Nelson City Council

Assessment of Air Quality Management Options

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Executive Summary

The Nelson City Council (NCC) is in the process of reviewing and updating the Nelson Air Quality Plan (AQP). As a precursor to the full AQP review, NCC is advancing a discrete plan change relating to domestic wood burners. Among other issues, the Council is anticipating health, social and economic factors to inform the potential 'shape' of the plan change. The Council has commissioned Market Economics Limited (M.E) to undertake an assessment of five scenarios that reflect different potential policy directions.

Our assessment uses the air quality (PM_{10}) modelling that was completed by Environet (Ltd) in 2015. We used the projected burner numbers (by type and airshed) and the PM_{10} concentrations as prepared by Environet and did not audit or adjust the modelling work. We assessed the scenarios against the baseline future as projected under the current Air Quality Plan with 20-year phase out. The other scenarios reflected:

- Enabling a limited number of ultra-low emission burners (ULEBs) through a combination of new/amended policies, rules or other methods (Sc2),
- Enabling an unlimited number of ULEBs through a combination of new/amended policies, rules or other methods (Sc3),
- Enabling a site-by-site 'allowance' of particulate matter to be discharged[1], irrespective of the heating mechanism used (Sc4),
- Enabling an unlimited number of National Environmental Standards for Air Quality (NES) compliant burners through a combination of new/amended policies, rules or other methods (Sc5), and
- Enabling a limited number of ULEBs through a combination of new/amended policies, rules or other methods but with a particular emphasis on behaviour change of burning practice across the Nelson Urban Area (Sc2b).

Our assessment focuses on domestic burners associated with the AQP, and consequently, PM_{10} emissions.

Approach

In terms of our approach, the assessment uses burner numbers (by type and age), the expected PM_{10} emissions and the associated change in PM_{10} concentrations, and the potential health effects. The health effects (and costs) were estimated using the methodology outlined in the Health and Air Pollution in New Zealand (HAPINZ) reports[2]. Essentially, the health costs are estimated by relating the increase in PM_{10} concentration levels to health effects. Next, the health effects are translated into costs. The cost of increasing PM_{10} emissions (from burners) fall to society. In terms of the burner costs, both the capital and operating expenditure were included in the assessment. In addition, Council's regulatory, monitoring and enforcement costs are also included in the assessment.

[1] This limit would likely be based on the discharge typically associated with a ULE burner.
[2] The HAPINZ reports can be accessed from: http://www.hapinz.org.nz/

The scenarios have different burner uptake rates, implying that the monetary flows vary in terms of when they occur. To assist with comparing the potential effects, a Discounted Cash Flow analysis was used, expressing future monetary flows in 'today's terms'.

Results

Nelson's four airsheds have their own distinct characteristics and factors affecting burner use, current and projected emissions levels. Based on the emissions modelling (by Environet), the results for each airshed are summarised in the following table. The table shows:

- The costs (or benefits) in Net Present Value (NPV) terms, and
- Health cost as a percentage of total cost.

Scenarios		Total Cost ($'m NPV @ 3.25%)			
		Nelson A	Nelson B1	Nelson B2	Nelson C
Sc 2	Limited ULEBs	11.0	18.0	125.6	108.6
Sc 3	Unlimited ULEBs	118.3	48.9	125.6	111.9
Sc 4	Performance Limits	-	-	129.0	109.1
Sc 5	Unlimited NES	220.1	63.8	174.9	178.0
Sc 6 (2b)	Behaviour Change	-10.5	-	26.9	18.7

Scenarios		Total Cost ($'m NPV @ 3.25%)			
		Nelson A	Nelson B1	Nelson B2	Nelson C
Sc 2	Limited ULEBs	20.9%	13.0%	6.0%	15.1%
Sc 3	Unlimited ULEBs	28.0%	14.4%	6.0%	15.1%
Sc 4	Performance Limits			8.4%	15.5%
Sc 5	Unlimited NES	63.8%	40.8%	23.8%	46.7%
Sc 6 (2b)	Behaviour Change	100.0%		-6.8%	-11.9%

From the above summary, the main observations are:

- The analysis suggests that the behaviour change approach (scenario) results in the lowest marginal cost being imposed on the community. This is the only scenario that results in a net improvement in PM_{10} levels relative to the current situation (AQP). Therefore, this is the only scenario that is expected to yield a health cost saving (benefit).
- The limited ULEB scenario (Sc 2) is the next lowest cost approach. In contrast to the behaviour change, this scenario is expected to transfer a portion of the total costs onto the community. That is, the PM_{10} concentrations are expected to increase, generating a health cost. Compared to the other scenarios (excluding the behaviour change scenario), this scenario has the smallest portion of health costs (relative to total costs).

- Scenario 5, unlimited NES burners, is the most expensive in terms of total costs and the health costs.

The analysis suggests that the behaviour change scenario is, relative to the other scenarios that were modelled, the most cost effective option.

Concluding Remarks

It is beyond the scope of this research to provide specific policy recommendations or guidelines. We note, however, that it may be desirable[3] to enable additional burners in the future, while ensuring that the resulting PM_{10} levels remain below t*he projected baseline levels (associated with the different airsheds).* For example, if the behaviour change scenario delivers a greater effect than expected, then there could be scope for additional burners over time. At a high level, such an option is likely to return a positive health effect and the private costs will be borne by the individual households (installing the burners). Therefore, in terms of potential costs and benefits, such an option is likely to have a favourable cost-and-benefit profile. This will only hold, if the 'new' emission levels remain below the baseline, i.e. the levels associated with the AQP levels. This will be consistent with a 'maintain or enhance' philosophy.

[3] From Council's perspective

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Abbreviations

AQP	Nelson Air Quality Plan
DCF	Discounted Cash Flow analysis
HAPINZ	Health and Air Pollution in New Zealand
MfE	Ministry for the Environment
NCC:	Nelson City Council
NES	National Environmental Standards for Air Quality
NPV	Net Present Values
PM_{10}	Particulate Matter (up to 10 micrometres in size)
SNZ	Statistics New Zealand
ULEB	Ultra-low emission burners

1 Introduction

The Nelson City Council (NCC) is in the process of reviewing and updating the Nelson Air Quality Plan (AQP). As a precursor to the full AQP review, NCC is advancing a discrete plan change relating to domestic wood burners. A potential outcome of the plan change is a more enabling approach to the installation of domestic wood burners than the operative AQP. The plan change is subject to a section 32 evaluation of the appropriateness of such a change.

This assessment relates to the domestic burners component of the AQP. It is our understanding that the overall AQP will be reviewed as part of a wider review. Therefore, the domestic component covered as part of this assessment, is seen as an interim measure. The assessment presented here relates to the domestic burner component, the associated PM10 emissions and focuses on the key economic factors associated with it.

The assessment focuses on the costs and benefits of the different options (scenarios) that have been modelled.

1.1 Project aim

The main aim of this assessment was to review the different burner profiles (i.e. scenarios) and to assess them in terms of the potential costs and benefits. This was done to provide an understanding of how the different options could contribute (or detract) from delivering the best outcomes for the Nelson community. Six scenarios were assessed, including:

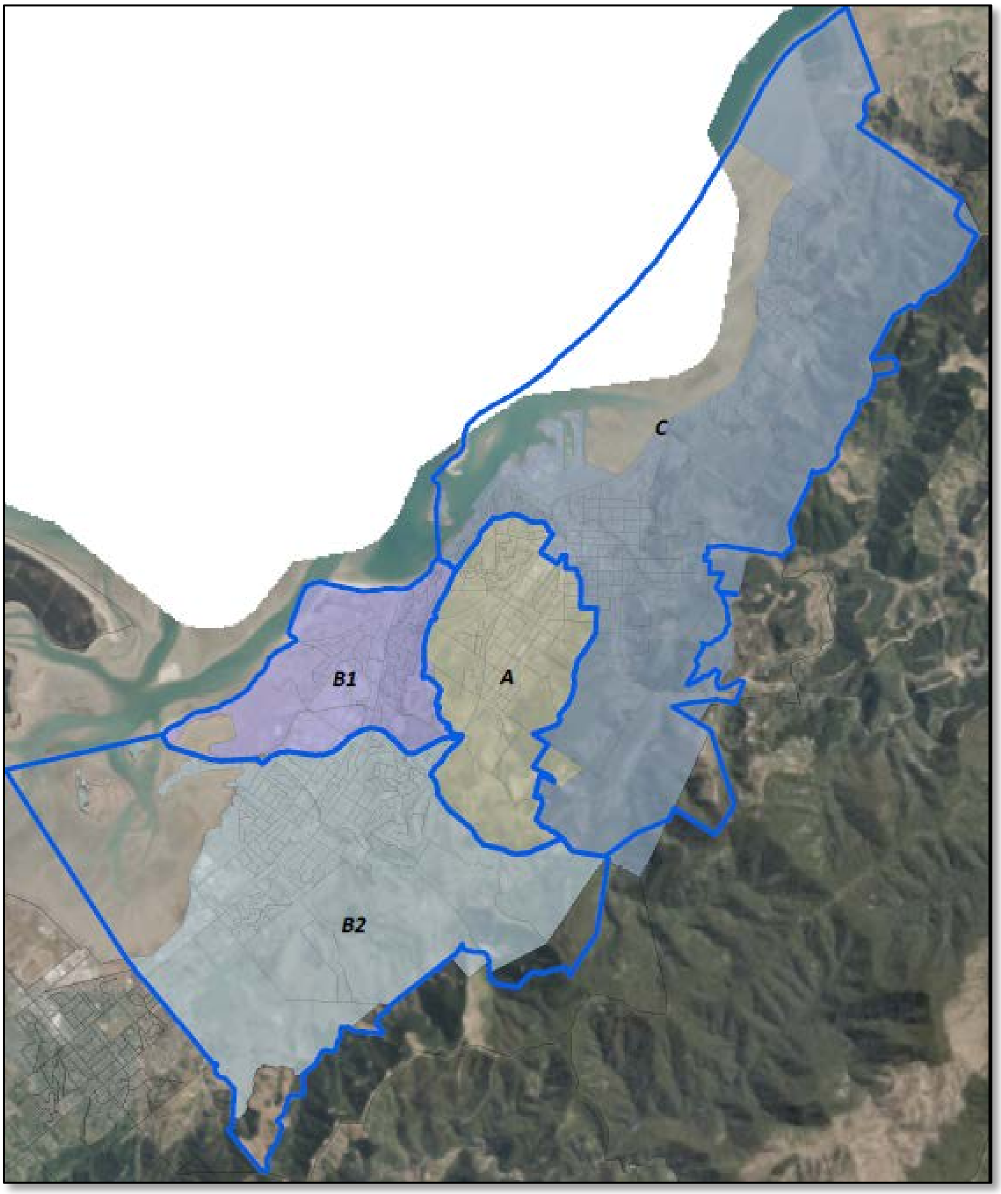
- The situation reflected by the current operative Air Quality Plan (Scenario 1). In this assessment, we treat this as the **baseline situation**.
- Enabling a **limited** number[4] of ultra-low emission burner or ULEBs in the different airsheds. The limit of burners has been determined by Council's air quality experts. Burner numbers will be changed by way of a combination of new/amended policies, rules or other methods (this is Scenario 2),
- In this scenario, the numbers of ULEBs in each airshed are **unlimited**, implying that a maximum uptake in the number of burners based on t the underlying demand for wood burners. The change is enabled through a combination of new/amended policies, rules or other methods,
- Enabling a site-by-site 'allowance' of particulate matter to be discharged[5], irrespective of the heating mechanism used (Scenario 4),
- An **unlimited number of National Environmental Standards** (NES) burners would be allowed under this scenario through a combination of new/amended policies, rules or other methods. This scenario can be seen as a 'worst case approach' because of the potential scale of change (limited restrictions on households),

[4] The limit number of ULEBs is based on enabling a shifting to ULEBs while maintaining current ambient air quality (PM_{10}) levels.
[5] This limit would likely be based on the discharge typically associated with a ULE burner.

- The sixth scenario that was assessed related to enabling a **limited** number of ULEBs through a combination of new/amended policies, rules and other methods but with a particular emphasis on **behaviour change**.

The air quality implications associated with the above, were assessed for each of Nelson's four airsheds (see Figure 1-1).

Figure 1-1: Nelson Airsheds



The assessment focuses on burner numbers, the implied air quality implications (in terms of PM_{10}) and the different costs associated with burners. These costs include:

- Capital costs, e.g. the cost of the appliance,
- Operational costs such as annual maintenance costs and fuel costs,
- The societal costs in terms of the health effects associated with PM_{10} levels, and
- The regulatory and other management costs. These include costs that will be incurred by Council as part of the implementation and management process.

The assessment compares the scenario against the trends associated with Scenario 1 – the current situation as enabled under the operative Air Quality Plan.

1.2 Limitations and caveats

The assessment is based on a number of specialist studies, most notably the scenario modelling undertaken by Environet[6]. M.E used the scenario results in terms of the air quality implications to assess and compare the options. In particular, our assessment relies on the following variables (sourced directly from Environet's modelling):

- Burner numbers (per broad age cohort and burner type),
- Emissions (percentage change over time in each airshed), and,
- The PM_{10} concentrations associated with each scenario.

In using Environet's results as inputs, we have assumed that the results:

- Are accurate and that the scenario associated with the current Air Quality Plan can be used as a business as usual situation. In other words, that we can use scenario 1 as a baseline against which to measure the other scenarios,
- Offer robust and accurate representations of the likely change in burner numbers that is expected for each scenario,
- Accurately estimate the expected emission trends (PM_{10}) and changes associated with each scenario, and,
- Use appropriate assumptions (e.g. demographic or household figures) when modelling the trends within each airshed.

M.E did not review the Environet's modelling or results for accuracy or robustness and did not test the assumptions underpinning the Environet model[7].

[6] Air Quality management in Nelson - Modelling of additional scenarios. 2015. Prepared for Nelson City Council. Prepared by Emily Wilton, Environet Ltd.

[7] During the project, M.E did discuss some of the model inputs and assumptions, such as household numbers, to make sure that our interpretation is consistent with how the results were to be used.

In terms of estimating the potential health costs associated with the different scenarios, M.E used the methods and factors outlined by Kuschel and Mahon in their 2010 update of the 2007 Health and Air Pollution in New Zealand (HAPINZ) study[8]. Subsequent to this report, a number of other refinements and updates have been completed. These more recent reports were reviewed, and where appropriate, the factors were updated to reflect any changes. The health costs (cost per case) are based on the mentioned HAPINZ study.

This assessment focuses on the health effects of domestic emissions associated with PM_{10}, but it is noted that this is not the only pollutant that causes health issues. Others include nitrogen dioxide, carbon monoxide and benzene. These have been excluded from the analysis due to the limited availability of monitoring data and the potential to double-count the health effects.

By using the HAPINZ approach, we inherently assume that there is a relationship between domestic emission (and concentrations) and health effects. This in an important assumption and forms a key principle of the HAPINZ modelling approach that we used in this assessment.

In terms of information sources, the main sources were:

- Statistics New Zealand (SNZ)
    - Census information,
    - Population projections,
    - Meshblock data about households.
- Environet
    - Air quality management in Nelson – Modelling of additional scenarios (2015),
    - Heating, household and fuel poverty data for Nelson (2014).
- Personal communications[9]
    - The Ministry for the Environment (MfE),
    - Discussions with Dr E Wilton (from Environet),
    - Nelson City Council staff.

The approach that we have used in this report is consistent with other similar assessments, including the Auckland Council Cost and Benefit Assessment of Domestic Air Management options[10] and an assessment undertaken for Environment Canterbury[11] on space heating.

8 Kuschel, G.; Mahon, K. (2010). A review and Update of HAPINZ for the Auckland Region. Prepared for Auckland Regional Council. ARC Internal Report No 2010/004. Changing any of the methods used to calculate the emissions, health effects and/or the costs would then mean that the estimates presented in this report would be over/understated.

9 By Lawrence McIlrath during October and November 2015.

10 Undertaken by M.E

11 Harris Consulting. Report to Environment Canterbury. Economic Analysis of Space Heating Provisions for Proposed Canterbury Regional Air Plan. Report R15/25. February 20115.

In terms of scope, this assessment has been undertaken from an air quality perspective and not a 'warm home' perspective.

1.3 Report structure

The rest of this report is organised as follows:

Section 2 describes the key features of the scenarios and the other key inputs used in the assessment. The assumptions used to translate the scenarios into costs and benefits are outlined and described.

Section 3 summarises the key findings for each airshed individually. A high-level, Nelson-wide, summary is also provided. The section concludes with a comparison of the scenarios in terms of the relative effectiveness and efficiency of the scenarios.

In the final section, Section 4, the main points are highlighted and some of the wider considerations are presented. As mentioned earlier, this assessment focusses on the air quality component of the plan, but there are other potential implications such as the ability to heat homes and the availability of alternative (not-burner) methods. The assessment concludes with a cursory comparison of how the burners compare to the alternative measures.

2 Scenarios and Assumptions

The assessment is based on six scenarios that reflect different growth profiles and burner numbers in each airshed. The profiles and the projected PM_{10} levels for each airshed, drive the costs associated with each scenario. This section starts by outlining the different scenarios and is followed by an overview of the logic applied to translate the changes into costs and benefits.

2.1 Scenarios

NCC is testing and assessing a range of scenarios for allowing the installation of new solid fuel burners in the four airsheds in the Nelson Urban Area. The potential air quality (PM_{10}) impacts of the different management options have been assessed by Environet[12]. The six scenarios reflect the following situations:

- Air Plan with 20 year phase out (Sc1),
- 20 year phase out, limited ultra-low emission burners (ULEB) (+xxx/airshed) (Sc2),
- 20 year phase out, unlimited ULEBs (Sc3),
- A performance limit option for Airshed X (Sc4),
- 20 year phase out *plus* NES burners all households (unlimited) (Sc5), and
- 20 year phase out, limited ULEBs (+xxx/airshed), 10% behaviour change (Sc2b or Sc6).

The scenarios are based on the air quality modelling work that has been undertaken for NCC. We note that as part of the air quality modelling work, a broad range of potential scenarios (and combinations of changes) were modelled. For the economic assessment, we used the five scenarios reflecting the main components. The five scenarios that we assessed were selected by NCC. Figure 2-1 illustrates the *general* alignment between the scenario selected for our assessment and the different air quality scenario (and combinations of activities) assessed by Environet.

The scenarios are applied to each airshed individually. The different scenarios include cross boundary dispersion effects as captured in the Environet modelling. The report identifies instances where and to what extent allowing an increase in PM_{10} emissions in one airshed may affect ambient air quality (PM_{10}) levels of another, due to the movement of contaminated air between them. This suggests that the overall, 'between' airshed effects need to be considered.

[12] Air Quality management in Nelson - Modelling of additional scenarios. 2015. Prepared for Nelson City Council. Prepared by Emily Wilton, Environet Ltd.

Figure 2-1: Alignment with Air Quality Modelling Work

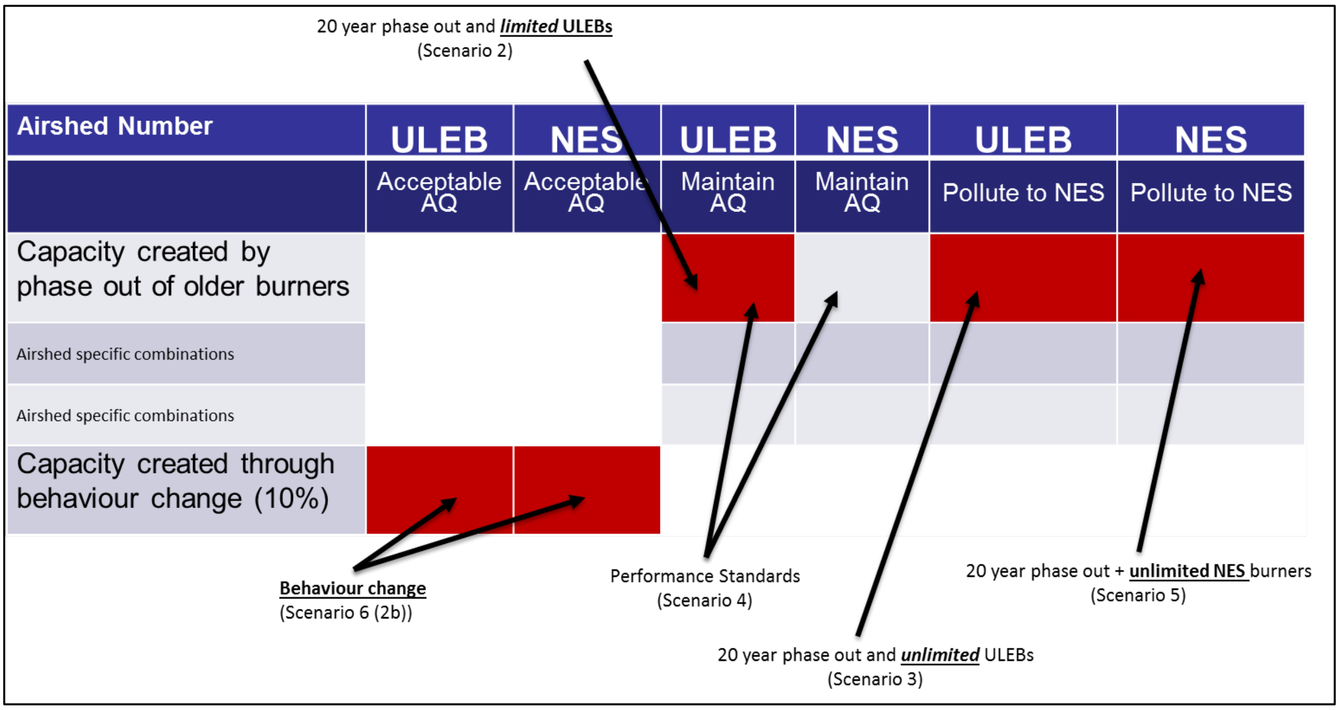


Figure 2-2: Airshed A: PM_{10} Changes

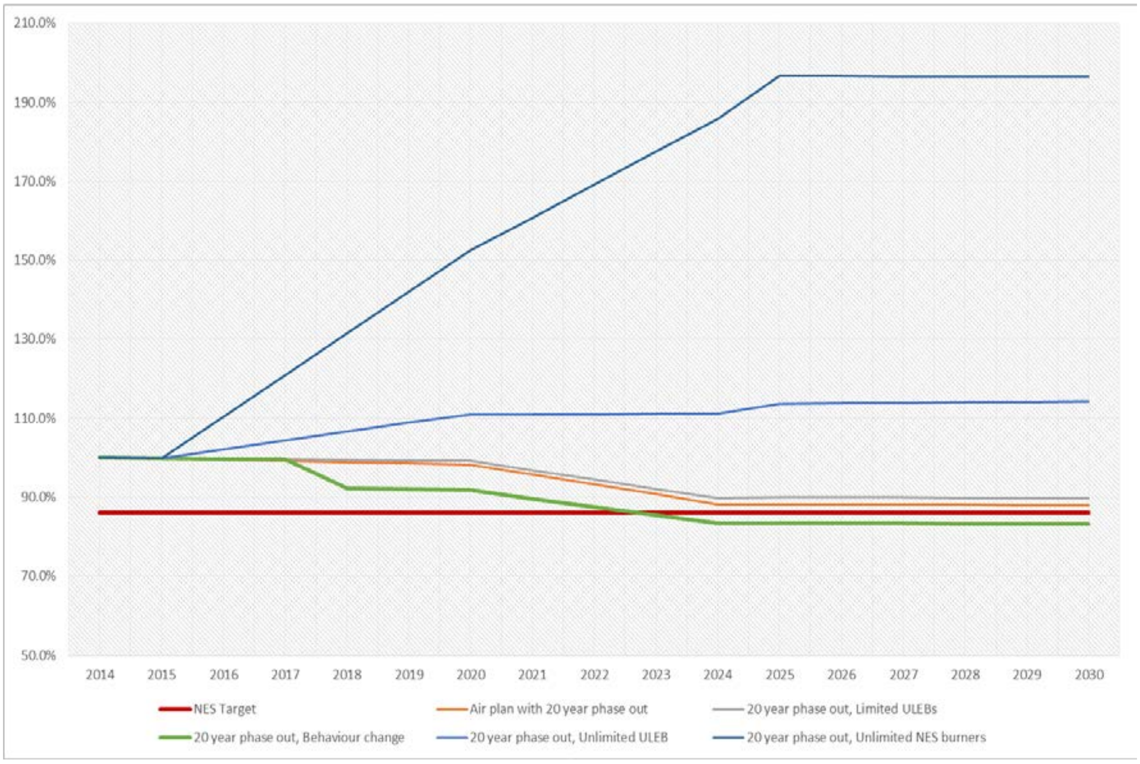


Figure 2-3: Airshed B1: PM_{10} Changes

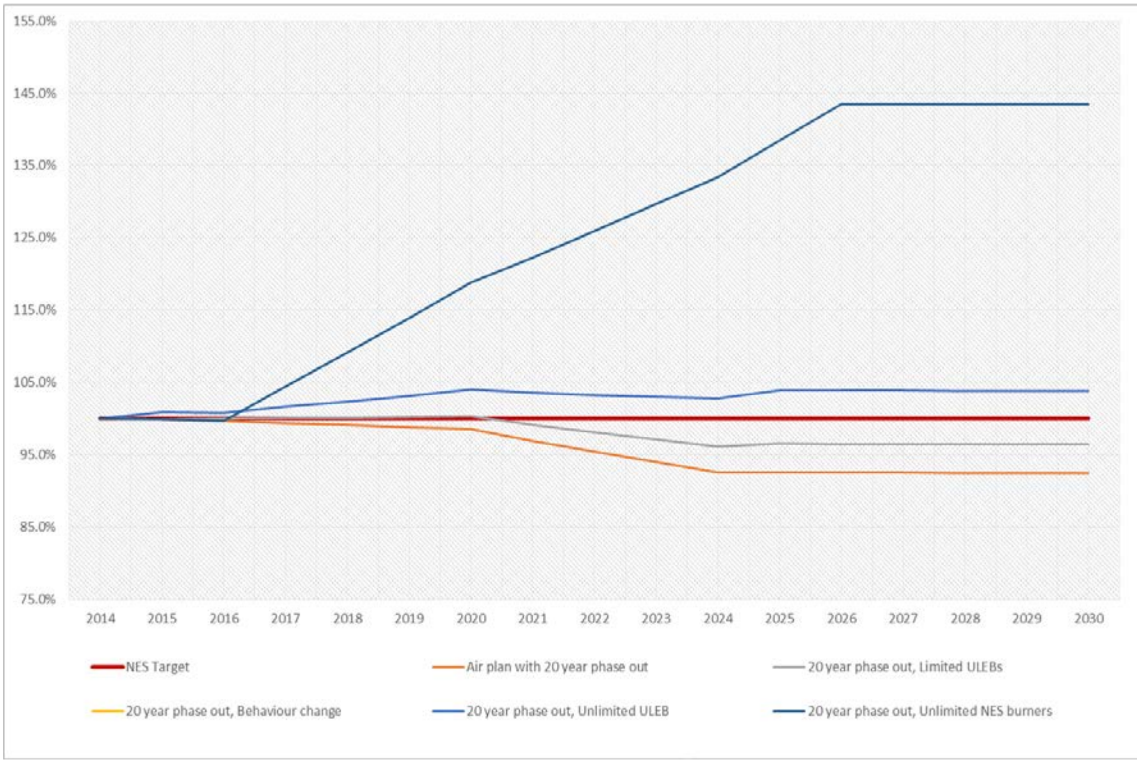


Figure 2-4: Airshed B2: PM_{10} Changes

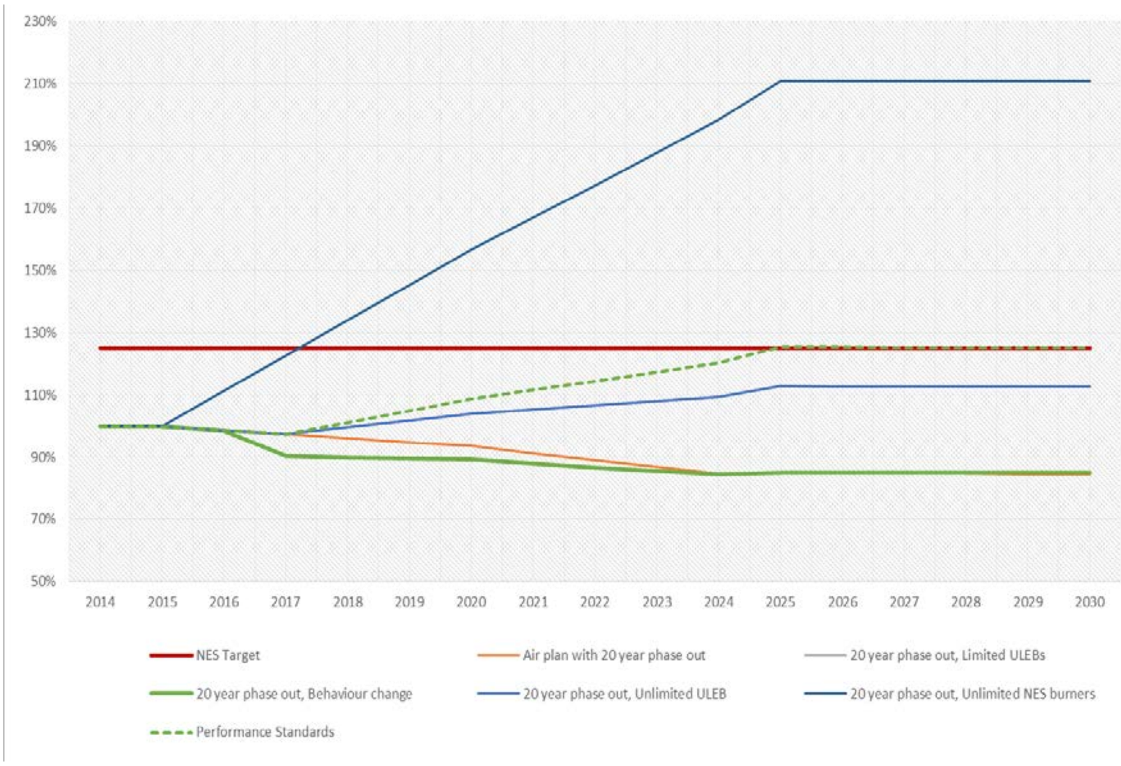
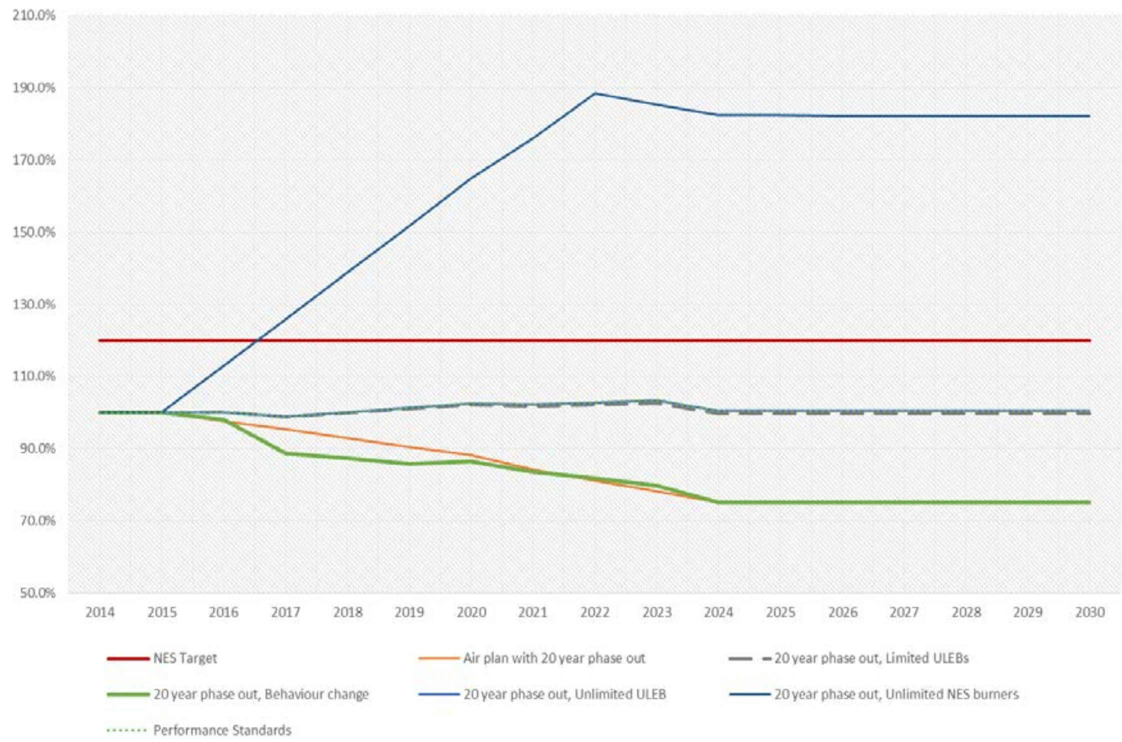


Figure 2-5: Airshed C: PM_{10} Changes



A description and interpretation of the different scenarios can be found in Environet's report[13].

The PM_{10} concentrations are a function of the mix and number of burners in each airshed. Environet modelled the change of the different burner types for each scenario. The change reflects a number of drivers, including the natural conversion of burners (removal and replacement at the end of its useful life). This is the phase out of old technology burners. This trend is ***included*** in most of the scenarios.

[13] Air Quality management in Nelson - Modelling of additional scenarios. 2015. Prepared for Nelson City Council. Prepared by Emily Wilton, Environet Ltd.

Appendix 1 shows the burner numbers in each airshed, for each scenario. The year on year change in burner numbers is used to estimate the potential cost that would be incurred by households in the different airsheds.

2.2 Core assumptions

Translating the different scenarios into costs and benefits was done using a set of assumptions. These assumptions are broadly consistent with other[14] similar assessments that have been undertaken throughout New Zealand. One of the problems faced when undertaking an assessment such as this one, is identifying the 'net gain' or 'net loss'; the baseline against which the change is assessed informs the scale and direction of the change (benefit or cost). In this assessment, we used Scenario 1 as the baseline as it reflects the 'current situation' in terms of what is permissible under current rules. This assessment compares the different scenarios **relative to** Scenario 1 and the change is interpreted as follows:

- If a scenario results in less cost being imposed on (or spending incurred) by households, then that difference is interpreted as a benefit, or conversely
- If a scenario results in a greater total cost imposed on, or incurred by households, then the difference is interpreted as a cost.

While the above will give an indication of the scale of the change (positive or negative), it is important to note that it will not provide any insight into the comparative effectiveness or efficiency of the scenario. This is done by expressing the change (cost and benefits) as a ratio of total change. The change in burner numbers is a consistent variable across most scenarios (and airsheds) and is used as an indicator of change. (Note: the ratios are presented in the next section). The assumptions about the costs and benefits, how these were estimated, and how these were used in this assessment are summarised below.

2.2.1 Health costs

The health costs were estimated using the HAPINZ approach. Essentially, this is done by translating the change in PM_{10} concentrations into the health effects and then applying a health cost ($) to each 'new' incident. The relationships between PM_{10} concentrations and different health effects are described in different HAPINZ studies and the cost per incident (health case) is described in the HAPINZ studies[15]. In other words, the difference in health incidences (the number of cases) between the baseline situation and the scenario was calculated and translated into Dollar values. In the assessment we estimate the **difference from the baseline and not the 'total $-values'[16].** Table 2-1 lists the health values that were used to monetise the health effects.

[14] Including the Auckland Council, Air Quality Domestic Fires Management Options (Cost Benefit Analysis) in 2011 and the Economic Analysis of Space Heating Provisions for the proposed Canterbury Regional Air Plan (Report no R15/25) that was prepared for Environment Canterbury by Harris Consulting.
[15] The different reports can be found on the HAPINZ website: www.hapinz.org.nz
[16] This approach will give the same result as estimating the total $-value of a scenario and subtracting the baseline scenario's total value from it.

Table 2-1: Health Effect (PM_{10}) and Cost per Case

Health Effect	Cost
Premature Mortality Effects	$3.56m
Acute Respiratory Hospital Admissions	$4,535
Acute Cardiovascular Hospital Admissions	$6,350
Restricted Activity Day	$62

Source: HAPINZ 2010 and subsequent updates.

The health costs (or benefits) are viewed as 'a cost (or benefit) to society'. This is because the costs/benefits accrue to the wider population, and cannot be attributed to distinct (identifiable) parts of that population based on the population's attributes. For example, the benefit of heating a home with a burner can be linked to a particular residence but the health effects of the resulting air pollution are likely to be felt by someone in the wider community (which may or may not be contributing to air pollution).

2.2.2 Direct costs

The direct costs were categorised into two main groups: burner costs and council costs. The aspects associated with each category are listed below. Generally, the burner costs relate to a household's spending on the wood burner (e.g. fuel, the appliance and cleaning), and council's costs cover planning, regulatory and enforcement activities.

Burner Costs

The private costs, i.e. the cost to the homeowner, includes installation costs, the cost of buying an appliance, removing an old burner as well as any consenting costs. The consenting cost (i.e. the cost of the consent paid to Council) is incurred by the household/homeowner when he/she invests in a new wood burning appliance. The consenting fee varies between $200 (free standing) and $250 (built-in)[17]. We use $210, suggesting that a large portion of consents would be for freestanding appliances.

The second cost to homeowners is the cost of the appliance and its installation. Numerous options exist, and the cost is influenced by the type of burner that is selected and the options that are included in the purchase. The burner model (and subsequent cost of the appliance) is influenced by the size of the appliance (heat output range), accessories included and model type. In addition, total installation cost is influenced by numerous factors, such as the flue design and requirements, removal of existing appliances, and the integration with existing heating appliances. Table 2-2 summarises the costs related to burners.

[17] Based on NCC Website.

Table 2-2: Burner Related Costs

Item	Cost ($2015)	Annual price changes (inflation)
Removing a burner	400	3.1%
Council consent	210	2.5%
Installation	700	3.1%
Appliance		
Multi-fuel burner	3,500	2.0%
Post 2009 burner	3,500	2.0%
Pellet fire	4,500	2.0%
ULEB[1]	10,000	2.0%
Maintenance		
NES compliant and other burners	100 p.a.	2.6%
ULEB	100 p.a.	2.6%

1 – The cost of ULEB could decrease over time as they become more widely available. However, the trajectory of such a price decline is uncertain. Therefore, we retain the current price. A lower price is assessed as part of the sensitivity analysis

Source: The costs were defined during discussion with Council staff. It is our understanding that Council staff derived these costs after consulting with local industry role players. The inflation rates are based on the PPI (output) published by SNZ (Table PPI024AA)

In addition to the above, households (with burners) will use the appliances and thereby incur costs relating to fuel (wood).

Fuel costs

Estimating the total fuel cost is based on the information supplied by Environet around the percentage of households using wood burners as a heating source, the average number of days per week that a house is heated using a wood burner, and estimates around the total wood used (per night). This is then used to derive total annual wood usage that is then multiplied by the cost of wood. The total cost of wood fuel is then adjusted to account for 'free fire wood'. This adjustment is applied on a 'per airshed' basis[18]. The average annual fuel costs were estimated at between $260 and $330 (per year).

2.2.3 Council Costs

In addition to the health and household costs, Council is also expected to incur additional costs. These costs are 'in addition' to current spending and will be allocated to the 'new actions' associated with the regulatory, enforcement and/or community engagement activities. The following costs have been identified:

- Meteorological reports
  - Estimated costs - $3,000 per airshed (over two years).
  - Additional monitoring equipment (one-off costs) of $20,000 - $35,000.
  - Additional meteorological station Airshed C and first trends analysis ($30,000 for the equipment, $14,000 for the first trend analysis; both of these costs are one offs).

[18] This adjustment was informed by the 2014 report titled: Heating, household and fuel poverty data for Nelson. Prepared for NCC by Emily Wilton, Environet Ltd.

- Costs associated with the behaviour change are mostly ongoing and is estimated at $15,000 (per year) for the support staff and $20,000 for the supporting information package. In addition, $25,000 will be needed to develop an effective and targeted communication strategy. It is envisaged that the strategy will be refreshed every five years.

These costs are projected to increase at around 2.5% per year, in line with Council's estimates of inflation.

The different scenarios and the cost assumption used in the assessment were outlined above. In the next section, the costs (benefits) of the different scenarios are estimated and interpreted.

3 Key Findings

This section summarises the key findings of the assessment and presents a selection of the indicators only. When comparing the results, it is important to consider the scale of change, the distribution over time and the total costs/benefits. We report the effects of the scenarios using discounted cash flow analysis (Net Present Value, NPV) as well as the cumulative effects.

The different scenarios are compared against each other at an airshed level to provide an indication of the 'on the ground' effects and costs. This spatial resolution provides an ability to relate the findings to the demographic and social features of each airshed. These relationships are used to identify the wider (beyond air quality) implications of the different scenarios. This is followed by a *high-level* comparison of alternative heating methods and the potential implications (for the plan change assessment) are highlighted.

3.1 Airshed level results

The four airsheds have their own distinct characteristics and factors affecting burner use, as well as current and projected emissions levels. The key results are presented and the main implications are highlighted by presenting the findings using:

- The total costs (or benefits) in Net Present Value (NPV) terms, and
- The relative effectiveness of the different scenarios (*additional cost per additional burner*[19]).

In undertaking an assessment such as this one where costs/benefits fall to the community, it is more appropriate to use a social discount rate. Deriving a specific discount rate is complex and difficult. Work done by Parker (2013)[20] and Grimes (2011)[21] suggest that discount rates in the ranging between 2% and 4% (depending on the application or project being assessed; we note that there is a wide distribution in terms of the rates used). With reference to the NPV analysis, a discount rate of 3.25% was used[22]. This is lower than the 8% discount rate used by the likes of Treasury and the New Zealand Transport Authority.[23]

Using a lower discount rate places greater[24] value on future benefits (and costs). Importantly, using a higher discount rate would not change the **relative** distribution of costs and benefits nor would it change the direction of the effect, e.g. translate a cost into a benefit or otherwise. Each airshed is assessed separately by looking at the above aspects.

[19] It is important to note that the cost per burner as presented here (and used in the discussions for the other airsheds) is the total *additional* cost divided by the *number of additional burners.* This is not equal to the cost per individual burner.

[20] C Parker. NZIER. Advice of Auckland's social discount rate policy. May 2013.

[21] Cost Benefit Analysis of the Warm Up New Zealand: Heat Smart Programme. June 2012. Motu, Covec, He Kainga Oranga/Housing and Health Research Programme, University of Otago, Wellington, Department of Mathematics Victoria University of Wellington.

[22] Appendix 2 summarises the results of the analysis using different discount rates (2.5%, 4.0%, 6.0%, 8.0% and 10%). A wide range of discount rates is used due to the uncertainty and difficulty in determining the 'true underlying' social rate of time preference or social opportunity costs (alternative ways to estimate the discount rates). This is in-line with Young's findings [Young. L. 2002. New Zealand Treasury. Determining the Discount Rate for Government Projects. Working Paper 02/21.

[23] They use rates between 6% and 10%, depending on the type of project.

[24] Relative to using a higher discount rate.

NOTE: The costs presented in this section are all in NPV terms and relative to the baseline (Scenario 1).

3.1.1 Nelson A

The effects of the different scenarios in terms of the costs and benefits are summarised in Table 3-1. The main observations are:

- The behaviour change scenario delivers a health **saving** of around $10.5m (in NPV terms). This is over a period out to 2030.
- Scenario 2 (enabling 200 ULEBs) delivers the second lowest cost option in terms of the total cost of $11m, of which 20.9% is in the form of additional health costs.
- Scenarios 3 and 5 both impose extra cost on the community. In Scenario 3, most of these costs (43.6%) arise from the operating cost (fuel and maintenance). However, in Scenario 5, health costs account for the largest proportion of total costs (63.7%) associated with the increase in burners in this airshed.

Table 3-1: Nelson A – Costs & Benefits

	Health Costs	Change over costs	Operating Costs	Total Costs
	NPV $'m @3.25%			
Sc 2: Limited ULEBs	2.3	5.1	3.6	11.0
Sc 3: Unlimited ULEBs	33.1	33.7	51.6	118.3
Sc 4: Performance Stds	-	-	-	-
Sc 5: Unlimited NES	140.3	31.2	48.6	220.1
Sc 6 (2b): Behaviour Change	-10.5	-	-	-10.5

	Private Cost	Wider Costs	Total Cost/Burner	Change in burners
	Cost per Additional Burner (NPV $ / change in burners in 2030)			
Sc 2: Limited ULEBs	43,600	11,500	55,200	200
Sc 3: Unlimited ULEBs	28,900	11,200	40,100	2,947
Sc 4: Performance Stds	-	-	-	-
Sc 5: Unlimited NES	29,400	51,800	81,200	2,710
Sc 6 (2b): Behaviour Change	-	-	-	-

With reference to the relative effectiveness of the different scenarios, Scenario 6(2a) that relates to the behaviour change, delivers a positive effect (health saving relative to the baseline), but this is done without any extra change in burner numbers. Therefore, it is not possible to express this saving on a 'per burner basis'. Scenario 2 (additional 200 ULEBs) will result in an additional cost, in NPV terms, of around $55,200 for each additional burner. A large portion (79%) of this extra cost is incurred by the household(s) replacing and installing the burners.

Scenario 3 (unlimited ULEBs) has a relatively low cost on a per burner basis ($40,100) and most (72%) of the costs are incurred by households. However, in absolute terms, the total cost associated with this scenario is the second highest.

The analysis suggests that, for Nelson A, the behaviour change approach (Scenario 6 (2b)) and the limited ULEB growth (200 extra units) appear to be the most effective. This is in light of the overall cost, the (lower is more favourable) and the relative cost effectiveness. This is in spite of Scenario 3 (unlimited ULEBs) having the lowest cost per burner, because this scenario's total cost is 11 times greater than the second most favourable scenario (Scenario 2: Limited ULEBs).

3.1.2 Nelson B1

The scenarios that have been assessed for this airshed are limited and do not include[25] the 'full suite' so any comparison with other airsheds should be undertaken with due care. Table 3-2 summarises the results for Nelson B1.

Table 3-2: Nelson B1 – Costs & Benefits

	Health Costs	Change over costs	Operating Costs	Total Costs
	NPV $'m @3.25%			
Sc 2: Limited ULEBs	2.3	6.7	9.0	18.0
Sc 3: Unlimited ULEBs	7.0	16.3	25.6	48.9
Sc 4: Performance Stds	-	-	-	-
Sc 5: Unlimited NES	26.0	16.3	21.4	63.8
Sc 6 (2b): Behaviour Change	-	-	-	-

	Private Cost	Wider Costs	$ Cost/Burner	Change in burners
	Cost per Additional Burner (NPV $ / change in burners in 2030)			
Sc 2: Limited ULEBs	31,300	4,700	36,000	500
Sc 3: Unlimited ULEBs	29,400	4,900	34,300	1,426
Sc 4: Performance Stds	-	-	-	-
Sc 5: Unlimited NES	26,500	18,200	44,700	1,426
Sc 6 (2b): Behaviour Change	-	-	-	-

For the Nelson B1 airshed, the scenario that returns the lowest overall cost is Scenario 2 (500 ULEBs). This scenario has a total cost (in NPV terms) of $18m, of which the health costs account for $2.3m – 12.8%. This is followed by Scenario 3 (Unlimited ULEBs) and Scenario 5 (Unlimited NES burners) with total costs of $48.9m and $63.8m respectively. For these two scenarios, the change-over costs are broadly similar but the operating costs (fuel and maintenance) are higher for Scenario 3 (unlimited ULEBs). This is because of differences in when the change (to different burner types) are expected to occur, as the total change in burner numbers for these two scenarios is the same.

[25] This was based on the Environet modelling. The rationale for not running some of the scenarios are outlined in Wilton, E. Air Quality Management in Nelson. Modelling of Additional Scenarios - 2015. Prepared for Nelson City Council.
It is our understanding that some of the scenarios were not suiThis is because some scenario are not appropriate or implementable in an airshed

For Nelson B1, the two least cost scenarios of those considered are:

- Scenario 2 (500 ULEBs):
  - This scenario has the lowest overall costs and the second lowest cost per burner ratio. In terms of the cost per burner ratio, the total cost per burner is estimated at $36,000 of which $4,700 will be borne by the wider community through health costs. This is equal to 13.1% of the cost/burner.
- Scenario 3 (Unlimited ULEBs):
  - The unlimited ULEBs scenario has the lowest cost per burner because the total cost is distributed across a larger number of 'new burners'. The total health cost for this scenario is marginally ($300/burner) higher than Scenario 2, again reflecting the larger base (i.e. more burners introduced under this scenario). However, the total costs for this scenario are around 2.7 times greater than Scenario 2's costs. This difference is driven by the total number of additional burners that are projected under Scenario 3. The largest difference is in operating costs ($25.6m vs $9.0m) and the changeover costs ($16.3m compared to $6.7m). The health costs are also higher for Scenario 3, but this is a small portion of the overall costs.

Combined, this suggests that the scenario focusing on the phase out of the old burners and replacing these with ULEBs (up to 500), is the option that will impose the smallest additional cost on the community. On a per burner basis, Scenario 3 returns marginally (4.7%) lower costs than Scenario 2. However, in terms of the overall cost, Scenario 2's total costs are 63.2% lower than Scenario 3.

3.1.3 Nelson B2

The Nelson B2 airshed has a full array of scenarios. Some of the scenarios are close to each other in terms of the burner profiles, so the changeover and operating costs as well as the associated cost per burner ratios, are the same. However, in some cases (e.g. Scenario 4) the health costs differ because the scenario assumes that performance standards (e.g. more stringent emission controls) will be applied.

In the case of the Nelson B2 airshed, the different scenarios can be ranked (most cost-effective first) in terms of the total costs and cost per burner as:

Total Cost	Cost per Burner
1. Behaviour Change (Sc 6 (2b)), 2. Limited and Unlimited ULEBs (Sc 2 & 3) 3. Performance Standards (Sc 4), and 4. Unlimited NES (Sc 5).	1. Limited and Unlimited ULEBs (Sc 2 & Sc 3), 2. Behaviour Change (Sc 6 (2b)), 3. Performance Standards (Sc 4), and 4. Unlimited NES (Sc 5).

Table 3-3: Nelson B2 – Costs & Benefits

	Health Costs	Change over costs	Operating Costs	Total Costs
	NPV $'m @3.25%			
Sc 2: Limited ULEBs	7.5	51.4	66.7	125.6
Sc 3: Unlimited ULEBs	7.5	51.4	66.7	125.6
Sc 4: Performance Stds	10.8	51.4	66.7	129.0
Sc 5: Unlimited NES	41.7	51.4	81.8	174.9
Sc 6 (2b): Behaviour Change	-1.8	14.4	14.4	26.9

	Private Cost	Wider Costs	$ Cost/Burner	Change in burners
	Cost per Additional Burner (NPV $ / 'change in burners in 2030)			
Sc 2: Limited ULEBs	25,925	1,641	27,566	4,558
Sc 3: Unlimited ULEBs	25,925	1,641	27,566	4,558
Sc 4: Performance Stds	25,925	2,380	28,304	4,558
Sc 5: Unlimited NES	29,225	9,143	38,368	4,558
Sc 6 (2b): Behaviour Change	29,229	-1,858	27,371	984

As with the preceding two airsheds, the analysis suggests that the behaviour change scenario delivers the change for the lowest overall cost. In this airshed, the behaviour change delivers a 'cost saving' through the health effects – this benefit is estimated at $1.8m. This effect is by way of an overall improvement in PM_{10} levels relative to the baseline. This was not the case with the two airsheds already discussed (see Figure 2-4).

In terms of the cost per burner findings, the behaviour change scenario (Scenario 6(2b)) is slightly more costly than Scenarios 2 and 3. The behaviour change scenario is 1.4% more expensive ($195 over 17 years) than Scenarios 2 and 3. In terms of the overall costs, the behaviour change scenario's total cost is estimated to be less than a quarter (21.4%) of Scenario 2 and 3. A part of this large difference is explained by the difference in ULEBs between these three scenarios. Under the behaviour change scenario, ULEBs are limited to 984 compared to 4,558 for the other two scenarios. Further, the behaviour change scenario aligns with the principles of user/polluter pays with no 'cost' loaded onto the community. Under Scenarios 2 and 3, around 5.2% of the cost (per burner) is shifted onto the wider community. These costs arise via the health effects.

3.1.4 Nelson C

The fourth airshed, Nelson C's results are summarised in the following table (Table 3-4). Overall, the number of new burners that would be enabled under the different scenarios is around the 3,000 mark for all the scenarios, excluding the behaviour change scenario (Scenario 6(2b)) which is modelled to accommodate an increase of 600 burners.

As with the other scenarios, the behaviour change scenario is projected to have the lowest overall cost with an NPV cost of $18.7m. This includes a health saving of $2.2m. The second lowest cost scenario is Scenario 2 (3000 ULEBs), that is projected to result in an additional cost, over the baseline scenario, of some $108.6m. This scenario is only marginally cheaper ($3.3m or 3%) than Scenario 3 (unlimited ULEBs). Scenario 5 (unlimited NES burners) returns the highest overall cost - $178.0m.

The patterns observed in this scenario are consistent with those identified in the other airsheds. In terms of the cost per burner basis, the relative efficiencies identified in this airshed are lower than the other airsheds despite a large number of burners being added in this airshed. On a per burner basis, Scenario 5 has the highest relative cost ($57,600) compared to Scenario 6(2b) with a cost per burner of $31,200. Clearly, the behaviour change scenario is expected to return the lowest overall cost at the lowest cost per burner. This scenario is further projected to result in a 'cost savings' to the wider community that is estimated at $2.2m (in NPV terms). On a per burner basis, this saving is estimated at $3,667/burner over the 17 years included in this assessment.

Table 3-4: Nelson C – Costs & Benefits

	Health Costs	Change over costs	Operating Costs	Total Costs
	NPV $'m @3.25%			
Sc 2: Limited ULEBs	16.4	34.3	57.9	108.6
Sc 3: Unlimited ULEBs	16.9	35.2	59.7	111.9
Sc 4: Performance Stds	16.9	34.3	57.9	109.1
Sc 5: Unlimited NES	83.0	35.2	59.7	178.0
Sc 6 (2b): Behaviour Change	-2.2	9.4	11.6	18.7

	Private Cost	Wider Costs	$ Cost/Burner	Change in burners
	Cost per Additional Burner (NPV $ / change in burners in 2030)			
Sc 2: Limited ULEBs	30,700	5,500	36,200	3,000
Sc 3: Unlimited ULEBs	30,700	5,500	36,200	3,092
Sc 4: Performance Stds	30,700	5,600	36,400	3,000
Sc 5: Unlimited NES	30,700	26,900	57,600	3,092
Sc 6 (2b): Behaviour Change	34,900	-3,700	31,200	600

The Nelson C airshed's projected burner numbers, cost per burner and the overall costs show the same pattern as the other airsheds. In all cases, the behaviour change scenario returns the lowest overall costs as well as the lowest cost per burner. This is then followed by Scenario 2 (limited ULEBs) which tends to have low total cost and comparatively low[26] cost on a per burner basis.

The behaviour change scenarios are the only ones (in Airshed B1 and Airshed C) that return a cost savings (for the health cost component). This suggest that the other scenarios and the burner growth profiles result in an increase in the cost to the wider community i.e. the costs arising from the negative health effects associated with higher PM_{10} levels.

[26] Low relative costs per burners are viewed as favourable over a high cost.

Key observations

- The analysis suggests that the behaviour change scenario results in the lowest marginal cost being imposed on the community.
- The limited ULEB scenarios (Scenario 2) is the second best option in terms of the cost being imposed on the community – specifically the wider costs which are not related to installing a new appliance or operating the burner.
- The scenarios related to allowing (for each household in each airshed) unlimited NES burners are the highest cost option and have the highest cost on a per burner basis.

3.2 Council Costs

As mentioned in section 2.2.3, the council is expected to incur additional costs in overseeing and managing air quality. It is our understanding that these costs are in addition to current costs. All scenarios will have similar costs structures. Council's costs are relatively small when compared to the overall costs. In **NPV terms,** the costs for the main aspects are:

- Monitoring Costs
    - Ongoing monitoring costs NPV$108,780
    - Equipment and setup costs[27] NPV $$34,000 to $49,000,
- Behaviour change related costs (total) NPV $566,380

In the context of the overall costs (as described in the preceding sections), these costs will increase the total cost of the behaviour change scenario by 1.9% while increasing the total costs of Scenario 2 (to increase ULEBs while maintaining air quality) by 0.3%. With reference to Scenarios 3, 4 and 5 respective, the increases are 0.2%, 0.3% and 0.1% respectively.

3.3 Other Considerations

It is important to note that the air quality modelling (of the scenarios) is based on the assumption that households would be in a position to exercise their rights to install a new (or replacement) burner. That is, households would exercise their right to a burner. However, the probability of all households taking up this option is low. Factors limiting the potential uptake include:

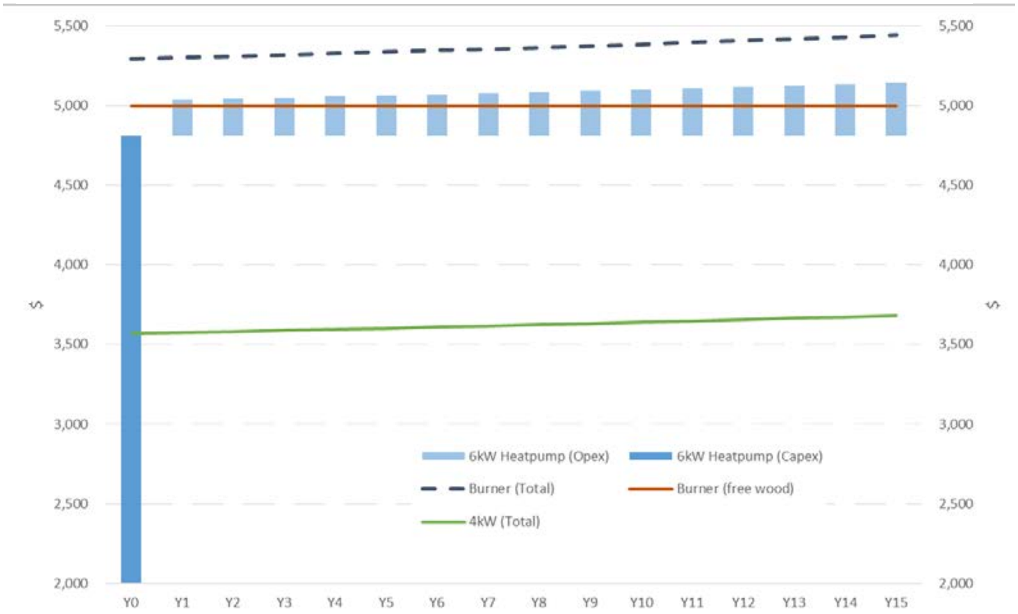
- The affordability and ability to pay for a new/replacement burner,

[27] These costs are one offs and not expected to repeat.

- The desirability and attractiveness of a burner relative to other heating measures,
- The ongoing costs (perceived or real) of burners, specifically fuel costs, and
- The ability to install (or replace) a new burner in the property's features.

With reference to affordability, this is an important aspect but in light of the potential ability to collect free firewood, a wood burner might be more cost efficient than other heating sources because the fuel would be at no cost. For some households, access to free firewood would be a key consideration winter heating would not place any demand on the household's budget. To illustrate the potential implications of free firewood, we compared the longer-term cost of a heat pump with that of a burner. To keep the comparison simple, we use the initial appliance cost and the energy cost (electricity vs wood vs free wood). Figure 3-1 illustrates the comparison.

Figure 3-1: Cost comparison



In order for residents to make an informed decision about the way to heat their houses, they would normally consider the heating appliance; the capital cost (initial capital outlay) and the ongoing energy costs. The one off costs consist of appliance costs and installation cost where applicable. In terms of the ongoing costs, we used estimates of Nelson households' annual heating expenditure and the estimated energy costs per unit (Appendix 3) to derive an annual heating budget. We have assumed that, on average, households use around 3,000 kWh per year.[28]

[28] Based on heating for five months of the year (153 days).

The initial capital cost (installation and purchasing the appliance) is substantial for all the options but the heat pumps have a comparative advantage. The medium sized heat pumps are in the order of $3,350 to purchase and install. Installing a NES burner is almost 50% more costly and a ULEB is around three times more expensive. With reference to a larger heat pump (around 6kW), a similar pattern emerges but the differences are not as pronounced, coming in at around 6%.

The two heat pump examples presented above shows that, compared to the burner option, a heat pump could be a more cost effective option. This is based on the relatively high initial capital cost of the appliance. This raises the question of the potential effect of free wood. Around a third (34%) of wood is self-collected or obtained free of charge[29]. This suggests that component of the market could exhibit a preference for wood burners. As shown in Figure 3-1, comparing a large heat pump with a wood burner shows that under a 'free fuel' scenario, these two heating options are relatively similar. It is also worth noting that a larger heat pump is more likely to be installed (found) in a large dwelling.

The relative price difference between burners and heat pumps suggests that in the short to medium term, heat pumps could be favoured over burners. This means that the burner numbers modelled in the scenarios might not be fully taken up. If, for some reason, the burner uptake rate is slower than the rate modelled in the scenarios, then the emissions and the health costs will be different from the ones reported here.

3.4 Sensitivities

As part of the assessment, we conducted a sensitivity analysis by changing the different variables. The variables were increased and decreased by 10% and the percentage change across the airshed and scenarios were reviewed. The following variables were changed:

- Capital spending +10% and -10%,
- Operational spending +10% and -10%, and
- Health cost +10% and -10%.

In addition to these changes, the potential effects of lowering the cost of ULEBs by 50% were tested.

None of the above settings pointed to a different outcome (in terms of the airsheds and scenario level results). Reducing the ULEB cost (of the appliance) has the greatest effect in the airsheds that are projected to see the highest uptake of ULEBs, reducing the associated costs by up to 41.2%. However, the relative distribution of total cost between the scenarios does not change. Appendix 5 shows the results of the sensitivity analysis.

[29] Wilton, E. 2014. Heating, Household and Fuel Poverty Data for Nelson. Report by Environet prepared for Nelson City Council

3.5 Summary

In this section, a number of scenarios were assessed. These scenarios reflected different approaches and assumptions about the uptake and growth of burners in each airshed. The analysis suggests that the scenarios associated with 'behaviour change' are the 'least cost' scenarios. One reason for these low overall costs is the relatively small number of additional burners that are installed. The behaviour change scenario delivers a 'health benefit' because under this scenario, the total PM_{10} emitted is projected to be lower than the levels associated with the baseline (current Air Quality Plan).

Of the other scenarios, Scenario 2 returns the second lowest cost levels. This scenario relates to enabling a limited number of ULEBs in the different airsheds. Importantly, this scenario is materially more costly than the behaviour change approach. The remaining scenarios are more costly still.

In most scenarios[30], excluding the scenario related to the unlimited NES burners, the health costs form a relatively small portion of the total costs and range between 6% and 15%. The health costs, when expressed in $-terms, is estimated at between $14.6m for the behaviour change scenario and $28.5m for the limited ULEB approach. Apart from the behaviour change, the other scenarios all transfer a portion of the total cost onto the wider community. These public costs arise in the form of the health effects.

In summary, the analysis suggests that the behaviour change approach is the most cost effective when compared against the other scenarios.

[30] Airshed A is different with health costs capturing a larger share of overall costs (between 21% and 28%).

4 Concluding Remarks

This assessment reviewed five different scenarios and compared them against the potential PM_{10} levels associated with the current Air Quality Plan. Using the potential situation associated with the AQP as a baseline, we then compared the potential private and public costs associated with each scenario.

The analysis suggests that a behaviour change approach is, compared to the other scenarios, the most cost effective. Such an approach is likely to deliver further improvements in air quality (PM_{10}) and therefore deliver positive health effects (i.e. a benefit because the total health costs are reduced relative to the baseline). The other scenarios are not projected to lead to an improvement of air quality (PM_{10}), instead increasing PM_{10} level (relative to the baseline) that in turn, impose a health cost on the wider community.

While it is beyond of the scope of this research to provide specific policy recommendations or guidelines, we were asked to provide some high-level commentary on the potential for further future *increases in the number of burners in an airshed (above any limit set by the pending plan change)* ***if*** *PM_{10} levels in an airshed is below the projected ()levels associated with that airshed.* At a high level, such an option is likely to return a positive health effect compared to the baseline and the private costs will be borne by the individual households (installing the burners). Therefore, in terms of potential costs and benefits, such an option is likely to have a favourable cost-and-benefit profile. However, this will only hold if the 'new PM_{10} levels' are, and remain, below the projected baseline levels.

There are a number of practical issues that would need to be outlined for an option, such as the one suggested above, to be successful. This includes the PM_{10} monitoring regime; how it would be operated and the specific thresholds at which additional burners would be enabled (or allowed). It is envisaged that the Council will incur the monitoring costs as part of its ongoing responsibility to monitor air quality and that it then publishes, at signalled time intervals, the 'extra' levels of burners for each airshed[31]. By continuously signalling what the available capacity is, and how it is measuring the capacity, the Council can provide certainty and transparency to the market about the potential opportunity to invest in a burner as a heating source.

Over the past decade or so, Nelson City Council has had a strict air quality[32] management approach and this has contributed to an improvement of the city's air quality. This assessment has shown that continuing to improve the city's air quality is the most cost effective approach. The scenarios that lead to an increase in PM_{10} levels are shown to transfer costs onto the wider society, suggesting that there are some inefficiencies and externalities.

[31] Assuming that there is extra capacity.
[32] Referring to PM10 levels.

Appendix 1: Projected Burner Numbers

Nelson A		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Scenario 1	Multifuel burner	14	14	14	14	14	14	14	11	7	4	-	-	-	-	-	-	-
	Pre 2005 burner	206	206	206	206	206	206	206	154	103	51	-	-	-	-	-	-	-
	2005-2009 burner	443	443	443	443	443	443	443	443	443	443	443	354	266	177	89	-	-
	Post 2009 burner	886	886	886	886	886	886	886	941	996	1,051	1,106	1,194	1,283	1,372	1,460	1,549	1,549
	Pellet fire	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166
	ULEB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1,715	**1,715**	**1,715**	**1,715**	**1,715**	**1,715**	**1,715**	**1,715**	**1,715**	**1,715**	**1,715**	**1,715**	**1,715**	**1,715**	**1,715**	**1,715**	**1,715**
Scenario 2	Multifuel burner	14	14	14	14	14	14	14	11	7	4	-	-	-	-	-	-	-
	Pre 2005 burner	206	206	206	206	206	206	206	154	103	51	-	-	-	-	-	-	-
	2005-2009 burner	443	443	443	443	443	443	443	443	443	443	443	354	266	177	89	-	-
	Post 2009 burner	886	886	886	886	886	886	886	941	996	1,051	1,106	1,194	1,283	1,372	1,460	1,549	1,549
	Pellet fire	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166
	ULEB	-	-	20	40	60	80	100	120	140	160	180	200	200	200	200	200	200
		1,715	**1,715**	**1,735**	**1,755**	**1,775**	**1,795**	**1,815**	**1,835**	**1,855**	**1,875**	**1,895**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**
Scenario 3	Multifuel burner	14	14	14	14	14	14	14	11	7	4	-	-	-	-	-	-	-
	Pre 2005 burner	206	206	206	206	206	206	206	154	103	51	-	-	-	-	-	-	-
	2005-2009 burner	443	443	443	443	443	443	443	443	443	443	443	354	266	177	89	-	-
	Post 2009 burner	886	886	886	886	886	886	886	941	996	1,051	1,106	1,194	1,283	1,372	1,460	1,549	1,549
	Pellet fire	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166
	ULEB	-	-	287	574	860	1,147	1,434	1,721	2,008	2,294	2,581	2,868	2,884	2,900	2,915	2,931	2,947
		1,715	**1,715**	**2,002**	**2,289**	**2,575**	**2,862**	**3,149**	**3,436**	**3,723**	**4,009**	**4,296**	**4,583**	**4,599**	**4,615**	**4,630**	**4,646**	**4,662**
Sceanrio 4	Multifuel burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pre 2005 burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2005-2009 burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Post 2009 burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pellet fire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ULEB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Scenario 5	Multifuel burner	14	14	14	14	14	14	14	11	7	4	-	-	-	-	-	-	-
	Pre 2005 burner	206	206	206	206	206	206	206	154	103	51	-	-	-	-	-	-	-
	2005-2009 burner	443	443	443	443	443	443	443	443	443	443	443	354	266	177	89	-	-
	Post 2009 burner	886	886	886	886	886	886	886	941	996	1,051	1,106	1,194	1,283	1,372	1,460	1,549	1,549
	Pellet fire	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166
	ULEB	-	-	271	542	813	1,084	1,355	1,626	1,897	2,168	2,439	2,710	2,710	2,710	2,710	2,710	2,710
		1,715	**1,715**	**1,986**	**2,257**	**2,528**	**2,799**	**3,070**	**3,341**	**3,612**	**3,883**	**4,154**	**4,425**	**4,425**	**4,425**	**4,425**	**4,425**	**4,425**
Scenario 6 (2b)	Multifuel burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pre 2005 burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2005-2009 burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Post 2009 burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pellet fire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ULEB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Sc 1: Current AQP
Sc 2: Limited ULEBs
Sc 3: Unlimited ULEBs
Sc 4: Performance Stds
Sc 5: Unlimited NES
Sc 6 (2b): Behaviour Change

Nelson B1		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Scenario 1	Multifuel burner	14	14	14	14	14	14	14	11	7	4	-	-	-	-	-	-	-
	Pre 2005 burner	116	116	116	116	116	116	116	87	58	29	-	-	-	-	-	-	-
	2005-2009 burner	194	194	194	194	194	194	194	194	194	194	194	155	116	78	39	-	-
	Post 2009 burner	481	481	481	481	481	481	481	513	546	578	611	650	688	727	766	805	805
	Pellet fire	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
	ULEB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		833	**833**	**833**	**833**	**833**	**833**	**833**	**833**	**833**	**833**	**833**	**833**	**833**	**833**	**833**	**833**	**833**
Scenario 2	Multifuel burner	14	14	14	14	14	14	14	11	7	4	-	-	-	-	-	-	-
	Pre 2005 burner	116	116	116	116	116	116	116	87	58	29	-	-	-	-	-	-	-
	2005-2009 burner	194	194	194	194	194	194	194	194	194	194	194	155	116	78	39	-	-
	Post 2009 burner	481	481	481	481	481	481	481	513	546	578	611	650	688	727	766	805	805
	Pellet fire	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
	ULEB	-	-	50	100	150	200	250	300	350	400	450	500	500	500	500	500	500
		833	**833**	**883**	**933**	**983**	**1,033**	**1,083**	**1,133**	**1,183**	**1,233**	**1,283**	**1,333**	**1,333**	**1,333**	**1,333**	**1,333**	**1,333**
Scenario 3	Multifuel burner	14	14	14	14	14	14	14	11	7	4	-	-	-	-	-	-	-
	Pre 2005 burner	116	116	116	116	116	116	116	87	58	29	-	-	-	-	-	-	-
	2005-2009 burner	194	194	194	194	194	194	194	194	194	194	194	155	116	78	39	-	-
	Post 2009 burner	481	481	481	481	481	481	481	513	546	578	611	650	688	727	766	805	805
	Pellet fire	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
	ULEB	-	-	143	285	428	571	713	856	998	1,141	1,284	1,426	1,426	1,426	1,426	1,426	1,426
		833	**833**	**975**	**1,118**	**1,261**	**1,403**	**1,546**	**1,688**	**1,831**	**1,974**	**2,116**	**2,259**	**2,259**	**2,259**	**2,259**	**2,259**	**2,259**
Sceanrio 4	Multifuel burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pre 2005 burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2005-2009 burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Post 2009 burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pellet fire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ULEB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Scenario 5	Multifuel burner	14	14	14	14	14	14	14	11	7	4	-	-	-	-	-	-	-
	Pre 2005 burner	116	116	116	116	116	116	116	87	58	29	-	-	-	-	-	-	-
	2005-2009 burner	194	194	194	194	194	194	194	194	194	194	194	155	116	78	39	-	-
	Post 2009 burner	481	481	481	481	481	481	481	513	546	578	611	650	688	727	766	805	805
	Pellet fire	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
	ULEB	-	-	-	143	285	428	570	713	856	998	1,141	1,283	1,426	1,426	1,426	1,426	1,426
		833	**833**	**833**	**975**	**1,118**	**1,260**	**1,403**	**1,546**	**1,688**	**1,831**	**1,973**	**2,116**	**2,259**	**2,259**	**2,259**	**2,259**	**2,259**
Scenario 6 (2b)	Multifuel burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pre 2005 burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2005-2009 burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Post 2009 burner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pellet fire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ULEB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Sc 1: Current AQP
Sc 2: Limited ULEBs
Sc 3: Unlimited ULEBs
Sc 4: Performance Stds
Sc 5: Unlimited NES
Sc 6 (2b): Behaviour Change

Nelson B2		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Scenario 1	Multifuel burner	39	39	39	39	39	39	39	29	20	10	-	-	-	-	-	-	-
	Pre 2005 burner	364	364	323	283	243	202	162	121	81	40	-	-	-	-	-	-	-
	2005-2009 burner	455	455	455	455	455	455	455	455	455	455	455	455	455	455	455	455	455
	Post 2009 burner	1,228	1,228	1,268	1,308	1,349	1,389	1,430	1,480	1,530	1,580	1,630	1,630	1,630	1,630	1,630	1,630	1,630
	Pellet fire	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
	ULEB	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		2,182	**2,183**	**2,184**	**2,185**	**2,186**	**2,187**	**2,188**	**2,189**	**2,190**	**2,191**	**2,192**	**2,193**	**2,194**	**2,195**	**2,196**	**2,197**	**2,198**
Scenario 2	Multifuel burner	39	39	39	39	39	39	39	29	20	10	-	-	-	-	-	-	-
	Pre 2005 burner	364	364	323	283	243	202	162	121	81	40	-	-	-	-	-	-	-
	2005-2009 burner	455	455	455	455	455	455	455	455	455	455	455	364	273	182	91	-	-
	Post 2009 burner	1,228	1,228	1,268	1,308	1,349	1,389	1,430	1,480	1,530	1,580	1,630	1,721	1,812	1,903	1,994	2,085	2,085
	Pellet fire	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
	ULEB	-	-	-	-	572	1,144	1,715	2,287	2,859	3,431	4,002	4,574	4,574	4,574	4,574	4,574	4,574
		2,182	**2,182**	**2,182**	**2,182**	**2,754**	**3,326**	**3,897**	**4,469**	**5,041**	**5,613**	**6,184**	**6,756**	**6,756**	**6,756**	**6,756**	**6,756**	**6,756**
Scenario 3	Multifuel burner	39	39	39	39	39	39	39	29	20	10	-	-	-	-	-	-	-
	Pre 2005 burner	364	364	323	283	243	202	162	121	81	40	-	-	-	-	-	-	-
	2005-2009 burner	455	455	455	455	455	455	455	455	455	455	455	364	273	182	91	-	-
	Post 2009 burner	1,228	1,228	1,268	1,308	1,349	1,389	1,430	1,480	1,530	1,580	1,630	1,721	1,812	1,903	1,994	2,085	2,085
	Pellet fire	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
	ULEB	-	-	-	-	572	1,144	1,715	2,287	2,859	3,431	4,002	4,574	4,574	4,574	4,574	4,574	4,574
		2,182	**2,182**	**2,182**	**2,182**	**2,754**	**3,326**	**3,897**	**4,469**	**5,041**	**5,613**	**6,184**	**6,756**	**6,756**	**6,756**	**6,756**	**6,756**	**6,756**
Sceanrio 4	Multifuel burner	39	39	39	39	39	39	39	29	20	10	-	-	-	-	-	-	-
	Pre 2005 burner	364	364	323	283	243	202	162	121	81	40	-	-	-	-	-	-	-
	2005-2009 burner	455	455	455	455	455	455	455	455	455	455	455	364	273	182	91	-	-
	Post 2009 burner	1,228	1,228	1,268	1,308	1,349	1,389	1,430	1,480	1,530	1,580	1,630	1,721	1,812	1,903	1,994	2,085	2,085
	Pellet fire	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
	ULEB	-	-	-	-	572	1,144	1,715	2,287	2,859	3,431	4,002	4,574	4,574	4,574	4,574	4,574	4,574
		2,182	**2,182**	**2,182**	**2,182**	**2,754**	**3,326**	**3,897**	**4,469**	**5,041**	**5,613**	**6,184**	**6,756**	**6,756**	**6,756**	**6,756**	**6,756**	**6,756**
Scenario 5	Multifuel burner	39	39	39	39	39	39	39	29	20	10	-	-	-	-	-	-	-
	Pre 2005 burner	364	364	323	283	243	202	162	121	81	40	-	-	-	-	-	-	-
	2005-2009 burner	455	455	455	455	455	455	455	455	455	455	455	364	273	182	91	-	-
	Post 2009 burner	1,228	1,228	1,268	1,308	1,349	1,389	1,430	1,480	1,530	1,580	1,630	1,721	1,812	1,903	1,994	2,085	2,085
	Pellet fire	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
	ULEB	-	-	457	915	1,372	1,830	2,287	2,744	3,202	3,659	4,117	4,574	4,574	4,574	4,574	4,574	4,574
		2,182	**2,182**	**2,640**	**3,097**	**3,554**	**4,012**	**4,469**	**4,927**	**5,384**	**5,841**	**6,299**	**6,756**	**6,756**	**6,756**	**6,756**	**6,756**	**6,756**
Scenario 6 (2b)	Multifuel burner	39	39	39	39	39	39	39	29	20	10	-	-	-	-	-	-	-
	Pre 2005 burner	364	364	323	283	243	202	162	121	81	40	-	-	-	-	-	-	-
	2005-2009 burner	455	455	455	455	455	455	455	455	455	455	455	364	273	182	91	-	-
	Post 2009 burner	1,228	1,228	1,268	1,308	1,349	1,389	1,430	1,480	1,530	1,580	1,630	1,721	1,812	1,903	1,994	2,085	2,085
	Pellet fire	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
	ULEB	-	-	-	-	125	250	375	500	625	750	875	1,000	1,000	1,000	1,000	1,000	1,000
		2,182	**2,182**	**2,182**	**2,182**	**2,307**	**2,432**	**2,557**	**2,682**	**2,807**	**2,932**	**3,057**	**3,182**	**3,182**	**3,182**	**3,182**	**3,182**	**3,182**

Sc 1: Current AQP
Sc 2: Limited ULEBs
Sc 3: Unlimited ULEBs
Sc 4: Performance Stds
Sc 5: Unlimited NES
Sc 6 (2b): Behaviour Change

Nelson C		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Scenario 1	Multifuel burner	57	57	57	57	57	57	57	43	29	14	-	-	-	-	-	-	-
	Pre 2005 burner	618	618	550	481	412	344	275	206	137	69	-	-	-	-	-	-	-
	2005-2009 burner	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464
	Post 2009 burner	326	326	395	464	532	601	670	753	836	919	1,002	1,002	1,002	1,002	1,002	1,002	1,002
	Pellet fire	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
	ULEB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1,519	**1,519**	**1,519**	**1,519**	**1,519**	**1,519**	**1,519**	**1,519**	**1,519**	**1,519**	**1,519**	**1,519**	**1,519**	**1,519**	**1,519**	**1,519**	**1,519**
Scenario 2	Multifuel burner	57	57	57	57	57	57	57	43	29	14	-	-	-	-	-	-	-
	Pre 2005 burner	618	618	550	481	412	344	275	206	137	69	-	-	-	-	-	-	-
	2005-2009 burner	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464
	Post 2009 burner	326	326	395	464	532	601	670	753	836	919	1,002	1,002	1,002	1,002	1,002	1,002	1,002
	Pellet fire	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
	ULEB	-	-	300	429	857	1,286	1,714	2,143	2,571	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
		1,519	**1,519**	**1,819**	**1,947**	**2,376**	**2,804**	**3,233**	**3,661**	**4,090**	**4,519**	**4,519**	**4,519**	**4,519**	**4,519**	**4,519**	**4,519**	**4,519**
Scenario 3	Multifuel burner	57	57	57	57	57	57	57	43	29	14	-	-	-	-	-	-	-
	Pre 2005 burner	618	618	550	481	412	344	275	206	137	69	-	-	-	-	-	-	-
	2005-2009 burner	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464
	Post 2009 burner	326	326	395	464	532	601	670	753	836	919	1,002	1,002	1,002	1,002	1,002	1,002	1,002
	Pellet fire	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
	ULEB	-	-	309	442	884	1,325	1,767	2,209	2,651	3,092	3,092	3,092	3,092	3,092	3,092	3,092	3,092
		1,519	**1,519**	**1,828**	**1,960**	**2,402**	**2,844**	**3,286**	**3,727**	**4,169**	**4,611**	**4,611**	**4,611**	**4,611**	**4,611**	**4,611**	**4,611**	**4,611**
Sceanrio 4	Multifuel burner	57	57	57	57	57	57	57	43	29	14	-	-	-	-	-	-	-
	Pre 2005 burner	618	618	550	481	412	344	275	206	137	69	-	-	-	-	-	-	-
	2005-2009 burner	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464
	Post 2009 burner	326	326	395	464	532	601	670	753	836	919	1,002	1,002	1,002	1,002	1,002	1,002	1,002
	Pellet fire	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
	ULEB	-	-	300	429	857	1,286	1,714	2,143	2,571	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
		1,519	**1,519**	**1,819**	**1,947**	**2,376**	**2,804**	**3,233**	**3,661**	**4,090**	**4,519**	**4,519**	**4,519**	**4,519**	**4,519**	**4,519**	**4,519**	**4,519**
Scenario 5	Multifuel burner	57	57	57	57	57	57	57	43	29	14	-	-	-	-	-	-	-
	Pre 2005 burner	618	618	550	481	412	344	275	206	137	69	-	-	-	-	-	-	-
	2005-2009 burner	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464
	Post 2009 burner	326	326	395	464	532	601	670	753	836	919	1,002	1,002	1,002	1,002	1,002	1,002	1,002
	Pellet fire	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
	ULEB	-	-	309	442	884	1,325	1,767	2,209	2,651	3,092	3,092	3,092	3,092	3,092	3,092	3,092	3,092
		1,519	**1,519**	**1,828**	**1,960**	**2,402**	**2,844**	**3,286**	**3,727**	**4,169**	**4,611**	**4,611**	**4,611**	**4,611**	**4,611**	**4,611**	**4,611**	**4,611**
Scenario 6 (2b)	Multifuel burner	57	57	57	57	57	57	57	43	29	14	-	-	-	-	-	-	-
	Pre 2005 burner	618	618	550	481	412	344	344	275	206	137	-	-	-	-	-	-	-
	2005-2009 burner	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464
	Post 2009 burner	326	326	395	464	532	601	601	684	767	850	1,002	1,002	1,002	1,002	1,002	1,002	1,002
	Pellet fire	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
	ULEB	-	-	60	86	171	257	343	429	514	600	600	600	600	600	600	600	600
		1,519	**1,519**	**1,579**	**1,604**	**1,690**	**1,776**	**1,861**	**1,947**	**2,033**	**2,119**	**2,119**	**2,119**	**2,119**	**2,119**	**2,119**	**2,119**	**2,119**

Sc 1: Current AQP
Sc 2: Limited ULEBs
Sc 3: Unlimited ULEBs
Sc 4: Performance Stds
Sc 5: Unlimited NES
Sc 6 (2b): Behaviour Change

Appendix 2: Alternative Discount Rates

All values are in $'m

Nelson A										
Scenario	Cost	2.50%	***3.25%***	4.00%	5.00%	6.00%	7.00%	8.00%	9.00%	10.00%
Scenario 2	Health Costs	2.5	***2.3***	2.1	1.8	1.6	1.5	1.3	1.1	1.0
Scenario 2	Change over costs	4.6	***4.2***	3.9	3.5	3.1	2.8	2.6	2.3	2.1
Scenario 2	Operating Costs	3.9	***3.6***	3.3	2.9	2.5	2.3	2.0	1.8	1.6
Scenario 3	Health Costs	36.4	***33.1***	30.1	26.6	23.5	20.9	18.6	16.5	14.7
Scenario 3	Change over costs	21.1	***19.8***	18.6	17.2	15.9	14.8	13.7	12.8	11.9
Scenario 3	Operating Costs	56.8	***51.6***	46.9	41.4	36.6	32.4	28.8	25.6	22.8
Scenario 4	Health Costs	-	***-***	-	-	-	-	-	-	-
Scenario 4	Change over costs	-	***-***	-	-	-	-	-	-	-
Scenario 4	Operating Costs	-	***-***	-	-	-	-	-	-	-
Scenario 5	Health Costs	154.4	***140.3***	127.7	112.8	99.8	88.5	78.7	70.1	62.6
Scenario 5	Change over costs	19.6	***18.5***	17.4	16.1	14.9	13.8	12.8	11.9	11.1
Scenario 5	Operating Costs	53.5	***48.6***	44.2	39.0	34.5	30.6	27.1	24.2	21.5
Scenario 6 (2b)	Health Costs	-11.5	***-10.5***	-9.6	-8.5	-7.6	-6.8	-6.1	-5.4	-4.9
Scenario 6 (2b)	Change over costs	-	***-***	-	-	-	-	-	-	-
Scenario 6 (2b)	Operating Costs	-	***-***	-	-	-	-	-	-	-

Nelson B1										
Scenario	Cost	2.50%	***3.25%***	4.00%	5.00%	6.00%	7.00%	8.00%	9.00%	10.00%
Scenario 2	Health Costs	2.6	***2.3***	2.1	1.9	1.7	1.5	1.3	1.2	1.0
Scenario 2	Change over costs	4.6	***4.3***	4.1	3.7	3.4	3.2	2.9	2.7	2.5
Scenario 2	Operating Costs	9.9	***9.0***	8.1	7.2	6.4	5.6	5.0	4.5	4.0
Scenario 3	Health Costs	7.7	***7.0***	6.4	5.7	5.0	4.5	4.0	3.5	3.2
Scenario 3	Change over costs	10.2	***9.6***	9.0	8.4	7.8	7.2	6.7	6.2	5.8
Scenario 3	Operating Costs	28.2	***25.6***	23.2	20.5	18.1	16.1	14.3	12.7	11.3
Scenario 4	Health Costs	-	***-***	-	-	-	-	-	-	-
Scenario 4	Change over costs	-	***-***	-	-	-	-	-	-	-
Scenario 4	Operating Costs	-	***-***	-	-	-	-	-	-	-
Scenario 5	Health Costs	28.7	***26.0***	23.6	20.8	18.3	16.2	14.3	12.7	11.3
Scenario 5	Change over costs	10.3	***9.6***	9.0	8.3	7.6	7.0	6.4	6.0	5.5
Scenario 5	Operating Costs	23.7	***21.4***	19.5	17.1	15.1	13.3	11.8	10.5	9.3
Scenario 6 (2b)	Health Costs	-	***-***	-	-	-	-	-	-	-
Scenario 6 (2b)	Change over costs	-	***-***	-	-	-	-	-	-	-
Scenario 6 (2b)	Operating Costs	-	***-***	-	-	-	-	-	-	-

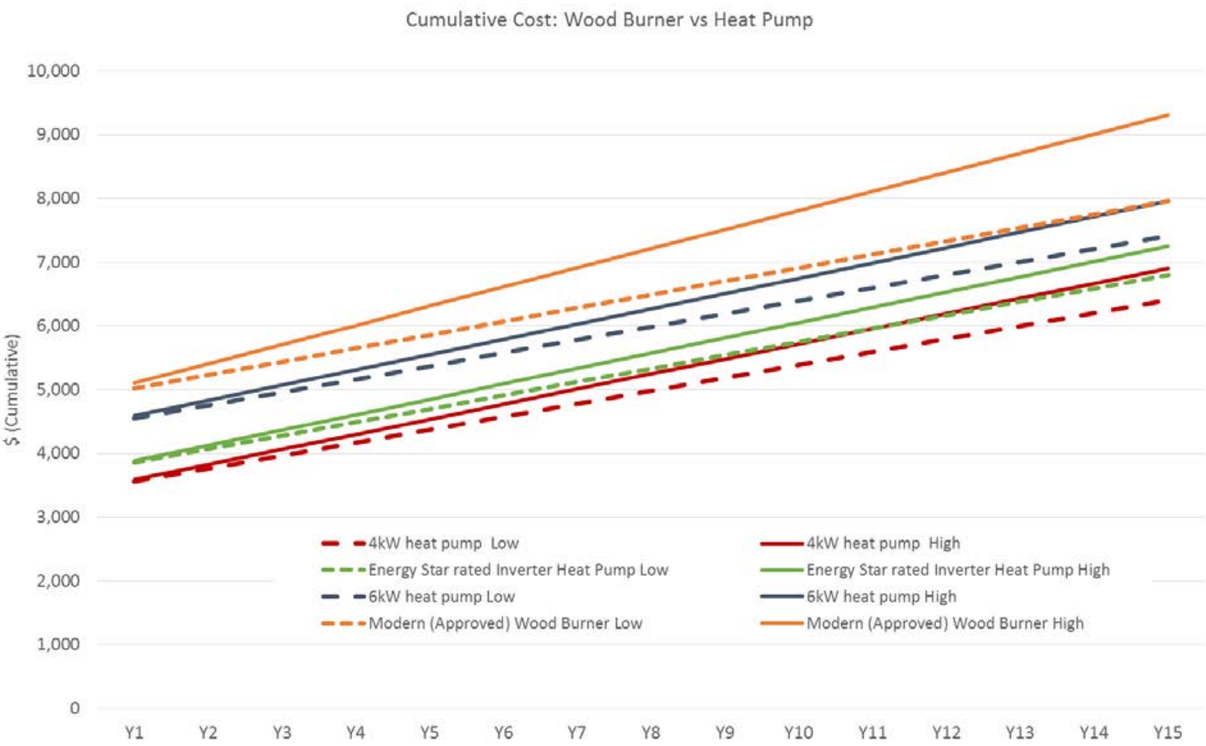
Nelson B2										
Scenario	Cost	2.50%	***3.25%***	4.00%	5.00%	6.00%	7.00%	8.00%	9.00%	10.00%
Scenario 2	Health Costs	8.3	***7.5***	6.8	6.0	5.2	4.6	4.1	3.6	3.2
Scenario 2	Change over costs	31.9	***29.9***	28.1	25.9	23.8	22.0	20.3	18.8	17.4
Scenario 2	Operating Costs	73.7	***66.7***	60.4	53.1	46.7	41.1	36.3	32.1	28.5
Scenario 3	Health Costs	8.3	***7.5***	6.8	6.0	5.2	4.6	4.1	3.6	3.2
Scenario 3	Change over costs	31.9	***29.9***	28.1	25.9	23.8	22.0	20.3	18.8	17.4
Scenario 3	Operating Costs	73.7	***66.7***	60.4	53.1	46.7	41.1	36.3	32.1	28.5
Scenario 4	Health Costs	12.0	***10.8***	9.8	8.6	7.6	6.7	5.9	5.2	4.7
Scenario 4	Change over costs	31.9	***29.9***	28.1	25.9	23.8	22.0	20.3	18.8	17.4
Scenario 4	Operating Costs	73.7	***66.7***	60.4	53.1	46.7	41.1	36.3	32.1	28.5
Scenario 5	Health Costs	45.9	***41.7***	37.9	33.5	29.6	26.3	23.4	20.8	18.6
Scenario 5	Change over costs	31.7	***29.9***	28.3	26.2	24.4	22.7	21.2	19.8	18.5
Scenario 5	Operating Costs	90.0	***81.8***	74.3	65.6	58.0	51.4	45.7	40.6	36.2
Scenario 6 (2b)	Health Costs	-2.0	***-1.8***	-1.7	-1.5	-1.4	-1.2	-1.1	-1.0	-0.9
Scenario 6 (2b)	Change over costs	10.3	***9.7***	9.0	8.2	7.6	6.9	6.4	5.9	5.4
Scenario 6 (2b)	Operating Costs	15.9	***14.4***	13.1	11.5	10.1	8.9	7.8	6.9	6.1

Nelson C										
Scenario	Cost	2.50%	***3.25%***	4.00%	5.00%	6.00%	7.00%	8.00%	9.00%	10.00%
Scenario 2	Health Costs	18.1	***16.4***	14.9	13.2	11.7	10.4	9.2	8.2	7.3
Scenario 2	Change over costs	21.2	***20.2***	19.2	18.0	16.8	15.8	14.8	13.9	13.1
Scenario 2	Operating Costs	63.8	***57.9***	52.7	46.5	41.1	36.4	32.3	28.8	25.7
Scenario 3	Health Costs	18.6	***16.9***	15.4	13.6	12.0	10.7	9.5	8.4	7.5
Scenario 3	Change over costs	21.8	***20.7***	19.7	18.4	17.3	16.2	15.2	14.3	13.5
Scenario 3	Operating Costs	65.8	***59.7***	54.3	47.9	42.4	37.6	33.3	29.7	26.4
Scenario 4	Health Costs	18.6	***16.9***	15.4	13.6	12.0	10.7	9.5	8.4	7.5
Scenario 4	Change over costs	21.2	***20.2***	19.2	18.0	16.8	15.8	14.8	13.9	13.1
Scenario 4	Operating Costs	63.8	***57.9***	52.7	46.5	41.1	36.4	32.3	28.8	25.7
Scenario 5	Health Costs	91.2	***83.0***	75.7	67.0	59.5	52.9	47.1	42.1	37.7
Scenario 5	Change over costs	21.8	***20.7***	19.7	18.4	17.3	16.2	15.2	14.3	13.5
Scenario 5	Operating Costs	65.8	***59.7***	54.3	47.9	42.4	37.6	33.3	29.7	26.4
Scenario 6 (2b)	Health Costs	-2.4	***-2.2***	-2.1	-1.9	-1.7	-1.6	-1.4	-1.3	-1.2
Scenario 6 (2b)	Change over costs	6.9	***6.5***	6.2	5.8	5.4	5.1	4.8	4.5	4.2
Scenario 6 (2b)	Operating Costs	12.8	***11.6***	10.5	9.3	8.2	7.3	6.5	5.8	5.1

Appendix 3: Energy cost per unit

	c/kWh
Modern clean air approved Wood Burner	$0.07 - $0.10
Energy Star rated Inverter Heat Pump	$0.07 - $0.08
4kW heat pump COP's -3.82, 4.55	$0.068 - $0.079
6kW heat pump COP's - 3.83, 4.40	$0.068 - $0.08
Figures supplied by Nelson City Council and based on 2014 Consumer New Zealand heating cost study	

Appendix 4: Alternative heating approach: Wood burner vs Heat Pump



Appendix 5: Sensitivities

	Change	Range	
		Min	*Max*
Capital spending	10%	2.2%	3.9%
	-10%	-3.9%	-2.2%
Operating costs	-10%	-2.8%	-1.8%
	+10%	3.8%	5.8%
Health Costs	-10%	-4.4%	-1.2%
	+10%	1.2%	4.4%
ULEBs Price	-50%	-14.8%	-9.2%
	+10%	1.8%	3.0%