable conditions compared to a house of similar price that incorporated passive solar design.

10.0.4 While this bulletin has mostly addressed energy efficiency and assumed that reductions of energy use will come out of that, in some cases, an increased use of energy is called for. It is of concern that the HCS found that, in 46% of households, no occupied bedrooms were heated in winter, even where those bedrooms were occupied by children or older adults. This is unlikely to provide a warm and healthy home. The existence of rangehood/extractor fans in just 62% of houses also suggests that more than a third of all houses still require active ventilation to be installed to remove steam from kitchens and bathrooms to ensure a dry home.

11 MORE INFORMATION

SR372 *Warm, dry, healthy? Insights from the 2015 House Condition Survey on insulation, ventilation, heating and mould in New Zealand houses* (2017)

SR370 *BRANZ 2015 House Condition Survey: Comparison of house condition by tenure* (2017)

SR342 *Measuring our sustainability progress: Benchmarking New Zealand's new detached residential housing stock* (2015)

ER32 *Retrofitting insulation in residential properties* (2018)

ER27 *Doing better in residential dwellings: Going beyond the Code in energy and accessibility performance* (2018)

These can be downloaded from www.branz.co.nz/study_reports.

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www.tenancy.govt.nz

www.hud.govt.nz/residential-housing/healthy-rental-homes/healthy-homes-standards

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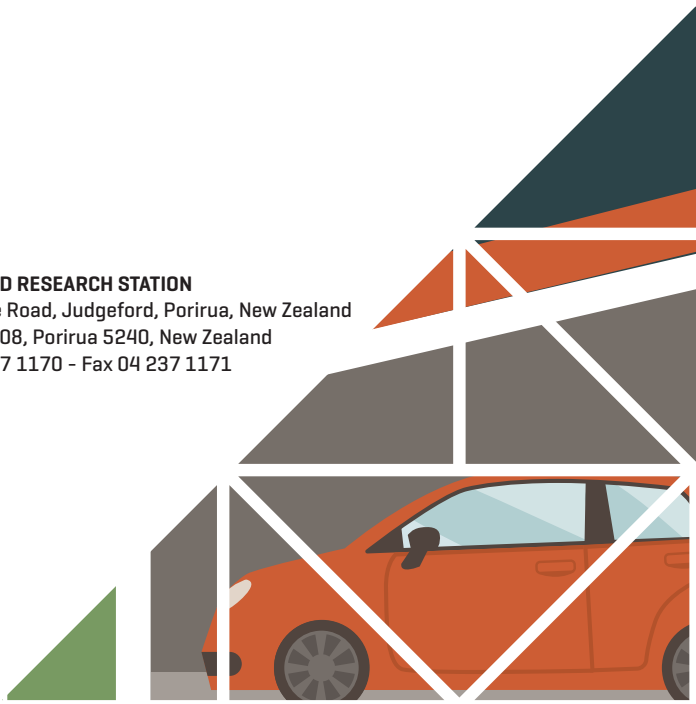

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