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Potential impacts of management measures - heating, household and fuel poverty data for Nelson - 2014

Envirolink Report NCC089

EXECUTIVE SUMMARY

Management of air quality in most urban areas of New Zealand targets solid fuel burning, in particular the main source of particulate concentrations in excess of National Environment Standards. Measures targeting domestic heating are typically cost effective relative to other sources. However, measures can impact on home warmth and there is potential for negative health impacts as an unintended consequence. Understanding of characteristics of dwellings, heating and households is important for policy makers to assess the costs and benefits of measures.

Information on dwelling characteristics, heating methods and heating behaviours was collected during a 2014 survey in Nelson. Additional information was obtained from Statistics New Zealand on fuels for space heating by income, tenure and source of income. Data were analysed for Nelson.

Key findings were:

- Around 5837 households in Nelson (combined airshed area only) used a wood burner for home heating in their main living area in 2014. This compares with around 5755 from the 2013 census.
- The proportion of households with no insulation in Nelson appears to have decreased from around 12% in 2006 to 4% in 2014.
- The proportion of households reporting ceiling insulation has increased by 10% since 2006 and the proportion reporting underfloor insulation has increased by 25%.
- Around 16% of households with wood burners have one or less forms of insulation.
- The majority of wood burners are used in owner occupied accommodation (77%).
- Around 40% of households using wood had a total household income of more than $77,000. However, around 18% of householders using wood burners had total earnings of less than $30,000 per year.
- Around two thirds of the wood used on wood burners was purchased from wood suppliers.
- The main types of households using wood burners are families with school age or younger children (36%) and couples who have no children at home (28%).
- Around 21% of wood burners are used in homes where the occupants are retired.
- Around 33% of wood burners are used in homes where the occupants are more than 60 years old
- Wood burners are typically used in larger houses (3+ bedrooms) more than 40 years old.
- Around 16% of households in Nelson are estimated to meet the definition of fuel poverty (when 10% or more of the annual income is spent on energy).

Overall the data suggest that it is unlikely that there has been an increase in cold homes in Nelson since 2006 as a result of the phasing out of high emission wood burners. The proportion of households that do not heat their homes has not increased over this period and there are fewer households relying on high cost heating methods such as electricity (non-heat pump) and unflued gas. In addition there has been an increase in the proportion of dwellings with ceiling and underfloor insulation, meaning houses should require less energy to achieve the same temperature (or the same energy may be used but the household may be warmer). Based on dwelling and heating method information, household warmth should have been more achievable in 2014 than in 2006.

These data may assist decision makers in evaluating potential impacts of policy on households in Nelson.

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1 INTRODUCTION

1.1 Background

The Nelson City Council's Air Plan became operative in 2008. The Plan included management measures targeting domestic home heating as the main source of winter time breaches of the National Environmental Standard (NES) for PM_{10}. The plan aimed to reduce PM_{10} concentrations in Nelson's Airshed A by 70% and in other airsheds by lesser amounts. The measures included in the Air Plan were:

i. A ban on outdoor rubbish burning from 2004

ii. Emission limits for new installations of solid fuel burners of 1.5 g/kg and an energy efficiency of 65% (when tested to NZS 4013).

iii. A ban on the use of open fires from January 2008.

iv. A ban on the installation of solid fuel burners in new dwellings or existing dwellings using other heating methods from 23 August 2003 (notification date of the Air Plan).

v. Airshed A and B1 - staged phase out of older burners from 2010, 2011 and 2013. The latter phase out date of wood burners installed between 2000 and 2003 was withdrawn following 2011 revisions to the NES. This resulted in approximately 320 burners in Airsheds A and B1 which did not get phased out and for which no legislative replacement date currently exists.

vi. Airshed B2 – staged phase out of older (pre 1990s burners) by 2010 and pre 1995 burners by 2012.

An evaluation of the effectiveness of the Air Plan in reducing PM_{10} concentrations in Nelson to meet the NES was carried out in 2014 (Wilton, 2014d). Results suggested significant reductions in concentrations in Airshed A and B1 where concentrations in breach of the NES historically occurred. Additional reductions in 2014 levels of around 14% are likely to be required for ongoing compliance with the NES (Wilton & Zawar Reza, 2014). An Air Plan review has been instigated by Nelson City Council. The review will consider additional management measures that may be required in Nelson as well as whether some existing rules could be revised to allow burners to be installed in new and existing dwellings not using solid fuel in some areas of Nelson.

Management of air quality in most urban areas of New Zealand targets solid fuel burning, in particular the main source of particulate concentrations in excess of National Environment Standards. Measures targeting domestic heating are typically cost effective relative to other sources (United Nations Economic Commission for Europe, 2014). However, measures can impact on home warmth and there is potential for negative impacts as an unintended consequence. Understanding of characteristics of dwellings, heating and households is important for policy makers to assess the costs and benefits of measures.

This report provides details of dwelling characteristics with respect to heating, insulation, home warmth of households for Nelson to assist in the Plan review. It will help inform Council of the likely impact of any further management measures targeting solid fuel burning.

The objectives of this study are to advise Nelson City Council on:

- Levels of insulation in homes
- Wood use for home heating in rented and owner occupied accommodation
- Other dwelling information – such as age of dwelling, storeys and number of rooms by heating method.
- Household characteristics (age, ethnicities, income source, prevalence of health issues)
- Heating characteristics – (full house, partial house, all day, part days) and an analysis of reasons for part day heating
- Wood sources for home heating
- Perceived levels of warmth with further analysis of household and dwelling characteristics for inadequate heating responses.
- An evaluation of income by wood use for rental and owner occupied dwellings in Nelson.
- An evaluation of the proportion of households that do not heat their homes in Nelson.
- An estimate of existing fuel poverty in Nelson

2 METHODOLOGY

A survey of 1337 households in Nelson was carried out during winter 2014 for Nelson City Council to collect information for an update of the air emission inventory for Nelson airsheds. Data were collected based on obtaining representative sample sizes for the airshed level. A subset comprising 937 households (3.1% sample error) was used to analyse results representative of Nelson as collation of the airshed specific data would have resulted in bias towards airsheds with greater sample sizes relative to total population. Selection of respondents to include/exclude for over represented airsheds was random. A sensitivity check was made of the impact of the subset of data relative to the whole dataset for a range of outputs. Using the whole dataset (1337 responses) resulted in minimal differences relative to the results reported here. .

Information on home insulation, tenure and dwelling and occupant characteristics were collected. Figure 2.1 shows the Nelson airshed areas included in the survey.

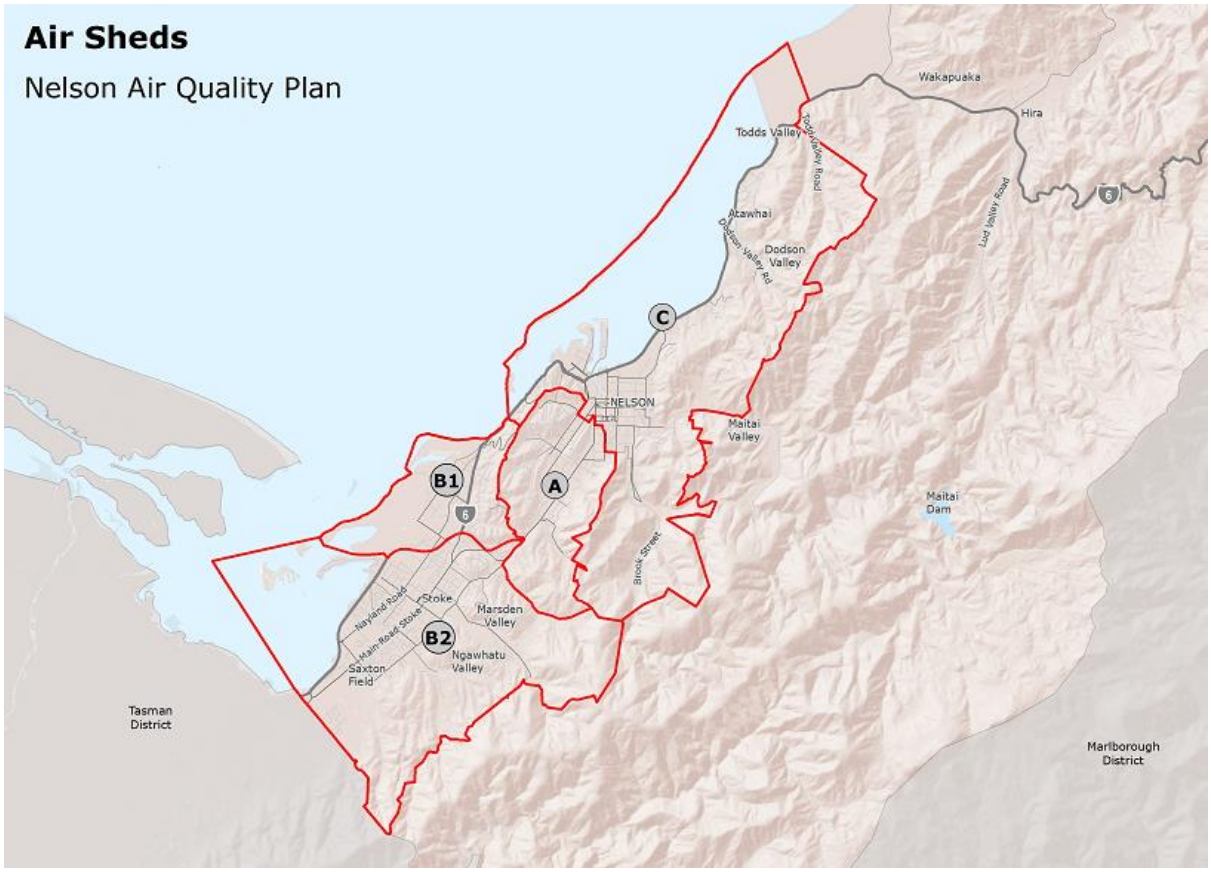

Figure 2-1: Nelson Airshed Areas

The telephone survey was carried out by Digipol using the survey questionnaire detailed in Appendix A.

An analysis of results was undertaken with a particular focus on household or dwelling characteristics by heating method. Most results are presented as a percentage of total households or as a percentage of households using wood burners or other heating methods.

3 HEATING METHODS

Table 3.1 summarises the heating methods for 2014 across the whole of Nelson. The majority of the households using solid fuel have wood burners with fewer than 120 households reporting multi fuel burner usage. Less than 310 households use pellet fires. Around 77% of households in Nelson use electricity to heat their main living area with 71% of these (55% of total households) using heat pumps. More than half of the households in Nelson use a heat pump in their main living area.

Table 3.2 shows that 75% of Nelson households use just one heating method in their main living area and around 20% use two methods. Only 2.5% of households report no heating methods with the majority of these having three or fewer forms of insulation in the dwelling. The point of this cross tabulation is to investigate whether lack of heating may occur as a result of a fully insulated house. A greater proportion of households in Christchurch (12%) report no heating in their main living area than in Nelson, although the proportion that report no fuel in the census is smaller (Wilton, 2014b).

Table 3.1: Home heating methods in Nelson - 2014

	2014 Heating methods	
	Percent	Households
Electricity	77%	13,948
Total Gas	7%	1,233
Flued gas	4%	731
Unflued gas	3%	502
Oil	0%	58
Open fire	0.0%	0
Open fire - wood	0%	0
Open fire - coal	0%	0
Total Wood burner	32%	5,837
Pre 2004 wood burner	7%	1,246
2004-2009 wood burner	9%	1,569
Post-2009 wood burner	17%	3,022
Total Multi-fuel burners	0.6%	116
Multi-fuel burners-wood	0.5%	96
Multi-fuel burners-coal	0.4%	77
Wood fired cooking stove	1.0%	173
Pellet burners	2%	308
Total wood	33%	6,311
Total coal	0%	77
Total households		18,051

Table 3.2: Number of heating methods used in Nelson compared with Christchurch

Number of heating methods	Percent of households Nelson	Percent of households Christchurch
One method	75%	67%
Two method	20%	18%
Three methods	1%	2%
No heating/no insulation (or don't know)	0.4%	1%
No heating 1-3 levels of insulation	2%	8%
No heating more than 3 levels of insulation	0.2%	3%

4 DWELLING INFORMATION

4.1 Age and size of dwelling

Table 4.1 shows the distribution of different heating methods by size of dwelling (as indicated by the number of bedrooms). Results indicate that wood does not appear a more popular heating method in larger homes overall although results suggest a slightly greater prevalence in 5 and 6 bedroom homes but a lower prevalence in four bedroom homes.

Heating methods by age of dwelling is shown in Table 4.2. This shows that wood burners are more prevalent in older dwellings with 72% of wood burners being used in dwellings more than 41 years old.

Table 4-1: Distribution of heating methods by number of bedrooms

Number of bedrooms	Electric	Gas	Wood burner	Average distribution
1	0%	4%	0%	3%
2	14%	25%	23%	23%
3	53%	48%	56%	49%
4	27%	21%	14%	21%
5	5%	2%	5%	3%
6	1%	0%	2%	1%

Table 4-2: Distribution of heating methods by number of age of dwelling

Age of dwelling	Wood burner	Gas	Electric heating	Average age distribution of dwellings
10 years or less	3%	14%	17%	12%
11-20 years	5%	15%	16%	14%
21-40 years	16%	23%	16%	22%
41 + years	72%	43%	52%	47%
Don't know	3%	5%	0%	4%

4.2 Insulation

The different types of household insulation used in Nelson homes in 2014 are compared to survey responses for the 2006 inventory in Table 4.3 (previously unreported data). An improvement in household insulation has occurred over this period with an additional 11% of households having ceiling insulation, 25% that have underfloor insulation and 18% having double glazing. In addition the proportion of households reporting no insulation has decreased from 12% in 2006 to 4% in 2014. While this is a reasonable improvement, it is worth noting around 20% of dwellings have only one form or insulation or no insulation. Table 4.4 shows the distribution of insulation by heating method.

Table 4-3: Insulation types and amounts

Insulation type	2006 %	2014 %	Degree of insulation	2006	2014
Ceiling	77%	88%	No insulation	12%	4%
Underfloor	26%	51%	Just one type	24%	16%
Wall	50%	52%	Two types	30%	28%
Cylinder wrap	19%	31%	Three types	19%	24%
Double glazing	7%	25%	Four types	7%	18%
None	12%	4%	Five types	2%	6%
Don't know	7%	4%			
Other	1%	1%			

Table 4-4: Amount of insulation by heating type

Insulation level	Electric	Gas	Wood burner
One type	16%	23%	13%
Two types	28%	27%	32%
Three types	24%	13%	25%
Four types	18%	27%	19%
Five types	6%	6%	5%
None or don't know	4%	3%	2%

4.3 Number of storeys

The number of levels a house is split across impacts the energy requirements for heating with two storey properties requiring less energy per square metre of dwelling than a single storey property. Table 4.5 shows that the majority of households with wood burners in Nelson are on a single level.

Table 4-5: Amount of insulation by heating type

	Wood burner	Electric	Gas	Overall
One storey house/ unit	60%	68%	63%	67%
Two or more storey house with living rooms and bedrooms on two or more levels	29%	23%	23%	23%
Two or more storey house with living and bedrooms on one level	10%	7%	9%	7%
Apartment with living and bedrooms on one level	0%	2%	2%	1%
Apartment with living and bedrooms on more than one level	0%	1%	2%	1%

5 HOUSEHOLDER CHARACTERISTICS

5.1 Income, source of income and characteristics of occupancy

Household income is relevant in terms of the affordability of different heating methods and the acceptability of the capital costs associated with changing methods. Table 5.1 provides a rough indication of the income distribution of households using wood burners. However, around 9% of respondents with wood burners did not answer the income question so any of the income categories for households with wood burners may be up to 9% higher than reported in Table 5.1.

At least one third of households in Nelson using wood burners have an annual household income of more than $77,000. At the other end of the income spectrum at least 19% of wood burners in Nelson are used by households with incomes less than $33,000 per year. Further details on income by tenure for wood use from the census are shown in section 5.6. Income categories are slightly different but income results are similar. Income and heating method data provide useful information when considering factors such as the impacts of potential management measures.

Table 5-1: Heating method by income

	Wood burner	Electric	Gas	Overall
Under $21,000	7%	9%	6%	9%
$21,000 - $33,000	12%	16%	16%	16%
$33,001 - $52,000	17%	17%	17%	18%
$52,001 - $77,000	22%	21%	20%	20%
$77,000 and over	33%	23%	28%	24%
Don't Know/Refused	9%	14%	13%	13%

Table 5.2 shows that the majority of households with wood burners have a main source of income being full time employment with 26% having part time employment. Around 21% of households with wood burners were retirees. Wood burners are most prevalent in households comprising of families with school age children (36%) and a couple without children at home (28%).

Table 5-2: Heating method by source of income

	Wood burner	Electric	Gas	Overall
Full-time paid employment	39%	35%	39%	36%
Part-time paid employment	28%	21%	19%	22%
Unemployed	6%	5%	6%	6%
Student	2%	2%	2%	2%
Primary caregiver (children/adult) at home	4%	2%	5%	3%
Retired	21%	34%	28%	30%
Refused/not sure	1%	2%	2%	1%

Table 5-3: Heating method by type of household

	Wood burner	Electric	Gas	Overall
Single person below 40 living alone	1%	1%	2%	1%
Single person 40 or older living alone	13%	27%	19%	24%
Young couple without children	2%	2%	2%	2%

Family with oldest child who is school age or younger	36%	22%	25%	26%
Family with an adult child still at home	13%	10%	20%	11%
Couple without children at home	28%	32%	27%	30%
Flatting together	3%	2%	5%	2%
Boarder	0%	1%	0%	1%
Other	1%	2%	0%	2%

5.2 Respondent ethnicity and age

Table 5.4 shows the heating method by age of respondent and illustrates around 32% of wood burners are used in households where the respondent was 60 years or older. This compares with 21% of respondents from Table 5.2 which were retired indicating around on third of the 60+ year old wood burner respondents in Table 5.4 are not retired. Table 5.5 shows that 22% of respondents over 80 use wood burners and that 92% of the over 80 age group use electricity. Age group categories add up to more than 100% because some households use multiple heating methods in their main living area.

Table 5-4: Heating method by age of respondent

	Wood burner	Electric	Gas	Overall
18-29 years	6%	4%	3%	4%
30-39 years	14%	11%	9%	12%
40-49 years	23%	17%	23%	19%
50-59 years	25%	23%	31%	24%
60-69 years	16%	19%	14%	18%
70-79 years	11%	18%	16%	16%
80 years or older	5%	8%	2%	7%
Refused	0%	0%	2%	0%

Table 5-5: Age of respondent by heating method

	Wood burner	Electric	Gas
18-29 years	45%	73%	5%
30-39 years	37%	70%	5%
40-49 years	39%	70%	9%
50-59 years	34%	74%	9%
60-69 years	30%	82%	5%
70-79 years	22%	87%	7%
80 years or older	22%	92%	2%

Heating method by ethnicity (Table 5.6) suggests no particular preferences for heating methods with all methods similar to the population ethnicity distribution.

Table 5-6: Heating method by ethnicity

	Wood burner	Electric	Gas	Overall
New Zealander of European descent	81%	81%	83%	81%
New Zealander of Maori descent	4%	3%	0%	4%

European	8%	9%	9%	9%
Samoan	0%	0%	0%	0%
Cook Island	1%	0%	0%	0%
Other Pacific Islander	0%	0%	0%	0%
Chinese	0%	0%	2%	0%
Indian	1%	1%	2%	1%
Other Asian	0%	0%	0%	0%
Other	4%	4%	3%	8%

5.3 Health issues

The prevalence of chronic health problems was estimated for Nelson households based on reported respiratory illness and other chronic health problems. Around 19% of total households had at least one person with chronic respiratory illness (Table 5.7). From the data collected a factor of 1.2 could be applied to estimate the total number of people affected by respiratory illness. The prevalence of illness did not differ significantly between wood burning households and total households.

Table 5-7: Heating method by health impact

	Wood burner	Electric	Gas	Overall
Respiratory illness	18%	18%	20%	18%
Other long term health	19%	24%	22%	22%

Table 5.8 shows the age of the respondents for households with an occupant that suffers from respiratory illness for all heating methods. This indicates around 57% of respondents with occupants of the dwelling having chronic respiratory illness were aged 60 or over and only 12% were less than 40 years old.

Table 5-8: Prevalence of respiratory illness by age

	Respiratory illness	
	Number	Percentage
18-29 years	77	2%
30-39 years	385	10%
40-49 years	520	13%
50-59 years	751	19%
60-69 years	905	23%
70-79 years	1079	27%
80 years or older	270	7%

5.4 Heating behaviour

The extent to which households heat their home both spatially and temporally is summarised by heating method in Table 5.8. This shows that only 9% of households in Nelson heat their whole house for all of the day with a further 11% heating the living area only all day. An evaluation of reasons for not heating during the daytime found that around half of the households surveyed did not have people typically at home during the daytime. Around 21% did not heat during the day because of the cost and around 30% did not heat their home during the day either because of a combination of cost and not being at home or because the home received enough sun during the daytime that it didn't need heating.

Around 65% of households with wood burners use them in the evening only, with over half of these using them to heat the main living area only and the remainder heating the whole house.

A greater proportion of homes using wood burners heated the whole house in the evening compared with electricity or gas heated main living areas. Whole house all day use was not significantly different between wood burning households and those using electricity.

Table5.9: Heating method by space heating behaviour

	Wood burner	Electric	Gas	Pellet	Overall
One room (living room) in evening	37%	46%	53%	44%	44%
Whole house in evening	28%	16%	13%	6%	19%
Living area 24/7 and rest of house evening only	10%	9%	11%	0%	9%
One room (living room) all day	10%	13%	6%	19%	11%
Whole house all day	10%	8%	8%	19%	9%
Other (Specify)	0%	1%	3%	0%	1%

5.5 Source of firewood

The majority (66%) of wood burnt on wood burners is purchased from a wood merchant with 34% being self-collected or obtained free of charge. Section seven of the report provides further detail on source of firewood by demographics.

5.6 Tenure, income and wood use

Table 5.10 shows the number of households with wood burners by income and tenure for 2013 based on Statistics New Zealand data for households reporting fuels used anywhere in a dwelling. The total number of wood burning households for the airshed areas from these data is 5754 compared with 5837 from the 2014 survey. Differences are well within the sample error of the survey. Table 5.10 shows that majority of wood burners are located in owner occupied dwellings with average household incomes of more than $50,000. Around 40% of wood burner prevalence is in households (owned and rented) with average incomes of more than $77,000 and 55% in households earning more than $50,000.

Table5.10: Wood use by income and tenure for Nelson

Owned $20,000 or Less	Owned $20,001 - $30,000	Owned $30,001 - $50,000	Owned $50,001 - $70,000	Owned $70,001 - $100,000	Owned $100,001 or More	Owned Not Stated	Owned Total
265	327	720	691	899	1067	412	4364
5%	6%	13%	12%	16%	19%	7%	77%
Rented $20,000 or Less	**Rented $20,001 - $30,000**	**Rented $30,001 - $50,000**	**Rented $50,001 - $70,000**	**Rented $70,001 - $100,000**	**Rented $100,001 or More**	**Rented Not Stated**	**Rented Total**
158	161	273	211	174	109	203	1324
3%	3%	5%	4%	3%	2%	4%	23%

Table 5.11 shows wood use by income and tenure by airshed with data expressed as a proportion of the households using wood in each airshed. In all airsheds more than 70% of the burners are in owner occupied

dwellings. Airshed A has the highest proportion of rented dwellings using wood at 27%. The income distribution for households using wood is similar across all airsheds.

Table 5-9: Wood use by income and tenure for Nelson by airshed

Owned $20,000 or Less	Owned $20,001 - $30,000	Owned $30,001 - $50,000	Owned $50,001 - $70,000	Owned $70,001 - $100,000	Owned $100,001 or More	Owned Not Stated	Owned Total
5%	5%	11%	12%	16%	18%	7%	73%
3%	5%	15%	13%	15%	19%	9%	77%
4%	7%	13%	12%	17%	18%	7%	79%
5%	5%	13%	11%	15%	20%	8%	78%
Rented $20,000 or Less	**Rented $20,001 - $30,000**	**Rented $30,001 - $50,000**	**Rented $50,001 - $70,000**	**Rented $70,001 - $100,000**	**Rented $100,001 or More**	**Rented Not Stated**	**Rented Total**
4%	3%	6%	4%	3%	1%	5%	27%
2%	2%	6%	4%	3%	3%	3%	23%
2%	2%	5%	4%	3%	2%	3%	21%
3%	3%	4%	4%	3%	2%	3%	22%

6 HOME WARMTH

6.1 Survey responses

The survey included questions relating to perceived household warmth as well as reasons for not heating during the daytime. An analysis was done to characterise households that reported inadequate household warmth. It is noted that perception of warmth will vary from person to person as will indoor temperatures that may correspond with "cold", "adequate" or "warm" heating. Tables 6.1 to 6.7 detail households reporting inadequate warmth by airshed, types of household, insulation, age, income and fuel source. Table 6.2 shows the distribution of perceived levels of warmth for different household types. This suggests higher levels of reported adequate or warm homes amongst single people and couples without children at home. Around 21% of households with young children report living in homes that are too cold. Table 6.3 suggest that this is the largest group of households that report their home being "too cold" at 33% of dwellings.

Table 6-1: Perceived warmth of homes by airshed

	Airshed A		Airshed B1		Airshed B2		Airshed C	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Too cold	885	20%	494	22%	1042	16%	532	12%
Adequate	1977	45%	911	41%	2876	43%	2206	48%
Warm	1549	35%	833	37%	2780	41%	1820	40%

Table 6-2: Household type by perceived warmth of home for different household types (expressed as a percentage of household type)

	Too cold	Adequate	Warm
Single person below 40 living alone	25%	25%	50%
Single person 40 or older living alone	12%	46%	42%
Young couple without children	36%	36%	27%
Family with oldest child who is school age or younger	21%	43%	36%
Family with an adult child still at home	19%	39%	41%
Couple without children at home	13%	48%	39%
Flatting together	32%	26%	42%
Boarder	60%	20%	20%

Table 6-3: Perceived warmth of homes by type of household (expressed as a percentage of homes with perceived warmth)

	Too cold	Adequate	Warm
Single person below 40 living alone	1%	1%	1%
Single person 40 or older living alone	17%	26%	27%
Young couple without children	5%	2%	2%
Family with oldest child who is school age or younger	33%	26%	25%

Family with an adult child still at home	13%	10%	12%
Couple without children at home	23%	34%	30%
Flatting together	4%	1%	2%
Boarder	2%	0%	0%

Table 6.4 shows that around half of the "too cold" respondents were in the 40-60 age bracket. Those aged 70 or over typically had adequate or warm homes.

Table 6-4: Perceived warmth of homes by age of respondent

	Too cold	Adequate	Warm	Too cold	Adequate	Warm
18-29 years	308	231	231	10%	3%	3%
30-39 years	385	1040	771	13%	13%	11%
40-49 years	751	1483	1117	25%	19%	16%
50-59 years	732	1695	1811	24%	21%	26%
60-69 years	385	1445	1329	13%	18%	19%
70-79 years	327	1387	1098	11%	17%	16%
80 years or older	116	616	501	4%	8%	7%
Refused	0	39	19	0%	0%	0%

Table 6.5 shows that most of the households that report inadequate warmth have three or fewer levels of insulation. Only a small number of households with five levels of insulation report have reported warmth levels of "too cold".

Table 6-5: Perceived warmth of homes by extent of insulation

	Too cold	Adequate	Warm	Too cold	Adequate	Warm
Just one type	655	1503	655	22%	19%	9%
Two types	867	2119	2042	29%	27%	30%
Three types	655	1965	1753	22%	25%	25%
Four types	308	1406	1464	10%	18%	21%
Five types	19	462	578	1%	6%	8%
none or don't know	501	482	405	17%	6%	6%

Table 6.6 shows the perceived levels of home warmth by income. This suggests that at least 20% of households that gave a "too cold" ranking have an average household income of greater than $77,000 and was the second largest group with this rating. The income group most affected by cold homes based on their own perception ranking is those earning between $33,000 and $50,000 per year.

Table 6-6: Perceived warmth of homes by income

	Too cold	Adequate	Warm	Too cold	Adequate	Warm
Under $21,000	308	501	713	10%	6%	10%
$21,000 - $33,000	443	1464	867	15%	18%	13%
$33,001 - $52,000	809	1233	1117	27%	16%	16%
$52,001 - $77,000	520	1772	1387	17%	22%	20%
$77,000 and over	597	1888	1869	20%	24%	27%
Don't Know/Refused	327	1079	944	11%	14%	14%

Table 6.7 shows the perceived level of warmth by fuel type. Note that there is an overlap in household reporting in this table as many households use more than one fuel type. Results suggest that only a small proportion of households using wood perceive the house temperature to be "too cold".

Table 6-7: Perceived warmth of homes by fuel type

	Too cold	Adequate	Warm	Too cold	Adequate	Warm
Wood	655	2350	2793	11%	41%	48%
Electricity	2427	6608	4739	18%	48%	34%
Gas	289	559	385	23%	45%	31%

6.2 No fuel used

The 2013 census includes a question regarding fuel use for space heating within homes. One option is no fuels used. These data were obtained from statistics New Zealand at the CAU level by income and tenure to provide further insight into potential cold homes. While census data typically contain a low error small response number and cross tabulations (e.g., tenure by fuel by income) contain inaccuracies owing to issues of confidentiality reporting for small sample sizes (responses with three households or fewer are reported as "..C"(confidential)).

Table 6.8 shows an estimate of the prevalence of no heating within households across the four airsheds. Households in rental accommodation are more likely to be not heating their homes than those in owner occupied accommodation. It also shows that the Airshed B1 contains the highest proportion of households that don't heat their homes and that Airshed B2 contains the lowest. Table 6.9 shows the distribution of households that don't heat by tenure and income. Slightly more than half of households that do not report using fuels for space heating have an annual household income of less than $50,000. Around 12% have household incomes of more than $77,000. While it is expected that most households that do not use fuels for heating are going cold some households may require minimal or no heating as a result of insulation, materials and design.

Table6.8: Prevalence of no fuel use by tenure and airshed

	Owned	Rented	Not stated	Total	Total Households	Percent households
Airshed A	15	57	6	78	4425	1.8%
Airshed B1	9	33	3	45	2259	2.0%
Airshed B2	6	42	6	54	6756	0.8%
Airshed C	14	37	9	60	4611	1.3%
	44	169	24	237		

Table6.9: No fuel use by income and tenure (percentage of total households using wood)

Owned $20,000 or Less	Owned $20,001 - $30,000	Owned $30,001 - $50,000	Owned $50,001 - $70,000	Owned $70,001 - $100,000	Owned $100,001 or More	Owned Not Stated	Owned Total
3%	3%	4%	2%	2%	2%	3%	19%
Rented $20,000 or Less	**Rented $20,001 - $30,000**	**Rented $30,001 - $50,000**	**Rented $50,001 - $70,000**	**Rented $70,001 - $100,000**	**Rented $100,001 or More**	**Rented Not Stated**	**Rented Total**
17%	11%	15%	10%	3%	5%	11%	71%

Figure 6.1 shows the trends in reporting of no fuels used for space heating in the census over time for the four aisheds. Data indicates a peak in no heating in all airsheds in 2001 with decreases between 2001 and 2006.

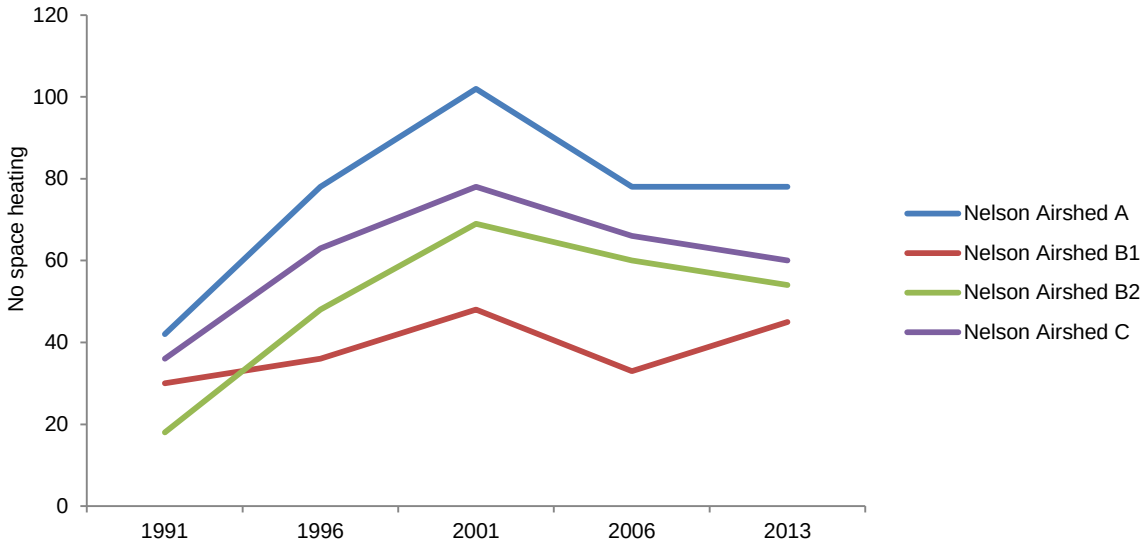

Figure 6-1: Trends in "no fuels used" for space heating by airshed (1991-2013)

6.3 Other indicators of colder homes

One of the potential impacts of the air plan was an increase in "cold homes" in Nelson as a result of householders being unable to afford to replace wood burners with NES compliant burners at the time they were phased out or as a result of households missing the phase out dates and no longer having wood burning as a heating option.

Wood burners and heat pumps have a similar kWh operating cost so the move from wood burner to heat pump is unlikely to result in financial disadvantages that might significantly impact on the household warmth. The exception is households that obtain wood free of charge. These households had additional motivation to replace burners prior to the end of the phase out date, or if renting to select a home with a wood burner. However, it is possible that some households that may previously have obtained wood free of charge are no longer able to use it as a fuel because of the lack of a burner in a property. These households would now be in the position of having to fund an alternative heat source, most probably high cost electricity or low cost electricity (heat pump).

The indicators of more households going cold in Nelson include:

- Proportion of households that do not heat their homes.
- An increase in the proportion of households that use high cost electricity heating as the main heating method.
- An increase in the proportion of households that use unflued gas heating as the main heating method.

Section 6.2 shows that the number of households that do not use fuels to heat their homes peaked in all Airsheds in 2001 and has not increased between 2006 and 2013 in any airshed except for Airshed B1 which increased from 1.6% of households in 2006 to 2% of households in 2013 as a result of an additional twelve dwellings reporting no heating in 2013. Across Nelson there was no change in the number of households reporting no heating between 2006 and 2013.

An evaluation was carried out of the number of households across Nelson that used high cost electricity as their main heating method (any method excluding heat pumps) in 2006 and in 2014. In 2006 15% of households in Nelson used non heat pump electric heating as their main heating source compared with 13% in 2013.

A similar evaluation of the proportion of households using unflued gas heating in 2006 and 2013 showed a reduction in the prevalence of this high cost heating method with 16% of households in Nelson using unflued gas heating in 2006 and only 3% using unflued gas heating in 2014.

An analysis of data suggests it is unlikely that there has been an increase in cold homes in Nelson since 2006 as a result of air plan rules. The proportion of households that do not heat their homes has not increased over this period and there are fewer households relying on high cost heating method such as electricity (non-heat pump) and unflued gas. In addition there has been an increase in the proportion of dwellings with ceiling and underfloor insulation, meaning houses should require less energy to achieve the same temperature (or the same energy may be used but the household may be warmer).

7 ADDITIONAL ANALYSIS OF DATA

The following assessment provides further cross tabulations on survey information from the 2014 Nelson home heating and demographics survey. Sample sizes at the level of three cross tabulations are smaller than for results presented previously so **results should be treated as indicative only**.

The following three level cross tabulations were made:

- Insulation in houses with wood burners and occupants over 60 years old.
- Insulation in houses with wood burners occupied by families with the oldest child being school age or younger.
- Insulation in houses with wood burners by house size (as indicated by number of bedrooms)
- Source of wood for dwellings occupied by families with the oldest child being school age or younger.
- Source of wood for households with different income levels.
- Source of wood for rented versus owner occupied dwellings
- Chronic respiratory illness by age (all heating methods)

7.1 Insulation

Table 7.1 shows the extent of insulation in households with wood burners for different household categories. These suggest a similar extent of insulation in larger households (more than three bedrooms) to smaller households with the exception of more of the smaller house having one or fewer levels of insulation. Similarly Table 7.2 shows the extent of insulation for households using electricity.

Table 7.3 shows the extent of insulation in households where one of the occupants of the dwelling has chronic respiratory illness. This suggests that households with an occupant with respiratory illness may be over represented in the households with one or fewer levels of insulation (or who did not know) and slightly under represented in households with four or more types of insulation.

7.2 Source of wood and tenure

Table 7.4 shows the source of wood for families, rented and owner occupied dwellings and by income. Households with a combined income of between $33,000 and $50,000 per year tend may have a slightly higher proportion of wood use that has been obtained free of charge.

Table 7-1: Insulation extent in households with wood burners

	Wood burner households	Small/ medium houses (3 bedrooms or smaller)		Larger houses		Families with children		Age over 60	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
Wood burner use		3930	29%	1907	43%	2119	45%	1869	25%
No insulation /don't know	2%	270	7%	39	2%	116	5%	58	3%
Just one type	14%	559	14%	231	12%	270	13%	308	16%
Two types	32%	1310	33%	578	30%	713	34%	636	34%
Three types	25%	944	24%	501	26%	501	24%	405	22%
Four types	19%	694	18%	443	23%	424	20%	385	21%
Five types	5%	154	4%	116	6%	96	5%	96	5%

Table 7-2: Insulation extent in households with electricity

	Electricity households	Small/ medium houses (3 bedrooms or smaller)		Larger houses		Families with children		Age over 60	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
Electricity use		10634	78%	3314	75%	3140	67%	6280	85%
No insulation /don't know	4%	1040	10%	116	3%	250	7%	482	8%
Just one type	16%	1830	17%	347	10%	424	14%	982	16%
Two types	28%	3005	28%	886	27%	809	33%	1695	27%
Three types	24%	2485	23%	809	24%	828	24%	1483	24%
Four types	18%	1695	16%	828	25%	578	18%	1252	20%
Five types	6%	578	5%	327	10%	250	4%	424	7%

Table 7-3: Insulation levels for households with an occupant that has chronic respiratory illness

	All households	Respiratory illness	
		Number	Percent
No insulation /don't know	4%	308	9%
Just one type	16%	616	19%
Two types	28%	982	30%
Three types	24%	751	23%
Four types	18%	482	15%
Five types	6%	135	4%

Table 7-4: Source of firewood for families, by tenure and by income

	Proportion of wood	
	Obtained free of charge	Bought
Households using wood burners	34%	66%
Family with oldest child who is school age or younger	37%	63%
House owned	34%	66%
House rented	28%	72%
Income <$33k	29%	71%
Income $33-$50K	42%	58%
Income $52-$77K	32%	68%
Income >$77K	35%	65%

8 FUEL POVERTY

Fuel poverty has been defined overseas as the inability to acquire adequate household energy services for 10% of household income. This includes everything energy is used for within the home setting, including heating to WHO recommended safe indoor temperatures for health (healthyhousing.org.nz).

An estimate of the proportion of households in Nelson that might be in fuel poverty based on this definition was made but based on achieving temperatures of 18 degrees for a main living area and 16 degrees for other rooms. This is lower than the recommended 18 degrees for bedrooms and 21 degrees for the main living area recommended by WHO (2007) and was selected because energy requirement data for New Zealand specific insulation levels were only available for these or lower temperatures. While these temperatures are lower than WHO recommendations it should be noted that many households do not heat to this extent.

It should be noted that the assessment is theoretical and for purposes of establishing an indication of the proportion of dwellings in Nelson which meet the definition of fuel poverty. The estimates of energy consumption will over estimate relative to average usage because most households do not heat to the prescribed level. It is also noted that in our view the definition is crude and that there may be better approach to characterising the impacts of fuel costs on household warmth.

Table 8.1 shows the baseline energy requirements excluding space heating as well as the annual space heating energy requirements. The average cost per month for households heating to 18 degrees (main living area) and 16 degrees (other living areas) using electricity (fan), wood burners (purchased wood) and electricity (heat pump) based on 30 cents/kWh (fan heater), 8 cents kWh (wood burner), 24 cents/kWh flued gas and 39 cents/kWh unflued gas and 7 cents/kWh (heat pump). The categories of dwellings for which annual and monthly energy requirements are estimated are defined as follows:

- Average dwelling – this is the weighted average energy requirement across households in Nelson with weightings applied based on proportions of dwellings that are different ages, have insulation, are different sizes and different number of storeys (from Wilton, 2014).
- Typical dwelling – this is based on a 130 m^2 dwelling and the average energy requirements of a pre 1974 dwelling with retrofitted ceiling insulation (132 kWh/m^2) or a 1973-1999 dwelling (119 kWh/m^2) as these are the most common dwelling types.
- No insulation retrofits – this is the average energy requirements for the Nelson housing stock if no retrofitting of insulation had been carried out, that is if all dwellings only met the insulation requirements applicable at the time the dwelling was built.
- Worst case – this is based on a 130 m^2 single story dwelling which is pre 1973 and has not retrofitted insulation.

The average household energy consumption is estimated in Section 2.3 as 11,000 kWh per year and EECA information suggests that on average 29% of this is used for space heating. The average space heating energy use is therefore around 3000 kWh per household across New Zealand. While these are nationwide statistics and colder areas such as the South Island will have higher consumption rates comparison to the average space heating requirements (`12,000 kWh) per household per year suggest that the level of heating in Nelson is probably well below the level required to heat the living area to 18 degrees and the other rooms to 16 degrees 24 hours a day. Data from the 2014 survey suggests that around half of the 64% of households that did not heat their homes during the daytime did so because they were not there. While many households may not need to heat for 24 hours a day for lifestyle reasons, it is likely that a large proportion of households do not heat their homes adequately.

Table 8.2 shows the annual household incomes thresholds for fuel poverty based on the need to spend 10% of income on household energy. Note that the baseline income threshold is around $27,000 for average household energy consumption excluding space heating. This shows the average income threshold for a household to be in fuel poverty based on electric fan heating in Nelson is likely to be around $56,000, $65,000 for unflued gas, $35,000 for wood and $34,000 if a heat pump were being used (Table 8.2). Revised thresholds based on increased electricity costs (2.5% and 10%) are also illustrated.

Calculations were made using different approaches including the weighted average Nelson scenario for dwelling size, storeys and insulation ($56,000 for electricity) and the most typical (common) dwelling type ($68,000 for electricity). For those that reside in dwellings in Nelson that are old and uninsulated a much higher income is required to avoid fuel poverty ($112,000 for high cost electricity, $138,000 for unflued gas, $50,000 for wood burners and $48,000 for heat pumps).

An estimate of the impact of retrofitted insulation in Nelson on average cost of heating is also shown in Table 8.1 and suggests that retrofitting insulation has reduced the average household space heating requirements from 18,000 kWh per year to 15,000 kWh per year (a 17% reduction in space heating requirements).

Table 8-1: Heating requirements and energy cost data for Nelson

	2014 (average dwelling)	2014 (typical dwelling)	No insulation retrofits	Worst case insulation
Space heating energy requirement (kWh/ year)*[1]	11810	16304	19867	34219
Space heating energy requirement (kWh/ year) adjusted for occupancy[2]	10714	14791	18024	31044
Baseline energy requirement average/ household New Zealand excl space heating (kWh/year)	8057	8057	8057	8057
Daily heating requirements (kWh)	63	88	107	184
High cost electricity ($ per month)	$ 590	$ 815	$ 993	$ 1,711
Wood burner - ($ per month)	$ 157	$ 217	$ 265	$ 456
Unflued gas ($ per month)	$ 768	$ 1,060	$ 1,291	$ 2,224
Heat pump ($ per month)	$ 148	$ 204	$ 248	$ 428
Baseline energy costs excl space heating ($ per year)	$ 2,691	$ 2,691	$ 2,691	$ 2,691

Table 8-2: Annual household income thresholds for fuel poverty in Nelson

	2014 (average dwelling)	2014 (typical dwelling)	No insulation retrofits	Worst case
Baseline threshold (no space heating)	$ 26,910	$ 26,910	$ 26,910	$ 26,910
High cost electricity	$ 56,434	$ 67,669	$ 76,578	$ 112,458
Wood burner (wood purchased)	$ 34,783	$ 37,779	$ 40,155	$ 49,723
Flued gas	$ 45,147	$ 54,135	$ 61,262	$ 89,966
Unflued gas	$ 65,291	$ 79,896	$ 91,478	$ 138,122
Heat pump	$ 34,291	$ 37,099	$ 39,327	$ 48,297
High cost electricity – 2.5% price increase	$ 57,845	$ 69,360	$ 78,492	$ 115,269
Heat pump – 2.5% price increase	$ 35,148	$ 38,027	$ 40,310	$ 49,504
High cost electricity – 10% price increase	$ 62,077	$ 74,435	$ 84,236	$ 123,703
Heat pump – 10% price increase	$ 37,720	$ 40,809	$ 43,259	$ 53,126

Table 8.3shows an estimate of the number of households likely to be in fuel poverty in Nelson. These estimates are based on census home heating by income and tenure data and a threshold of $50,000 for households using non-heat pump sources of electricity and flued gas heaters for home heating, $30,000 for households using heat pumps or wood burners and $70,000 for households using unflued gas heaters. Categories have been rounded typically downwards to the nearest category for which census income data are available. As this method only

[1] Based on heating for five months of the year

[2] Based on 32% of households not requiring daytime heat because of lack of occupancy

includes income by fuel type it does not include households which report no fuel use. In addition to households identified based on the annual income thresholds discussed above those reporting no fuel use and earning less than $50,000 per year (non-heat pump threshold) were included.

The estimates are indicative only as they are based on an average dwelling and do not take into account potential relationships between insulation and house size and income. For example a household earning $70,000 would be in fuel poverty if they used any form of heating other than a heat pump or wood burner in an older uninsulated home (Table 8.2). They also do not take into account the lower heat requirements of around 32% of households in Nelson who do not need to heat during the daytime because nobody is home. The difference in energy requirements for evening only versus all day heating is around 29%. The impact of this on income thresholds for fuel poverty is to reduce them by around 10%. This has minimal impact on the estimates of fuel poverty, however, as the income classification data used typically more than 10% lower than the thresholds indicated in Table 8.2 as a result of the income groupings for which data are available (i.e., census data income bands are normally $20,000-$30,000 increments).

Results suggest around 16% of Nelson households may be in fuel poverty. This compared with around 22% of households in Christchurch and 26% of households in Timaru (Wilton, 2014a).

Table 8-3: Estimates of fuel poverty prevalence in Nelson

	Owner occupied	Rental	Total	Percent total households
Nelson	1819	1193	3012	16%

9 REFERENCES

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APPENDIX A: QUESTIONNAIRE

Hi, I'm _____from DigiPoll and I am calling on behalf of the Nelson City Council.

May I please speak to an adult in your household who knows about your home and home heating systems?

We are currently undertaking a survey in your area on health, housing and methods of home heating. The survey will take about 5 minutes. Is it a good time to talk to you now?

We are not selling anything but only gathering your opinion.

The responses you give are anonymous and the Nelson City Council will not be given any information that could be used to identify individual households. Please be assured that all your responses will remain completely confidential.

The survey could be monitored or recorded for quality control purpose.

1. (a) Do you use any type of electrical heating in your MAIN living area during a typical year?

(b) What type of electrical heating do you use? Would it be...

- ☐ Night Store
- ☐ Radiant
- ☐ Portable Oil Column
- ☐ Panel
- ☐ Fan
- ☐ Heat Pump
- ☐ Don't Know/Refused
- ☐ Other (specify)

(c). Do you use any other heating system in your main living area in a typical year? *(If yes then question 3 otherwise Q9)*

2. (a) Do you use any type of gas heating in your MAIN living area during a typical year? *(If No then question 4)*

(b) Is it flued or unflued gas heating? If necessary: (A flued gas heating appliance will have an external vent or chimney)

(c) Which months of the year do you use your gas burner

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(d) How many days per week would you use your gas burner during

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(e) Do you use mains or bottled gas for home heating?

(f) What size gas bottle do you use?

(f.2) How many times in a winter would you refill your x kg gas bottle? Interviewer: Winter is defined as May to August inclusive.

3. (a) Do you use a log burner in your MAIN living area during a typical year? (This is a fully enclosed burner but does not include multi fuel burner i.e., those that burn coal) *(If No then question 5)*

(b) Which months of the year do you use your log burner

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(c) How many days per week would you use your log burner during?

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(d) How old is your log burner?

(e) In a typical year, how many pieces of wood do you use on an average winters day? Interviewers note : winter is defined as May to August inclusive.

(f) ask only If they used their log burner during non winter months How many pieces of wood do you use per day during the other months? Interviewers note : winter is defined as May to August inclusive.

(g) In a typical year, how much wood would you use per year on your log burner? (record wood use in cubic metres - note 1 cord equals 3.6 cubic meters of loosely piled blocks, one trailer equals about 1.65 cubic metres without cage, or 2.2 with cage)

(h) Do you buy wood for your log burner, or do you receive it free of charge?

(i) What proportion would be bought?

4. (a) Do you use an enclosed burner which burns coal as well as wood – i.e., a multi fuel burner in your MAIN living area during a typical year? (This includes incinerators, pot belly stoves, McKay space heaters etc but does not include open fires.) *(If No then question 6)*

(b) Which months of the year do you use your multi fuel burner?

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(c) How many days per week would you use your multi fuel burner during?

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(d) How old is your multi fuel burner?

(e) What type of multi fuel burner is it?

(f) In a typical year, how much wood do you use on your multi fuel burner per day during the winter? (ask them how many pieces of wood (logs) they use on an average winters day) Interviewer: Winter is defined as May to August inclusive

(g) ask only If they used their multi fuel burner during non winter months How much wood do you use per day during the

other months?

(h) In a typical year, how much wood would you use per year on your multi fuel burner?_____ (record wood use in cubic metres - note 1 cord equals 3.6 cubic meters of loosely piled blocks one trailer equals about 1.65 cubic metres without cage, or 2.2 with

(i) Do you use coal on your multi fuel burner?

(j) How many buckets of coal do you use per day during the winter? (how many buckets of coal used on an average winters day) Interviewer: Winter is defined as May to August inclusive .

(k) Ask only If they used their multi fuel burner during non winter months How much coal do you use per day during the other months?

(l) Do you buy wood for your multi fuel burner, or do you receive it free of charge?

(m) What proportion would be bought?

5. (a) Do you use an open fire (includes a visor fireplace which is one enclosed on three sides but open to the front) in your MAIN living area during a typical year? *(If No then question 7)*

(b) Which months of the year do you use your open fire

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(c) How many days per week would you use your open fire during?

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(d) Do you use wood on your open fire?

(e) On a typical year, how much wood do you use per day during the winter? (ask them how many pieces of wood (logs) they use on an average winters day) Interviewer: Winter is defined as may to August inclusive

(f) Ask only If they used their open fire during non winter months How much wood do you use per day during the other months?

(g) In a typical year, how much wood would you use per year on your open fire? (record wood use in cubic metres - note 1 cord equals 3.6 cubic meters of loosely piled blocks one trailer equals about 1.65 cubic metres without cage, or 2.2 with cage)

(h) Do you use coal on your open fire?

(i) How many buckets of coal do you use per day during the winter? (how many buckets of coal used on an average winters day)____ Interviewer: Winter is defined as may to August inclusive

(j) Ask only If they used their open fire during non winter months How much coal do you use per day during the other months?

(k) Do you buy wood for your open fire, or do you receive it free of charge?

(l) What proportion would be bought?

6. (a) Do you use a pellet burner in your MAIN living area during a typical year? *(If No then question 8)*

(b) Which months of the year do you use your pellet burner

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(c) How many days per week would you use your pellet burner during?

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(d) How old is your pellet burner?

(e) What make and model is your pellet burner? First, can you tell me the make?

(e) and what model is your pellet burner?

(f) In a typical year, how many kilograms of pellets do you use on an average winters day? Interviewers note : winter is defined as May to August inclusive.

(g) Ask only If they used their pellet burner during non winter months How many kgs of pellets do you use per day during the other months? Interviewers note : winter is defined as May to August inclusive.

(h) In a typical year, how many kilograms of pellets would you use per year on your pellet burner?

7. (a) Do you use any other heating system in your MAIN living area during a typical year? *(If No then question 9)*

(b) What type of heating system do you use (if they respond with diesel or oil burner go to question c otherwise go to Q8)

(c) Which months of the year do you use your oil burner

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(d) How many days per week would you use your diesel/oil burner during?

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(e) How much oil do you use per year ?

8. Does your home have insulation?

- ☐ Ceiling
- ☐ Under floor
- ☐ Wall
- ☐ Cylinder wrap
- ☐ Double glazing
- ☐ None
- ☐ Don't know
- ☐ Other

9. Which of the following most closely describes how you heat your home:

- ☐ One room (living room) in evening

- Whole house in evening
- Living area 24/7 and rest of house evening only
- One room (living room) all day
- whole house all day
- Do not heat home
- other (Specify)

10. Do you choose not to heat your home during the day because
    - The house is not occupied
    - Cost of heating
    - other (Specify)

11. How would you rate the level of warmth in your home during winter?

    - Too cold
    - Adequate
    - Warm

12. a) Does anyone living at this house have a respiratory illness or other problems with breathing that require treatment?

If yes how many people have a respiratory illness or other problems with breathing that require treatment.

b) Does anyone living at this house have any other long term health issues (excluding respiratory related issues) which require treatment? (long term means more than 6 months).

If yes how many people.
If yes, what type of health conditions are you/ they being treated for?

13. Which option best describes where you live:

- One storey house/ unit
- Two or more storey house with living rooms and bedrooms
- Two or more storey house with living and bedrooms on one
- Apartment with living and bedrooms on one level
- Apartment with living and bedrooms on more than one level
- Other (Specify)

14. Which of the following describes you and your household situation?

- Single person below 40 living alone
- Single person 40 or older living alone
- Young couple without children
- Family with oldest child who is school age or younger
- Family with an adult child still at home
- Couple without children at home
- Flatting together
- Boarder

15. With which ethnic group do you most closely relate?

Interviewer: tick gender.

How many people live at your address?

Do you own your home or rent it?

Approximately how old is your home?

How many bedrooms does your home have?

Thinking about your future housing needs in, say, in ten years time,

How many bedrooms are you most likely to want?

- One
- Two
- Three or more

What size section are you most likely to want?

- Small (ranging from a courtyard or balcony to a section less than 400 m2)
- An average size section (400 m2 –
- Large (750m2 or bigger)

Would you like to stay in the same suburb?

- Yes
- No
- Don't know

Can you tell me the household annual income – if boarder refer to personal income

What is your employment status:

Thank you for your time today. Your answers will be very helpful. In case you missed it, my name is ---------- from DigiPoll in Hamilton. Have a nice day/evening.

APPENDIX B: CALCULATION OF HOUSEHOLD ENERGY REQUIREMENTS

The methodology used to calculate the household energy requirements was as per the method used in (Wilton, 2014a). This is outlined with Nelson data as follows:

Space heating - dwelling insulation classification data

A spreadsheet detailing the energy savings for different forms of insulation was provided by EECA. Table A.1 shows the different classifications and heat requirements for different levels of space heating. Data for 24-hour living and evening only for bedrooms and kitchen (heating to 18 degrees in living and 16 degrees in other rooms) were included in the analysis as the closest fit to the WHO specifications of whole house heating to 21 degrees in the main living area and 18 degrees in the rest of the house.

Table A-1: Heat requirements per m^2 for different house types and heating regimes to achieve 18 degrees C in living areas and 16 degrees C in other rooms

Design option description	Heating schedule	Heating kWh/m2 floor area	
		One storey	Two storey
01 Base design	24hr living, evening only bedrooms+kitchen	257.97	150.69
01 Base design	Evening only living+bedrooms+kitchen	95.43	65.30
01 Base design	Evening only living	50.44	25.93
02 CI1 0-75mm existing	24hr living, evening only bedrooms+kitchen	159.37	100.96
02 CI1 0-75mm existing	Evening only living+bedrooms+kitchen	60.01	45.42
02 CI1 0-75mm existing	Evening only living	29.20	16.02
03 CI2 75-120mm existing	24hr living, evening only bedrooms+kitchen	141.93	92.27
03 CI2 75-120mm existing	Evening only living+bedrooms+kitchen	53.38	41.65
03 CI2 75-120mm existing	Evening only living	25.83	14.46
04 CI3 R2.9 climate zones 1+2	24hr living, evening only bedrooms+kitchen	133.19	87.93
04 CI3 R2.9 climate zones 1+2	Evening only living+bedrooms+kitchen	50.07	39.76
04 CI3 R2.9 climate zones 1+2	Evening only living	24.19	13.70
05 CI4 R3.3 climate zone 3	24hr living, evening only bedrooms+kitchen	132.08	87.38
05 CI4 R3.3 climate zone 3	Evening only living+bedrooms+kitchen	49.65	39.52
05 CI4 R3.3 climate zone 3	Evening only living	23.98	13.60
12 UF1 foil poor	24hr living, evening only bedrooms+kitchen	244.49	145.54
12 UF1 foil poor	Evening only living+bedrooms+kitchen	89.13	62.30
12 UF1 foil poor	Evening only living	46.12	24.63
13 UF2 foil good	24hr living, evening only bedrooms+kitchen	225.44	139.94
13 UF2 foil good	Evening only living+bedrooms+kitchen	80.51	59.21
13 UF2 foil good	Evening only living	41.22	23.46
14 UF3 bulk poor	24hr living, evening only bedrooms+kitchen	226.67	140.36
14 UF3 bulk poor	Evening only living+bedrooms+kitchen	81.07	59.46
14 UF3 bulk poor	Evening only living	41.52	23.54
15 UF4 R1.3	24hr living, evening only bedrooms+kitchen	223.57	139.37
15 UF4 R1.3	Evening only living+bedrooms+kitchen	79.53	58.90
15 UF4 R1.3	Evening only living	40.72	23.35
16 UF5 concrete slab	24hr living, evening only bedrooms+kitchen	222.57	139.95
16 UF5 concrete slab	Evening only living+bedrooms+kitchen	87.10	60.85
16 UF5 concrete slab	Evening only living	44.59	23.82
22 WA1 1978-1999	24hr living, evening only bedrooms+kitchen	226.40	123.50

22 WA1 1978-1999	Evening only living+bedrooms+kitchen	81.31	51.57
22 WA1 1978-1999	Evening only living	44.40	21.44
26 WIN1 Double Glaz	24hr living, evening only bedrooms+kitchen	246.12	143.38
26 WIN1 Double Glaz	Evening only living+bedrooms+kitchen	90.78	62.20
26 WIN1 Double Glaz	Evening only living	47.80	24.43
28 AIRT1 draughtstopped	24hr living, evening only bedrooms+kitchen	255.35	149.70
28 AIRT1 draughtstopped	Evening only living+bedrooms+kitchen	94.32	64.86
28 AIRT1 draughtstopped	Evening only living	49.85	25.73

Post 2007/08 houses

Houses built post 2007 are most likely to be reflected in the following heat requirement conditions from Table A.1:

- Ceiling - CI4 R3.3 climate zone 3
- Wall - WA1 1978-1999. Note this is will overestimate the heat requirements as wall requirements for post 2008 homes is R = 2 compared with R = 1.5 for 1978-1999 dwellings. However no further data are available.
- Floor - UF4 R1.3
- Windows – 26 WIN1 Double Glaz
- Tightness - 28 AIRT1 draughtstopped

2001 – 2008 dwellings

Houses built after 2000 and before 2008 are most likely to be reflected in the following heat requirement conditions from Table 3.1:

- Ceiling - 04 CI3 R2.9 climate zones 1+2. Note that this will underestimate heat requirements as the building code requirement for this time was R = 2.6. However, no data for R 2.6 is available.
- Wall - WA1 1978-1999. Note this is will overestimate the heat requirements as wall requirements for post 2008 homes is R = 2 compared with R = 1.5 for 1978-1999 dwellings. However no further data are available.
- Floor - UF5 concrete slab. Additional information supplied with Table 3.1 indicates that this option has an R rating of 0.9.
- Tightness - 28 AIRT1 draught stopped

1978 – 1999 dwellings

Houses built between 1978 and 1999 are most likely to be reflected in the following heat requirement conditions from Table 3.1 for households that have not had insulation upgrades:

- Ceiling -. 03 CI2 75-120mm existing. This category has an R rating of 1.6 which is lower than the 1.9 reflected by the code at the time. However, given the likelihood of degradation over time it represents a reasonable approximation for ceiling insulation for dwellings built from 1978-1999.
- Wall - WA1 1978-1999.
- Floor - UF5 concrete slab. Additional information supplied with Table 3.1 indicates that this option has an R rating of 0.9.
- Tightness - 28 AIRT1 draught stopped

These groupings could be used as the assumed minimum insulation standards for households in this category. However, further analysis of this category using survey results are carried out because of insulation upgrades.

Pre 1978 dwellings

No insulation is the base case scenario that applies to houses build prior to 1978. However, a cross tabulation on insulation and dwelling age (pre 1974 from the 2014 Timaru survey) found that the majority of these dwellings had retrofitted insulation. In particular, 92% of respondents in pre 1974 dwellings indicated that the house had ceiling insulation, 54% had underfloor insulation and 32% indicated that the dwelling had wall insulation. Only 18% of these dwellings also had double glazing.

Space heating - dwelling heat requirement data

Table A.2 shows the summary heat requirements per square metre for one and two storey dwellings based on the combinations described above. Additional energy criteria are provided for pre 1978 dwellings that have had retrofitted insulation. This proportion was estimated using the 2014 home heating survey data and specifically examining the proportion of older (pre 1973 dwellings) that had different levels of insulation. Table A.3 shows the classifications of dwelling age from the survey and kWh energy ratings attributed to them based on the data shown in Table A.2. In most cases the kWh energy requirements are used for the nearest year categories without adaptation. The exception is the 1973-1993 category which includes five years of pre 1978 dwellings. The kWh energy requirement for the 1973-1993 was a weighted average of the 1978-1999 energy requirements (75%) and the pre 1978 energy requirements (25%). No year modifications were made for other categories owing to the smaller differences in energy requirements.

From Table A.3 weighted average heat requirements per m^2 for Nelson of 99 kWh/m^2 for single and 68 kWh/m^2 double story dwellings were calculated. These compare with 101 and 68 KWh/m2 estimated using a similar study for Christchurch indicating similar aged dwellings and insulation levels.

These data were used to estimate the heat requirements for different sized dwellings (Table A.4) along with a worst case scenario which uses a kWh/m^2 requirement of 258 (no insulation/ single story). Table A.4 also includes survey information on the proportion of dwelling with different numbers of bedrooms and provides an estimate of the sizes for these dwellings. Note that robust information on the average size of dwellings in Nelson was not sourced. This section of the table and subsequent calculations should be updated if this information becomes available.

Table A-2: Annual heat requirements per m^2 for different house ages to achieve 18 degrees C in living areas and 16 degrees C in other rooms.

	One level kWh m^2	Two level kWh m^2
Post 2007 households	52	41
2001-2007 households	64	49
1978-1999 households	72	53
Pre 1978	258	151
Pre 1978 with retrofit ceiling	132	87
Pre 1978 with retrofit ceiling, UF wall	66	49

Table A-3: Annual heat requirements per m^2 for different house ages and insulation levels and estimate of the proportion of houses in Nelson in 2014 in each age/ insulation category.

Dwelling age/insulation (as per survey)	Proportion	One level kWh m^2	Two level kWh m^2
2004-2014	13%	52	41
1994-2003 (no double glazing)	12%	64	49
1994 - 2003 with double glazing	3%	52	42
1974-1993 (no double glazing)	20%	119	78
1974-1993 with double glazing	4%	60	46
Pre 1974(no insulation)	5%	258	151
Pre 74 with retrofit ceiling	25%	132	87
Pre 74 with retrofit ceiling, UF and wall	8%	66	49
Pre 74 with retrofit all	10%	52	41

Table A-4: Heat requirements per m^2 for different house ages and insulation levels and estimate of the proportion of houses in Nelson in 2014 in each age/ insulation category.

Number of rooms	Proportion of dwellings	Assumed size of dwelling m^2	kwh per house single level by percentage in each size	kWh per house two or more levels	kWh worst case (no insulation, one level)
1 bedroom	3%	60	5953	4053	15478
2 bedroom	23%	90	8930	6080	23218
3 bedroom	49%	130	12899	8782	33536
4 bedroom	21%	180	17860	12160	46435
5 bedroom	3%	230	22822	15537	59334
6 bedroom	1%	250	24806	16888	64493

The proportion of dwellings in each size range was used to determine a weighted average energy requirement of 13000 kWh per single level dwellings and 9000 kWh per dwelling for two or more level dwellings. An overall average energy requirement per dwelling was estimated at 11800 kWh per dwelling based on survey data for Nelson which indicated around 67% of households were single level dwellings. Applying the data in this way requires the assumption that insulation levels/ dwelling age and size are distributed similarly across one and two storeyed properties. Because extrapolations such as this are required data should be treated as indicative.

An alternative approach of considering the average energy requirements for a typical house was also considered to assist with the approximation of typical heating requirements. From the survey data (e.g., Table A.3) the most common insulation categories were the 1973-1993 with no double glazing and the pre 1973 with retrofitted ceiling insulation which had similar energy requirements. These categories were combined and the average energy requirement (125 kWh/m^2) used to calculate the heating required for a typical 3 bedroom single level dwelling. The annual energy requirement using this approach was 16304 kWh. This is higher than the 11800 kWh estimate made using the weighted average approach largely because of the difference in energy requirements between one and two storey dwellings.

A worst case energy requirement per dwelling of 34000 kW was also estimated based on a single level pre 1978 dwelling, of average size with no insulation.

Calculation of total household energy requirements

The average annual household electricity usage for New Zealand is around 8000 kWh per year (Electricity Authority Te Mana Hiko, 2011). This includes space heating but not other forms of household energy use including gas, oil and the use of wood and coal for space heating and cooking. Table A.5 shows the average household energy consumption for New Zealand for different fuel types and the total per household (average) based on information from the Ministry of Business and Innovation and Employment (MOBIE) Energy Data Files (http://www.med.govt.nz/sectors-industries/energy/energy-modelling/data) and 1,549,890 households across New Zealand (2013 census of population and dwellings, Statistics New Zealand 2014).

Table 0-5: Residential energy consumption for New Zealand and average household energy consumption.

Source	Energy Type	PJ/ year	Year	kWh/hh
MOBIE	Residential electricity consumption	46.24	2012	8287.3
MOBIE	Residential gas consumption	5.7	2011	1021.6
MOBIE	Residential oil consumption	3.23	2011	578.9
MOBIE	Residential coal consumption	0.75	2011	134.4
MOBIE	Residential wood consumption	7.4	2011	1326.3
	Total			11348

The non space heating component of the average household energy consumption data was estimated based on 29% of household energy consumption being space heating (http://www.energywise.govt.nz/your-home). This gave an average non space heating energy consumption value of 8057 kWh. The cost of this was estimated at

$2700 based on daily kWh cost of 30 c/kWh (incl GST). Based on a 10% threshold for fuel poverty this suggests an annual income of around $27,000 would be required to avoid fuel poverty excluding space heating costs.