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Residual biomass fuel projections for New Zealand - Indicative availability by region and source

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Report information sheet

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Executive summary

Objective

The goal of this report and the accompanying tables is to describe the woody biomass residue resources in New Zealand by volume, type, energy content and region over time from 2017 to 2042 (25 years). The estimated costs of supply are included.

Approach

The 5 key resources; in-forest residues, municipal wood waste, wood processing residues, orchard residues and straws / stover from arable cropping are described in terms of gross volumes (tonnes and energy) and two levels of recoverability. The estimates of recoverable material vary by resource but are intended allow for some material being unsuitable for recovery for quality, financial or environmental reasons. The in-forest residues are assessed as three categories, landing, flat to rolling cutover and steep cutover.

The characteristics (moisture content, ash content, gross calorific value and typical net calorific value) of the residues are described.

The costs of the various resources including; any fees for accessing the materials, recovery / harvesting, hogging, screening, loading and transport are estimated based off 2017 costs for capital, fuel, labour etc. These costs are an estimate and are not intended to indicate market prices but as an indicator of where prices might start.

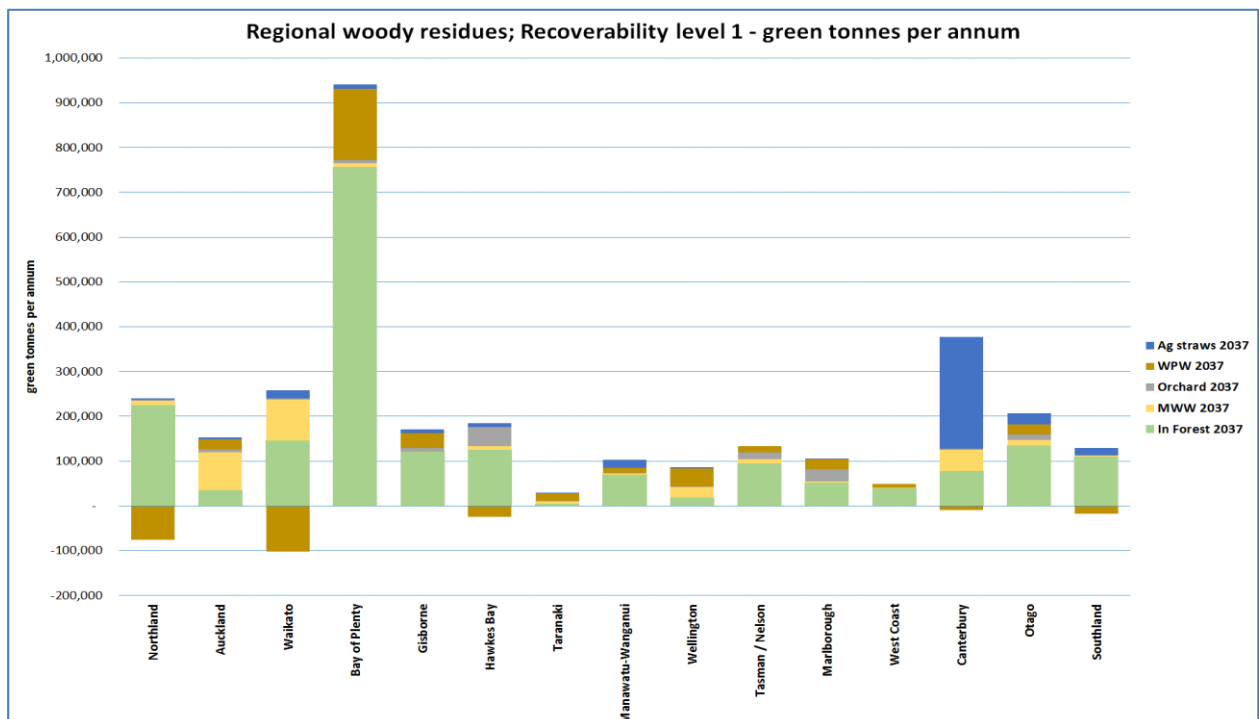
Key results

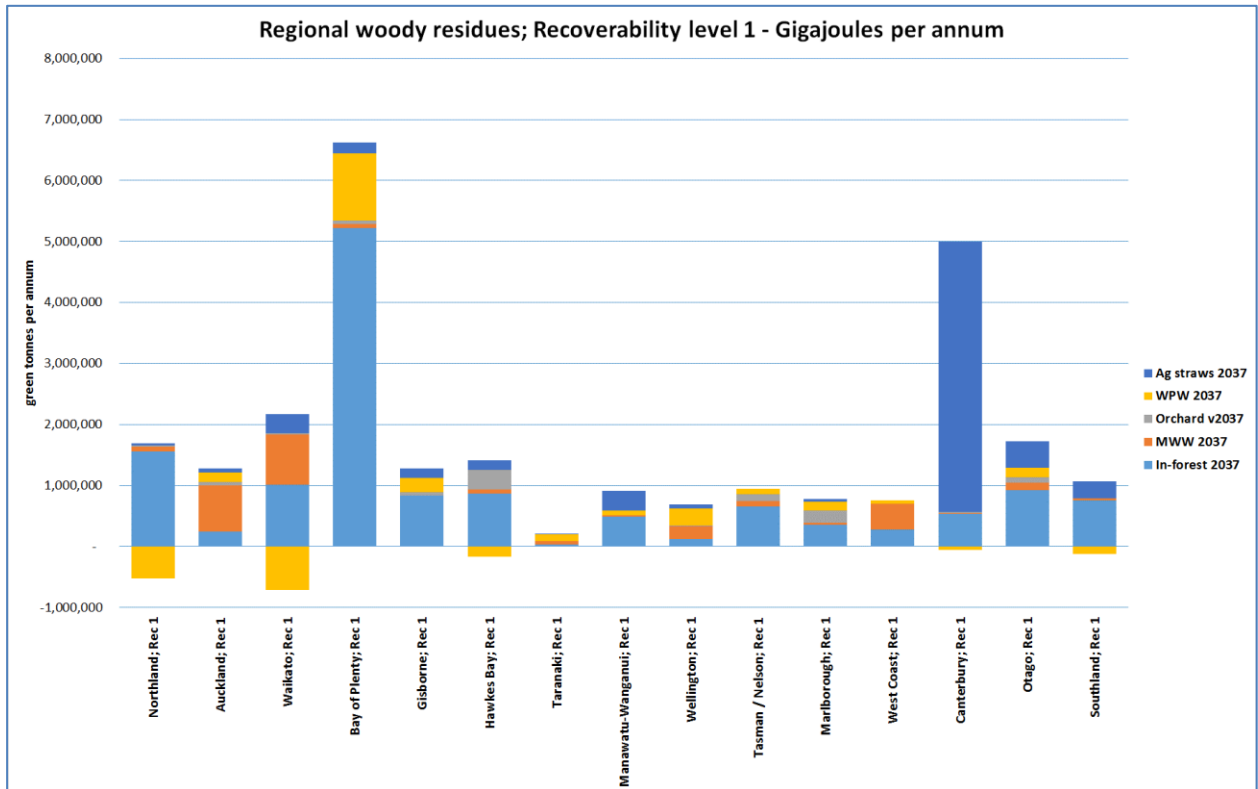
In-forest residues make up the bulk of the biomass residue supply. The in-forest residues are split into three categories based on accessibility and the cost of recovery.

The cheapest resource is municipal wood waste which currently attracts a gate fee averaging ~\$140 per tonne.

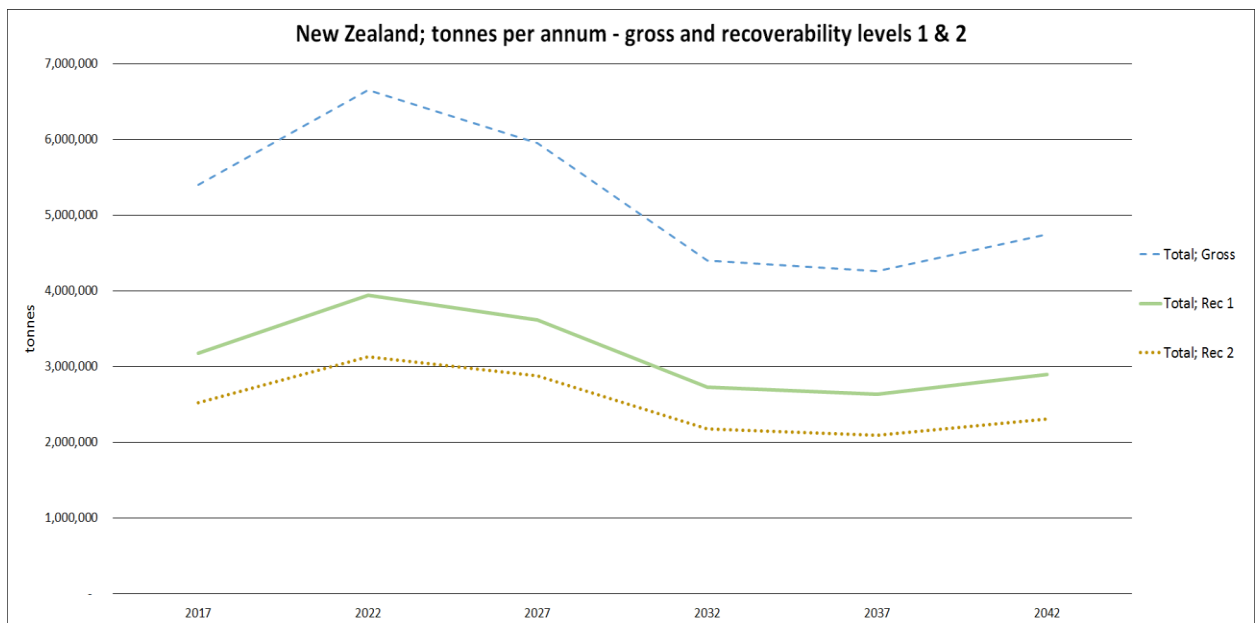
The best quality fuel (low ash) is likely to come from wood processing operations as it generally has low levels of contamination. This is a small resource as most of the wood processing residues are already used for energy by the wood processing operation or sold as other products (animal bedding, mulch etc.)

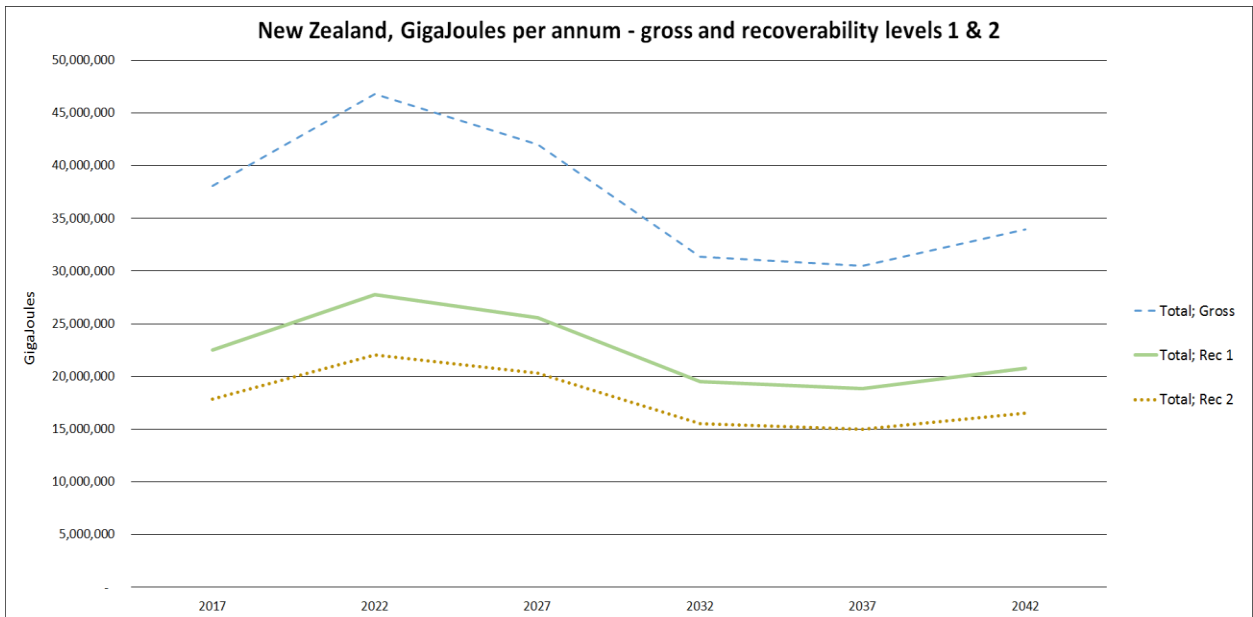
Straw and stover could make a substantial contribution in some regions (especially Canterbury).





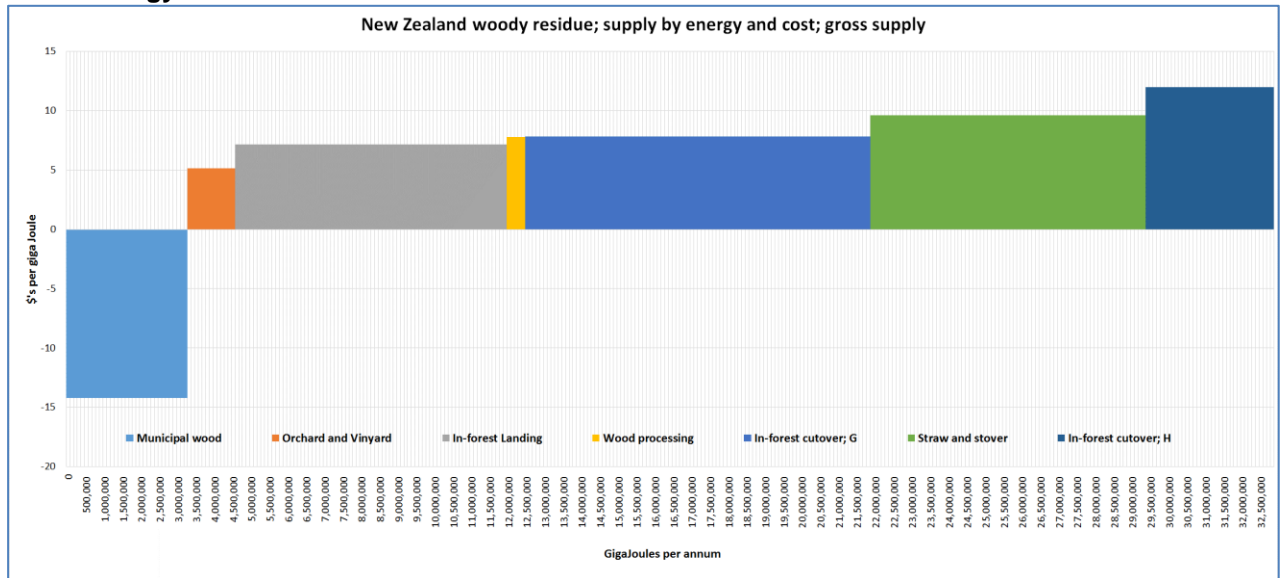
The two graphs below show the national volume of woody residues in tonnes and Gigajoules; for the gross amount and the two recoverability levels.





The three graphs below show the national level cost supply curves for the gross GigaJoules potentially available from the various resources and the estimated GigaJoules available at two levels of recoverability. It should be noted that the costs are indicative only - delivered price will vary by site, driven variables such as transport distance, truck size limitations and scale of demand.

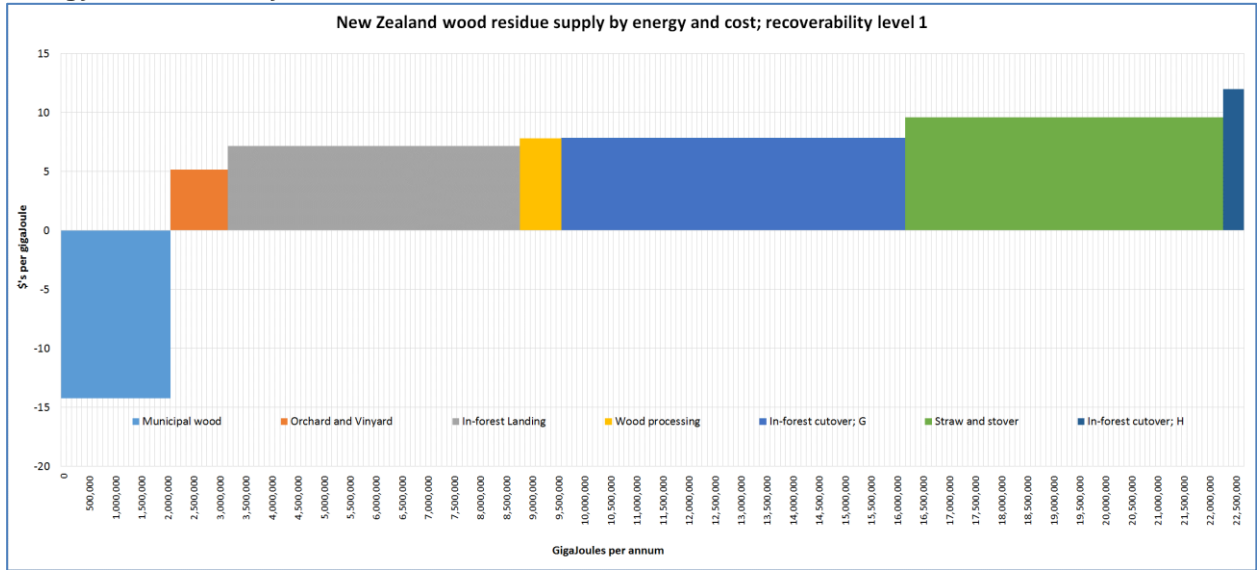
Gross energy



The gross energy potentially available is in the order of 32 PJ per annum, with a cost of up to \$12 per GJ. This energy is derived from approximately 4 million green tonnes of gross biomass supply.

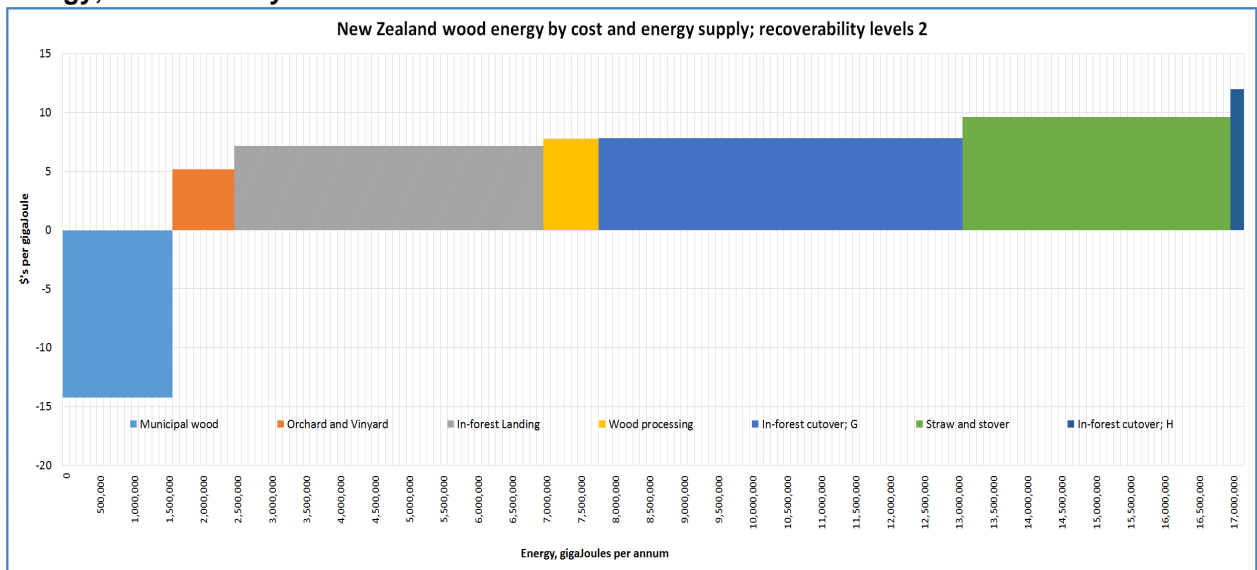
Not all the gross biomass will be available, especially not at the typical costs estimated. Two levels of recoverability were estimated for each resource, with the levels of recoverability varying by resource.

Energy; recoverability level 1



If the first level of recoverability is applied to all resources the amount of energy estimated to be available reduces to around 22 PJ or ~2.6 million green tonnes.

Energy; recoverability level 2



If the second level of recoverability is applied the gross amount of energy available reduces to around 17 PJ or 2.0 million tonnes.

Regional totals for tonnes and energy over time are presented.

Data tables for each resource by region over time for tonnes and energy content are provided in the appendices.

Further work

More up-to-date information on straws and stover location and area of arable cropping are required as the data in the current assessment is based on information circa 2007. The orchard residue data is more recent (2016) for the material derived from vineyards and kiwi fruit orchards. However the data on the residues from other fruit crops should be updated if possible. There may be value in breaking down the wood processing residues into that comprised of wood and bark, but this may present some challenges as it would involve getting detailed information from individual wood processors.

Residual biomass fuel projections for New Zealand - indicative availability by region and source.

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Introduction

The intent of this report is to present estimates of regional combustible biomass residues suitable for heat fuel supply for 2017 and periods of 5, 10, 15, 20 and 25 years into the future (out to 2042); for gross supply and estimates of realisable / recoverable supply (tonnes and energy).

The assumptions behind the data are provided to support the assessment and to allow others to apply their own assumptions to the base data on levels of recoverable biomass.

The resource analysis covers in-forest harvest residues, wood processing residues, municipal wood waste, horticultural wood residues and agricultural (straw & stover) residues.

In-forest residues were split into categories by site type; – landing / roadside, flat to rolling terrain (ground based harvest) cutover, steep terrain (hauler harvest) cutover. These residues have differing levels of accessibility, cost of recovery and levels of recoverability (Table 1). There are environmental limits which need to be applied to some resources (e.g. straw and stover and in-forest cutover residues) to maintain soil fertility and potentially mitigate soil erosion.

Estimates of currently surplus quantities available from wood processing facilities are included in the assessment. Wood processing residue estimates do not include that calculated as already being used by the wood processing industry for the production of on-site heat.

Estimates of the amount of greenhouse gases (GHGs) that could be reduced by displacing coal with biomass are made for national level data.

Bark from ports is a potential fuel resource. However, there are complicating issues around this material and its availability now and in the future;

- most of it is currently used for landscape mulch or composting
- predicting future volumes is difficult given the uncertainty around the impact of both phytosanitary regulations and log export markets / volumes.

Glossary

g t = green tonne = wood with an as received moisture content

odt = oven dry tonne = biomass at 0% moisture content

p.a. = per annum

GJ = GigaJoule

Stover = corn stalk from maize grain harvesting

GHG = greenhouse gas

GCV = gross calorific value

NCV = net calorific value

MWW = municipal wood waste

WPW = wood processing waste

Residuals Assessment: outline of approach and categories

Table 1 - outline of data categories and recoverability levels and factors

	Gross	Recoverable level 1	Recoverable level 2
Municipal wood waste	Total estimated at landfill	= Gross x 0.80 (to exclude treated and highly contaminated wood)	= Gross x 0.60 (for losses and sites to remote too use)
Wood processing waste	Gross amount after producer sites own use	= Gross x 0.95 to account for losses	=Gross x 0.90 for small remote sites and lack of participation
Horticultural residues	Gross amount produced	= Gross x 0.80 for losses during gathering and screening etc.	=Gross x 0.65 to account for sites too remote, small or lack of interest in utilisation)
Agricultural residues	Gross amount produced; accounting for 50% retention for soil sustainability	= Gross x 0.80 for losses during gathering and screening etc.	= Gross x 0.60 to account for sites too remote, small or lack of interest in utilisation)
In-forest Landing	Gross amount	= Gross x 0.80 to small / hard to recover	=Gross x 0.65 sites too remote
In forest Cutover			
a. GB	Gross amount; a	a. = Gross x 0.70, rest to small / hard to recover	a. = Gross x 0.56; allows for sites that are too remote
b. Hauler	Gross amount; b	b. = 10% recoverable; rest assumed to be too expensive and risky	b. = 5% recoverable; rest assumed to be too expensive and risky
In-forest total	In-forest total	In-forest total	In-forest total
All biomass totals	All biomass Gross totals	All biomass total at recoverability level 1	All biomass total at recoverability level 2

Methods

Fuel characteristics

Fuel characteristics (moisture content, ash content, net and gross calorific values) for the different resources were derived from a range of sources; including Trolve and Garrod (2007), Hall (2000), EECA (2010), van Loo (2008) and a range of laboratory testing results from bioenergy studies conducted by NZFRI and Scion (Veritec Laboratory reports).

Costs

Indicative delivered costs (including profit margins of 10%) were derived using 2017 cost inputs for capital, fuel, labour and consumables etc. and the transport and harvesting system costing template (Excel spreadsheet) in Riddle (1994). Capital costs were derived from the INFORME harvesting price guide (2016) and a range of sources for items such as fuel, oil, tyres, labour etc.

The same process was used on transport costs. Forest residue transport distances are based on forest industry data for average log hauls (Galbraith, 2007) and estimates of other distances derived from Google maps etc. Standard 44 tonne GVM trucks were used in the transport cost analysis. Potentially the use of HPMVs may reduce transport costs in the order of 10%, but these larger units are not able to use all rural roads due to bridge weight limit restrictions.

These indicative costs do not necessarily reflect actual delivered prices as site specific factors such as transport distance, limitations on truck size due to access restrictions and scale of demand can have a substantial influence. Costs were derived based on full utilisation of equipment, in reality some idle time will likely occur; increasing operation costs and risks which would be reflected in delivered costs.

However, as technology develops and system productivity improves costs may reduce over time. For example, recent innovations in chipper technology are expected to substantially reduce fuel consumption in this part of the system (where chipping is applicable).

In-forest residues maximum volumes

Forest harvest potential varies over time due to the uneven age class distribution of the forests, and can be estimated using data from the national exotic forest description (MPI, 2016). If we are looking at long term secure supply we need to consider the long term (out to 2045) volume as the maximum supply, not the peaks that might occur before then. This is of importance, as the in-forest residue resource is the largest resource and its fluctuations have considerable effect on the volumes available.

The low point in forest harvest and therefore in-forest harvest residue supply tends to occur at around 2035 to 2039.

In-forest residues smoothing

Due to the peakiness of the forest plantings (based on the mid 1990s planting boom) the residue calculation based on the forest age class data is also peaky. It is unlikely that the forest harvest will hit the maximum peak of the potential wood available as the required harvesting infrastructure is not likely to be available. Therefore, some smoothing of the harvest is predicted to occur (MPI wood availability forecasts, 2014). In the analysis here, smoothing of the data has been applied by averaging of adjacent periods.

Wood processing residues

Wood processing volumes were derived from a combination of data from Scions wood processing database and the EECA heat plant database; which allows estimates of the volume of wood processing residues produced along with the demand for those residues at an individual processor level.

Results

Residual material - fuel characteristics

Typical fuel characteristics for the range of resources assessed are shown in Table 2. The gross calorific values (GCVs) are adjusted for ash content. The net calorific values (NCVs) reflect the effect of moisture content.

It should be noted that the GCVs and NCVs are not absolute values - they are typical averages. Biomass is inherently variable and multiple samples gives a better indication of long term average energy values than any individual sample.

Woody biomass is by its nature quite variable from site to site as well as piece to piece, and results for individual samples will likely vary from the averages. For example, some woody biomass has high levels of resin content and this can push the energy content for that sample up as high as 22 to 23 MJ/kg oven dry. However, these levels are not a typical average for wood, which is generally accepted as being 18.7 to 18.9 MJ/kg oven dry.

Further, there are variations in ash and moisture content from sample to sample that will change both the GCV and the NCV. Again the values presented are typical averages. When conducting a site specific analysis of the opportunities it is important to consider the impact of ash, moisture etc. and get some samples tested. Setting of delivered fuel quality standards is therefore important.

Likely ranges for moisture, ash and NCV are shown in Table 3. In the tables below; CO = cutover, GB = ground-based, MWW = municipal wood waste and WPR = wood processing residues.

Table 2 - summary of fuel properties by residue type

	Moisture Content	Ash Content	GCV	NCV	NCV - 5%	NCV + 5%
Landing stem	56.5	1.8	19.8	6.8	6.5	7.2
Landing mixed	54.0	4.5	19.3	7.0	6.7	7.4
CO GB stem	51.5	0.9	20.0	7.7	7.3	8.1
CO GB mixed	51.5	4.8	19.2	7.4	7.0	7.8
CO Hauler stem	51.5	0.9	20.0	7.7	7.3	8.1
CO Hauler mixed	51.5	4.8	19.2	7.4	7.0	7.8
MWW	31.5	4.5	19.3	11.0	10.5	11.6
Orchard*	51.5	1.5	19.9	7.9	7.5	8.3
Straw	13.5	6.8	18.1	14.4	13.7	15.1
Stover	20.0	5.6	17.8	13.8	13.1	14.5
WPR Wood	54.5	0.7	20.1	7.3	6.9	7.7
WPR Bark debark	53.0	3.0	19.6	7.4	7.0	7.8
WPR Bark yard	58.0	7.5	18.7	6.1	5.7	6.4

*includes vineyards and kiwifruit orchards as well as pip, stone fruit and citrus orchards.

In-forest residues can be seasoned or force dried after hogging or chipping. Fuel treated in this way is likely to have a moisture content of around 35%, with an NCV of around 11 GJ per tonne.

Table 3 - ranges of fuel properties likely to be encountered

	Moisture Content	MC -10%	MC +10%	Ash Content	Ash -10%	Ash +10%	NCV, GJ/tonne	NCV -10%	NCV +10%
Landing stem	56.5	50.9	62.2	1.8	1.6	1.9	6.8	6.1	7.5
Landing mixed	54.0	48.6	59.4	4.5	4.1	5.0	7.0	6.3	7.7
CO GB stem	51.5	46.4	56.7	0.9	0.8	0.9	7.7	6.9	8.5
CO GB mixed	51.5	46.4	56.7	4.8	4.3	5.2	7.4	6.7	8.1
CO Hauler stem	51.5	46.4	56.7	0.9	0.8	0.9	7.7	6.9	8.5
CO Hauler mixed	51.5	46.4	56.7	4.8	4.3	5.2	7.4	6.7	8.1
MWW	31.5	28.4	34.7	4.5	4.1	5.0	11.0	9.9	12.1
Orchard / Vineyard	51.5	46.4	56.7	1.5	1.4	1.7	7.9	7.1	8.7
Straw	13.5	12.2	14.9	6.8	6.1	7.5	14.4	13.0	15.8
Stover	20.0	18.0	22.0	5.6	5.0	6.2	13.8	12.4	15.2
WPR Wood	54.5	49.1	60.0	0.7	0.6	0.7	7.3	6.6	8.0
WPR Bark debark	53.0	47.7	58.3	3.0	2.7	3.3	7.4	6.7	8.1
WPR Bark yard	58.0	52.2	63.8	7.5	6.8	8.3	6.1	5.4	6.7

Straw and stover volumes are substantial in some regions - and they are included as they are a combustible ligno-cellulosic biomass. However, these materials may not be suited to existing boiler infrastructure and may require purpose built boilers that are designed for straws. Otherwise densification and co-firing at low percentages (>5%) in coal boilers may be possible. The principal issue is the high ash content and ash composition which can cause fouling of the boiler if combustion conditions are not set correctly.

Recoverability factors

There is a difference between the gross amount of a biomass resource potentially available and that which can or should be recovered. The recoverability factors used in this analysis are explained here.

In-forest landing residues

There is no environmental limit on the amount of these residues that can be recovered. However, what is economically and physically feasible to recoverable is a consideration. The highest level considered to be realistic is 80% of the gross volume, this is on a landing by landing basis. Picking up every piece is considered to be financially unfeasible as some of the pieces will be very small, buried in dirt or out of easy reach. The second level of recoverability is 65%, this allows for the fact that not all landings are going to be viable for residue recovery, being too isolated, too small or difficult to access.

In-forest cutover residues - ground based logging

Not all the cutover residues should be removed for soil nutrition and fertility reasons. The highest level of recoverability is suggested as being 70%, with the focus being on the larger stem sections, with fine branches and branches with needles attached being left behind. For reasons of cost and

practicality, it is possible that only a proportion of the ground-based cutover would be accessed for residue recovery; if 20% is not accessed then the recoverable proportion becomes 80% of the 70% (56%).

In-forest residues - hauler logging

The vast majority of hauler logged cutover (steep terrain) will be inaccessible due to both cost and environmental reasons. Harvesting residues from steep terrain could cost up to \$90 per tonne (excluding hogging and transport), and removing residues such as branches from steep slopes may cause more sediment to reach water ways in heavy rainfall events, as it removes multiple small water and debris barriers. However, removal of slash piles from gully bottoms, streams and stream margins may be beneficial on some sites. Recovery levels were set at 10% of gross (high) and 5% of gross (low).

Municipal wood waste

Municipal wood waste comes in two broad categories, construction and demolition (C&D) waste and green waste. Some of both categories will be un-useable. Some of the C&D waste will be contaminated with treatment chemicals (e.g. CCA) and will be unsuitable for use as fuel. Recovery of the total useable fraction was estimated at 80% (high) and 60% (low), as some landfills are small, remote and collection and use may not be viable.

Horticulture and Viticulture wastes

Horticulture and Viticulture residues are principally derived from the removal of old or unwanted trees and vines. Data on this was derived from Saggar et al 2007, which indicates that turnover rates in orchards range from 4% to 12% per annum depending on the crop. The amount of material is adjusted over time allowing for a small expansion of the industry. Not all the estimated gross material will be available for cost / access reasons and recoverability was set at 80% (high) and 65% (low) of the gross.

Straw and stover residuals

Amounts of straw and stover residue produced were estimated based on Saggar et al, 2007 and Ministry of Agriculture and Forestry (MAF) 2011. These data (land area under crops, MAF 2011) need to be updated at some point, but this data gives indicative numbers. The total produced amount of material has to be reduced by half to give the gross available, as half the straw is deemed to be needed to be retained on site for soil nutrition and health (Saggar et al, 2007). Straw and stover data is presented in oven dry tonnes (ODT) per annum, as opposed to green tonnes which were used for wood residues. From the gross tonnage we take 50% as the start point; then use two recoverability factors, 80% and 60%, to account for some material being lost during harvest and transport or being inaccessible.

Wood Processing residues

Whilst most wood processing residues (saw dust, bark, shavings etc.) are already consumed for heat production there are some sites with excess supply. Recoverability of this material is expected to be high; level 1 is assumed to be 95% and level 2 90%.

Costs

The costs of providing the biomass from the various resources were estimated (Table 4). The rationale for the cost components in Table 4 are as outlined in the box below.

Table 4 - estimates of costs for delivered biomass

	Resource fee; \$ / green tonne	Harvesting; \$ / green tonne	Hogging; \$ / green tonne	Screening; \$ / green tonne	Loading; \$ / green tonne	Transport distance, km	Bulk density; t per m ³	Transport cost; \$ / green tonne	Total cost; green tonne	Moisture content	basic density	Total cost; odt	Total Cost; \$/GJ	t per m ³	Potential load, t per truck load	Actual Load (t) in 100 m ³ truck
Municipal wood waste	\$ 140	\$ -	\$ 15	\$ 5	\$ 3	65	0.37	\$ 17.00	\$ 100.00	0.35	0.661	-\$ 250	-\$ 13.81	0.245	24.457	24.5
Orchard and Vineyard residues	\$ 5	\$ -	\$ 15	\$ 3	\$ 3	65	0.37	\$ 15.60	\$ 41.60	0.45	0.781	\$ 104	\$ 5.56	0.289	28.897	28.8
In-forest Landing residues	\$ 10	\$ 5	\$ 15	\$ 3	\$ 3	85	0.37	\$ 18.70	\$ 54.70	0.56	0.977	\$ 137	\$ 7.56	0.361	36.149	29.5
Straw and stover residues	\$ 5	\$ 21	\$ -	\$ -	\$ 2	75	0.32	\$ 28.50	\$ 56.50	0.20	0.537	\$ 161	\$ 9.61	0.172	17.184	17.1
Wood processing residues	\$ 25	\$ -	\$ 15	\$ 3	\$ 3	65	0.37	\$ 14.30	\$ 60.30	0.53	0.915	\$ 151	\$ 8.19	0.339	33.855	29.5
In-forest cutover, G	\$ 10	\$ 15	\$ 15	\$ 3	\$ 3	85	0.37	\$ 18.70	\$ 64.70	0.56	0.977	\$ 162	\$ 8.94	0.361	36.149	29.5
In-forest cutover; H	\$ 5	\$ 45	\$ 15	\$ 3	\$ 3	85	0.37	\$ 18.7	\$ 89.70	0.56	0.977	\$ 224	\$ 12.39	0.361	36.149	29.5

Resource fee

The owners of the biomass will likely want at least a nominal fee for the right to access the residual biomass. The precedent has been set for this with the recovery of bin wood and hog fuel in some CNI forests. The exception is the municipal wood waste - where the site receiving the material will likely be paid to dispose of it.

Harvesting

The materials in most cases need to be collected into a useful volume, in some cases being retrieved from forest cutover or from orchards and paddocks. The systems used to do this vary widely from baling of straws to forwarders traversing forest cutover.

Hogging /chipping

A hogger or chipper will need to be medium to large to handle the larger pieces of wood residues, and so have though-puts in the order of 30 tonnes per hour. Typically the hogs do not have an operator, but are driven by remote control by the loader driver.

Screening

Most of the residual material will require screening to remove dirt, stones and fines. Municipal wood waste will also require removal of metals (magnets) and so has a higher cost. The straw and stover residues will not require screening as it should be clean. Some of the wood processing residues will require screening, particularly bark, to remove dirt. Other residues may require screening for size.

Loading

After preparation all the materials will require loading onto a truck. The most common form is hog fuel, with the exception of the straws which come as large bales, and therefore have a lower handling cost. The loading cost is based off a costing of a rubber-tyred front end loader and industry derived production rates.

Transport

Transport costs vary from product to product. This is based on variations in basic density, moisture content and bulk density. The truck costs were based on a truck and trailer unit with a maximum volume of 100 cubic metres and a maximum payload of 29.5 tonnes. Some products (straw and stover, municipal wood waste) reach the volume limit before they reach the trucks payload (weight) limit, increasing the cost of transport per tonne or GJ delivered.

Transport distances for the different resources were derived from a range of sources. In-forest residues used average log transport distances (Galbraith / NZFOA, 2007). Other distances were derived from interpretation and analysis of maps for point sources such as municipal landfills and

wood processing sites. Land use maps were used for area based resources such as orchard residues and crop residues.

A further impact on costs is local completion for supply; increasing demand within a region will push up costs, with first movers getting the better and cheaper resource.

These costs should be regarded as indicative only, and represent a low start point. There are numerous factors affecting system productivity which will affect the delivered cost. For example if a hogger is not fully utilised for logistics / demand reasons the costs might rise by \$2 to 4 per tonne, depending on the level of unutilised capacity.

Regional biomass - volumes and energy value

The following section is a set of graphs (Figures 1 to 31) which present the biomass supply by tonnage and energy for each region; with the gross supply and the two levels of recoverability.

These graphs are for the total woody biomass supply from all sources including straws and stover.

Many of the graphs have increases from 2017 to ~2027 and low points at or from ~2037. These variations are largely driven by the variations in wood available to harvest from plantation forests (MPI, 2016). These forests have an uneven age class distribution due to a planting boom in the mid-1990's. Wood from in forest harvest residues is the dominant resource across most regions (Figures 32 and 33).

Figure 1 - Northland; tonnes per annum

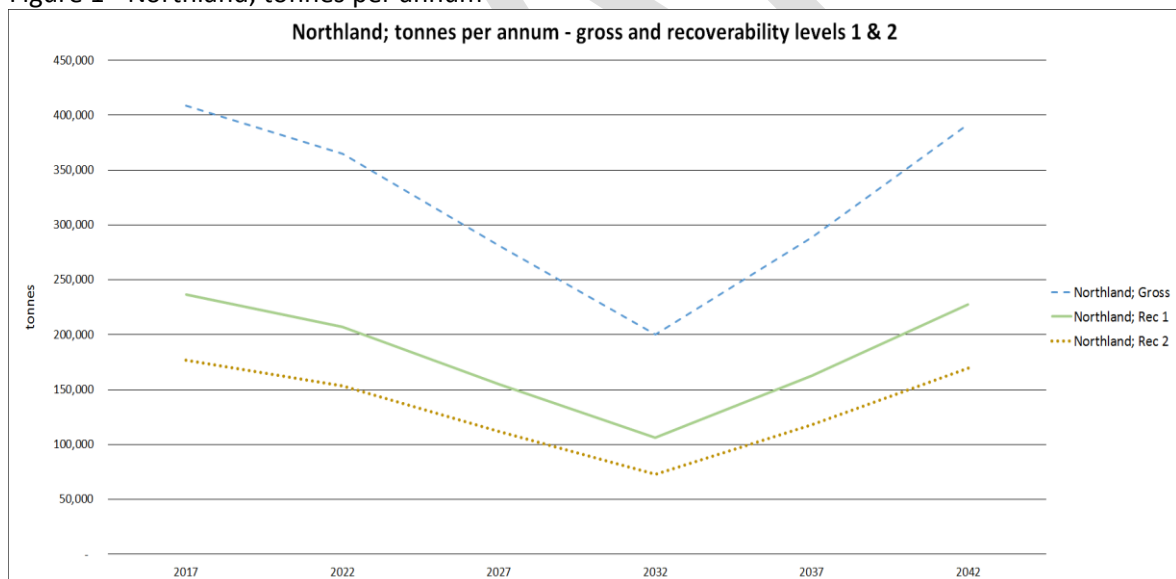


Figure 2 - Northland; Gigajoules per annum

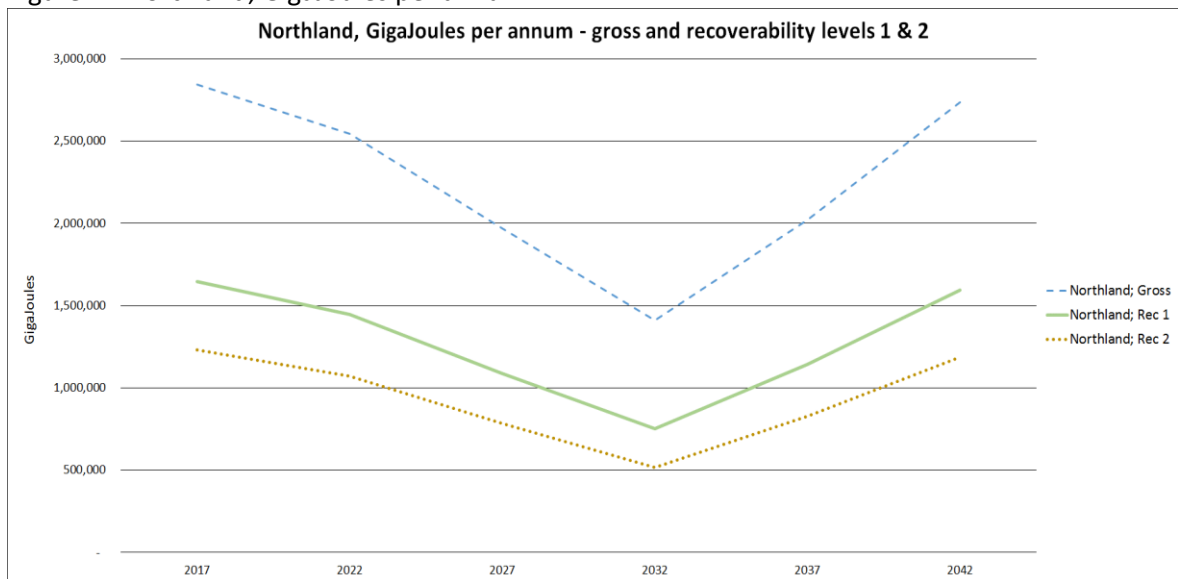


Figure 3 - Auckland; tonnes per annum



Figure 4 - Auckland; GigaJoules per annum

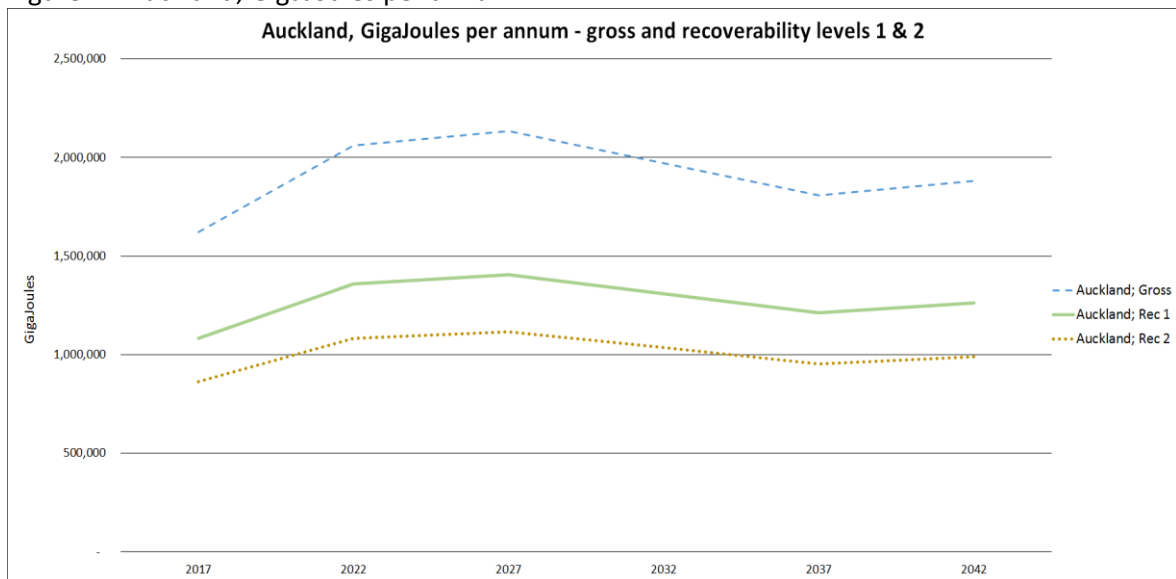


Figure 4 - Waikato; tonnes per annum

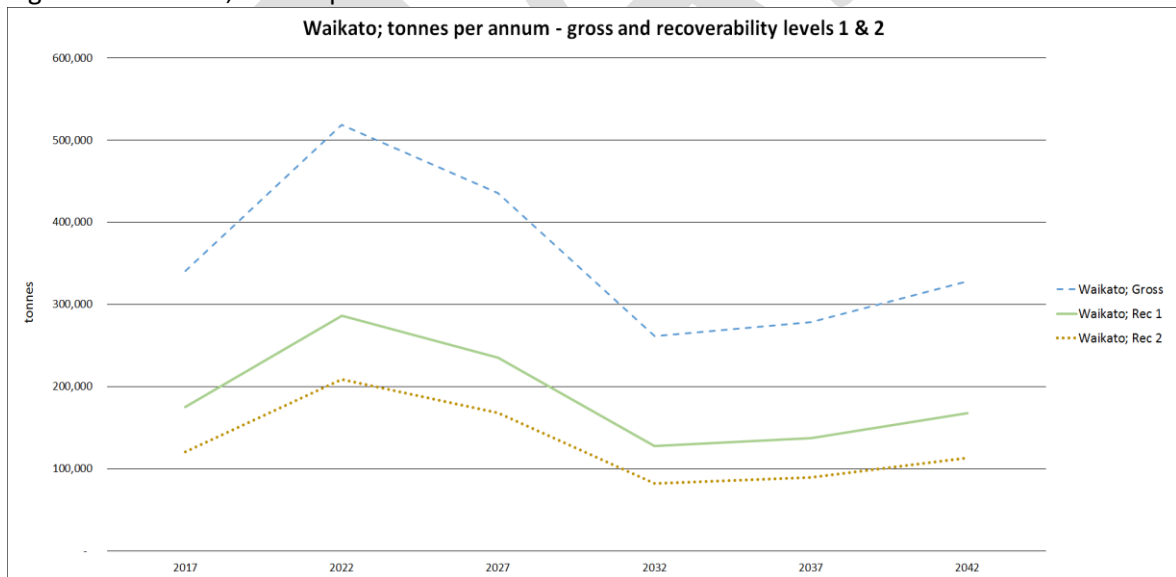


Figure 5 - Waikato; GigaJoules per annum

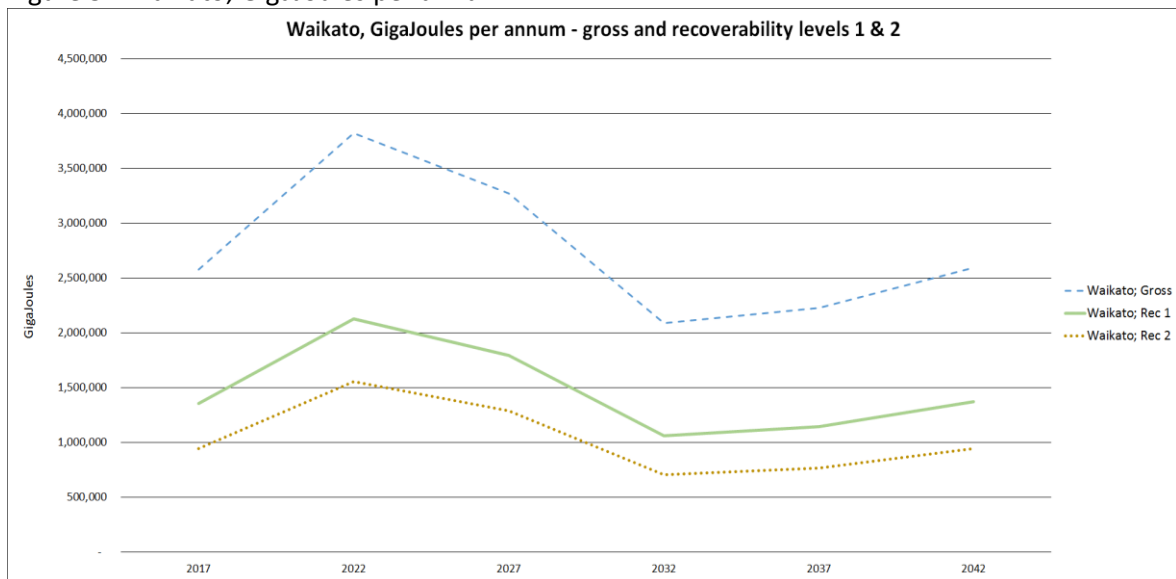


Figure 6 - Bay of Plenty; tonnes per annum

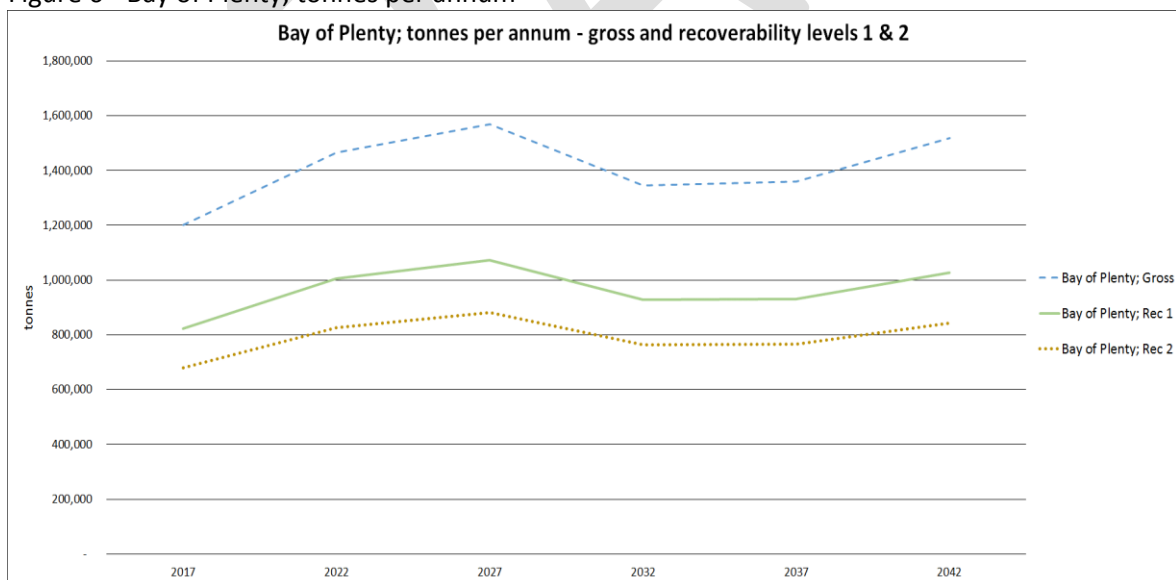


Figure 7 - Bay of Plenty; GigaJoules per annum

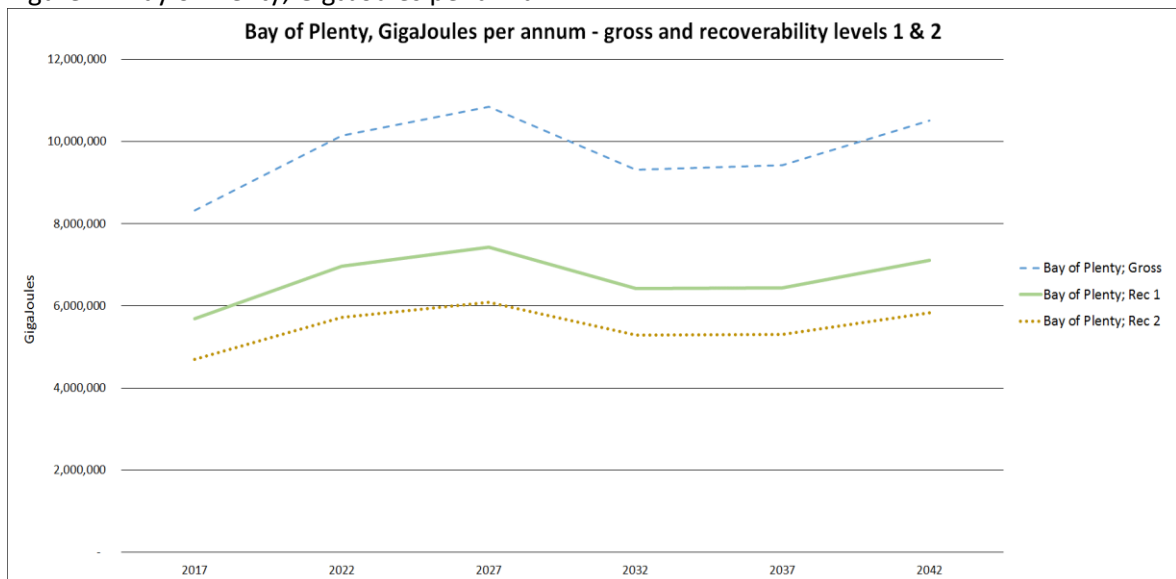


Figure 8 - Gisborne; tonnes per annum

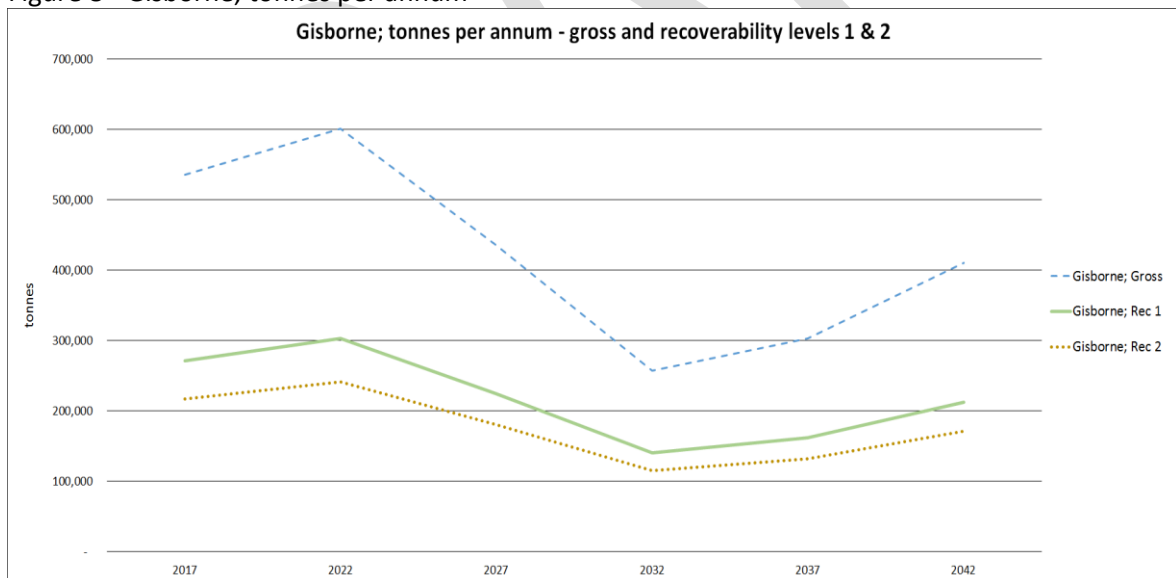


Figure 9 - Gisborne; GigaJoules per annum

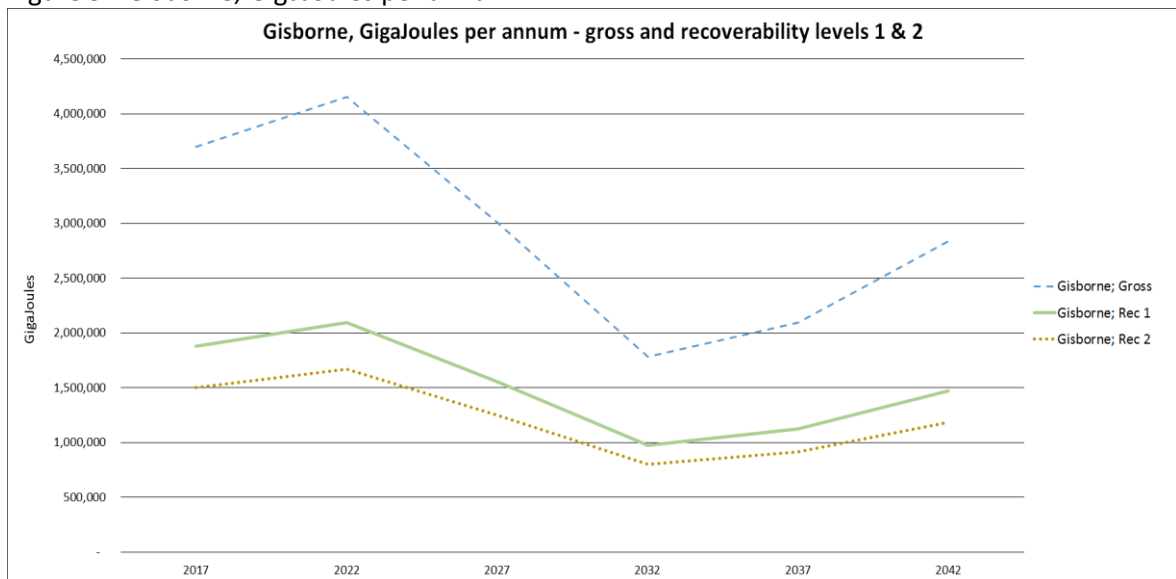


Figure 10 - Hawkes Bay; Tonnes per annum

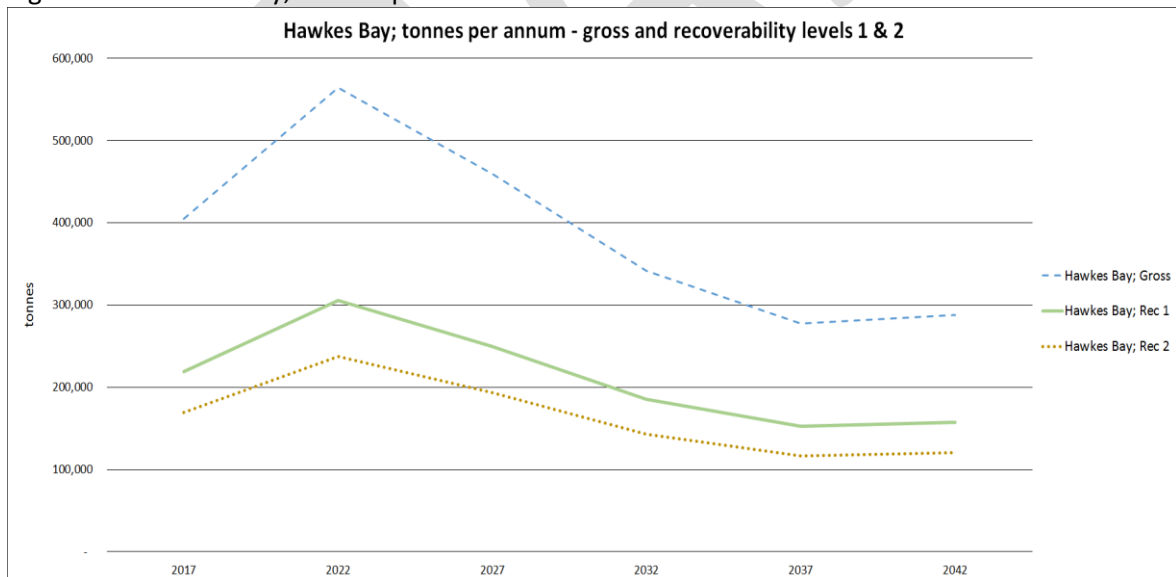


Figure 11 - Hawkes Bay; GigaJoules per annum

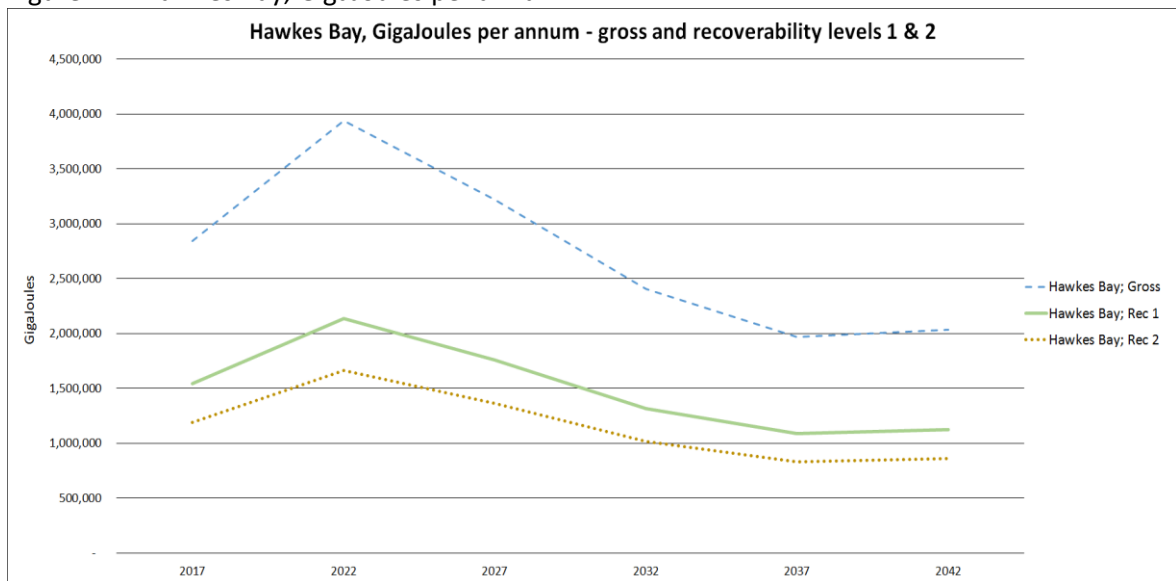


Figure 12 - Taranaki; tonnes per annum

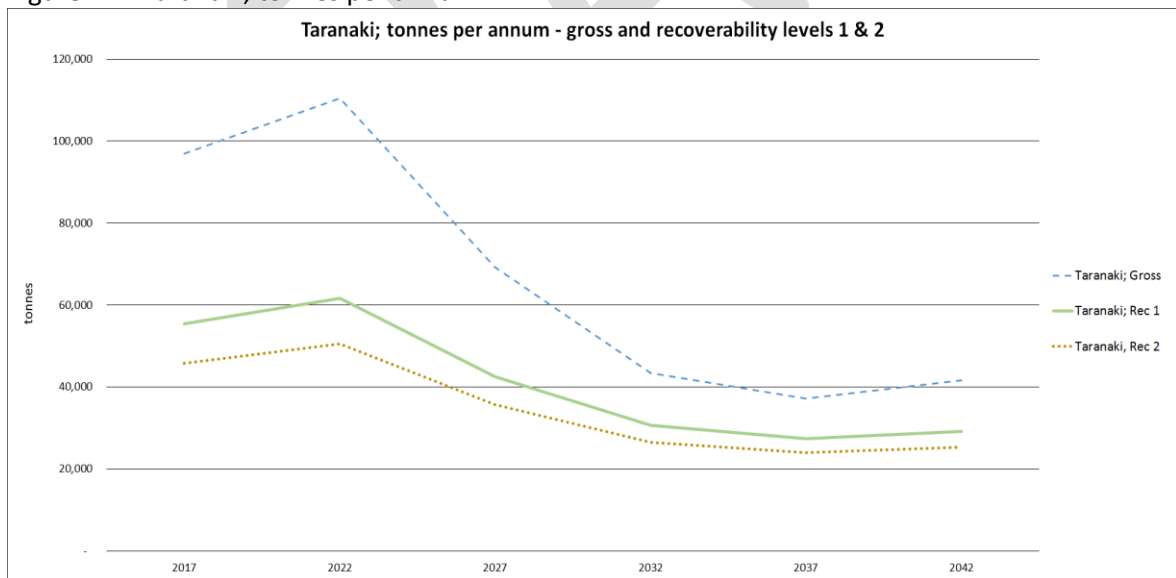


Figure 13 - Taranaki; GigaJoules per annum

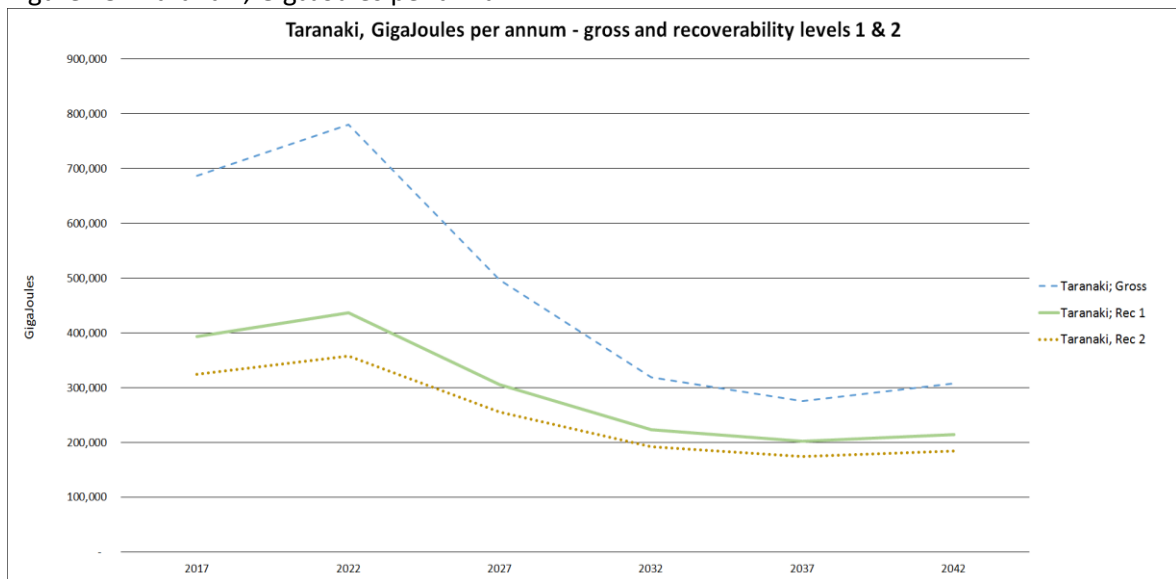


Figure 14 - Manawatu-Wanganui; tonnes per annum

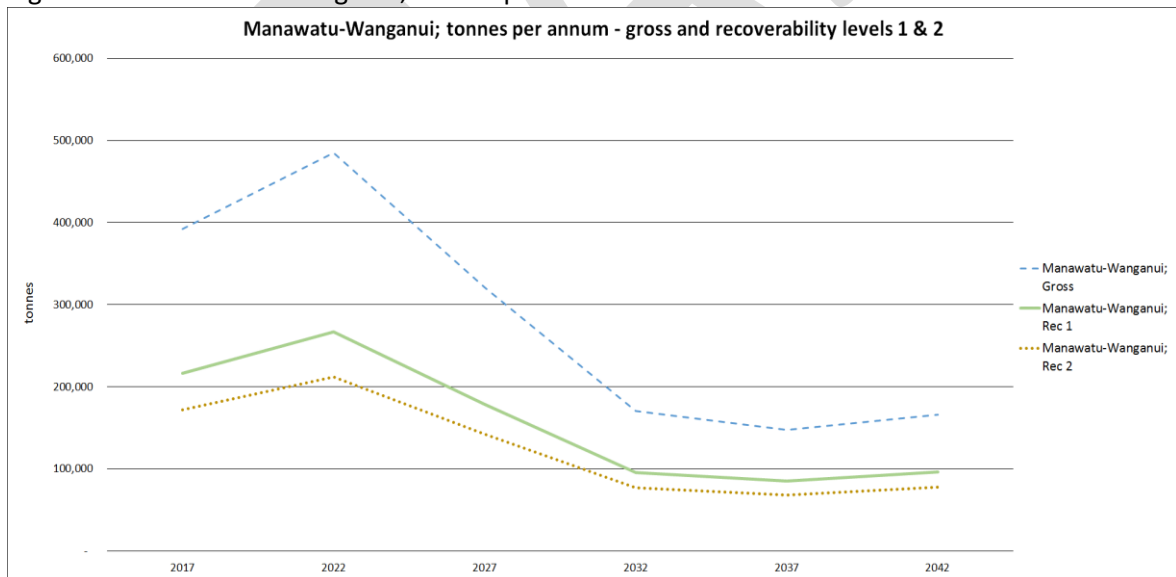


Figure 15 - Manawatu-Wanganui; GigaJoules per annum

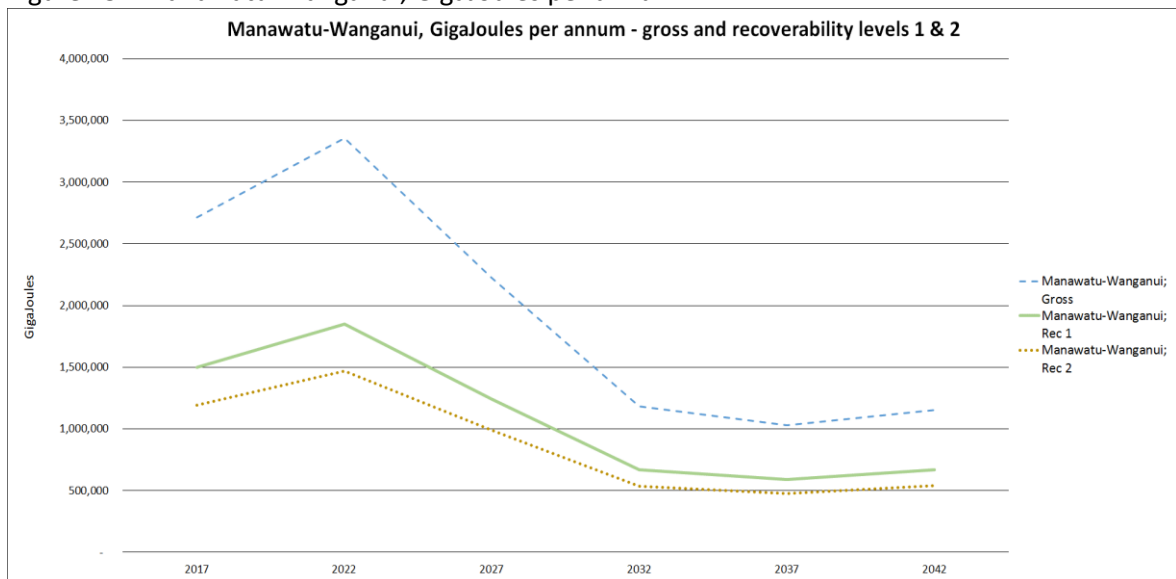


Figure 16 - Wellington; tonnes per annum

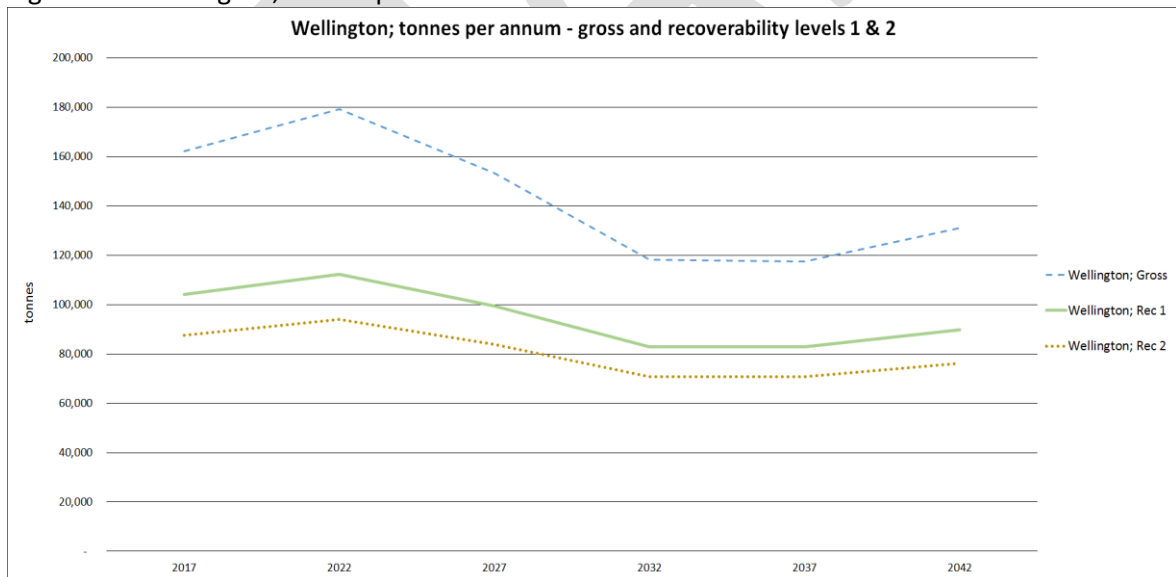


Figure 17 - Wellington; Gigajoules per annum

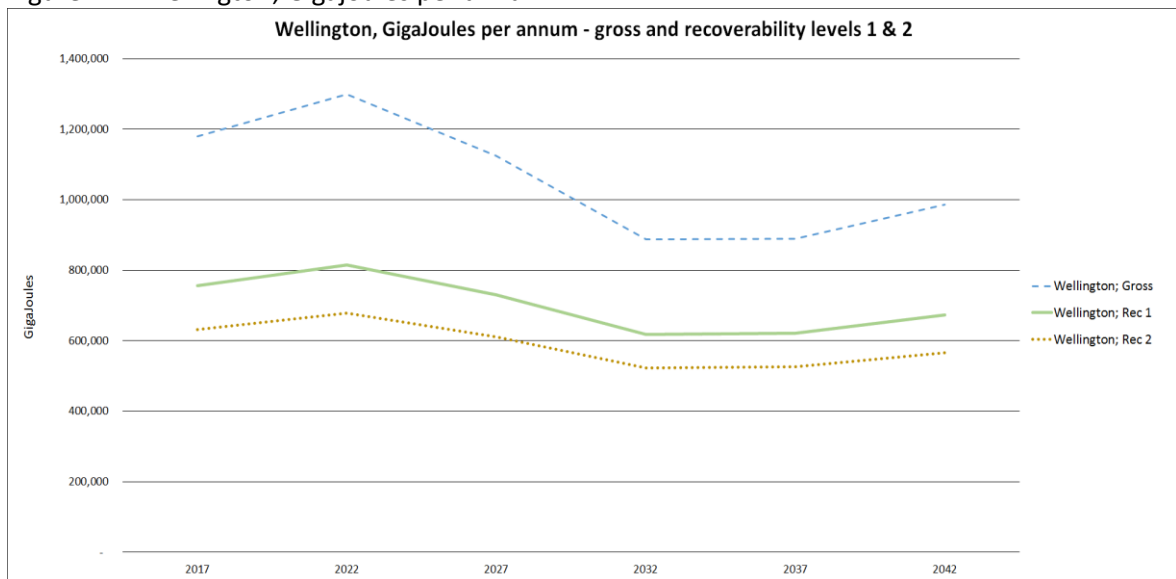


Figure 18 - Tasman-Nelson; tonnes per annum

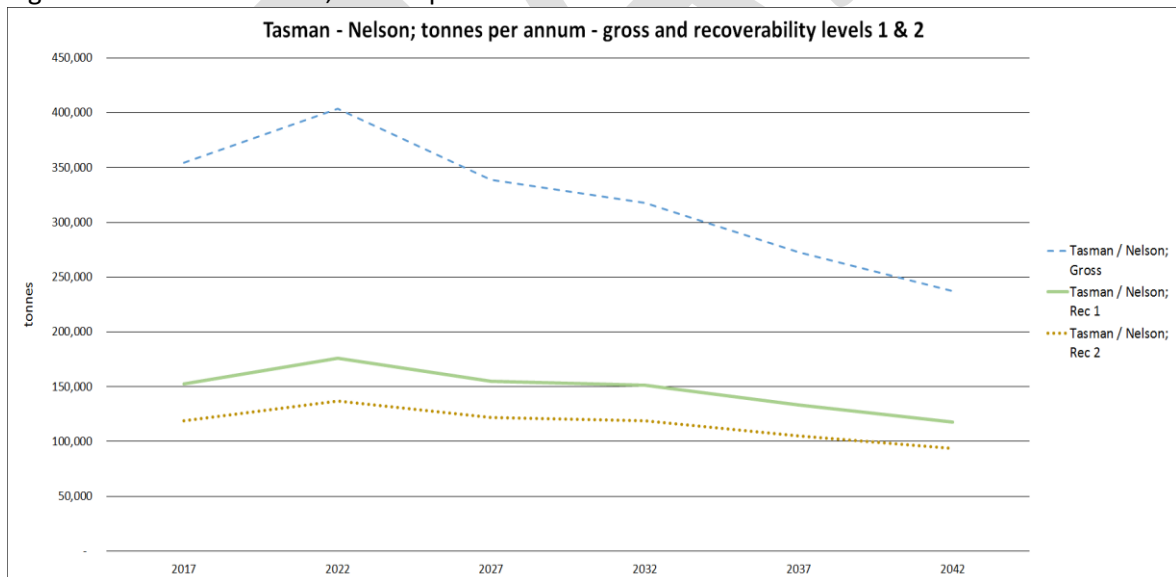


Figure 19 - Tasman-Nelson; Gigajoules per annum

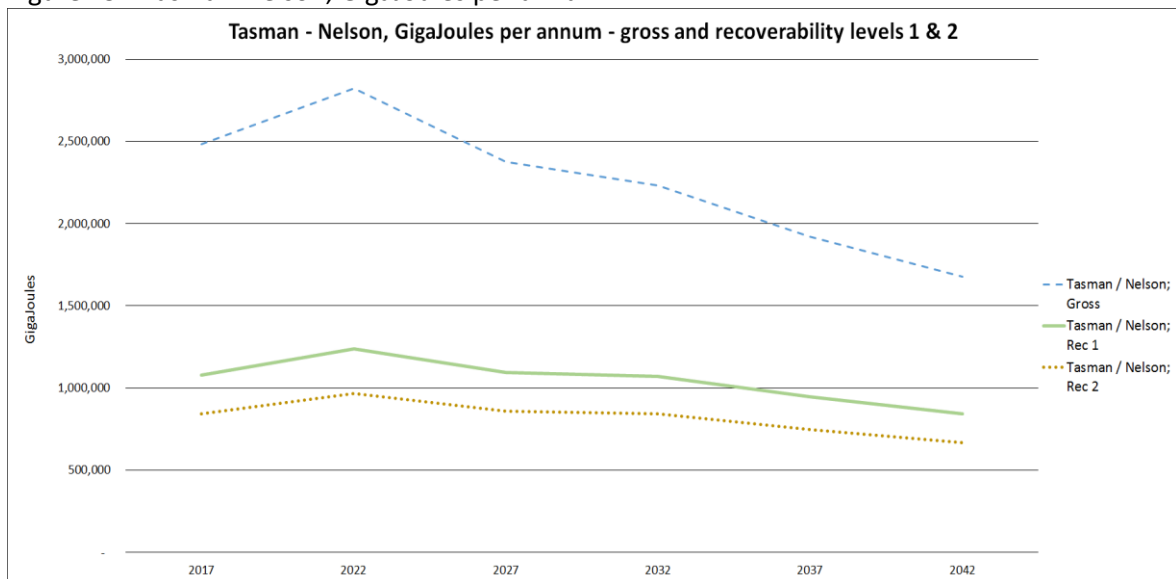


Figure 20 - Marlborough; tonnes per annum



Figure 21 - Marlborough; GigaJoules per annum

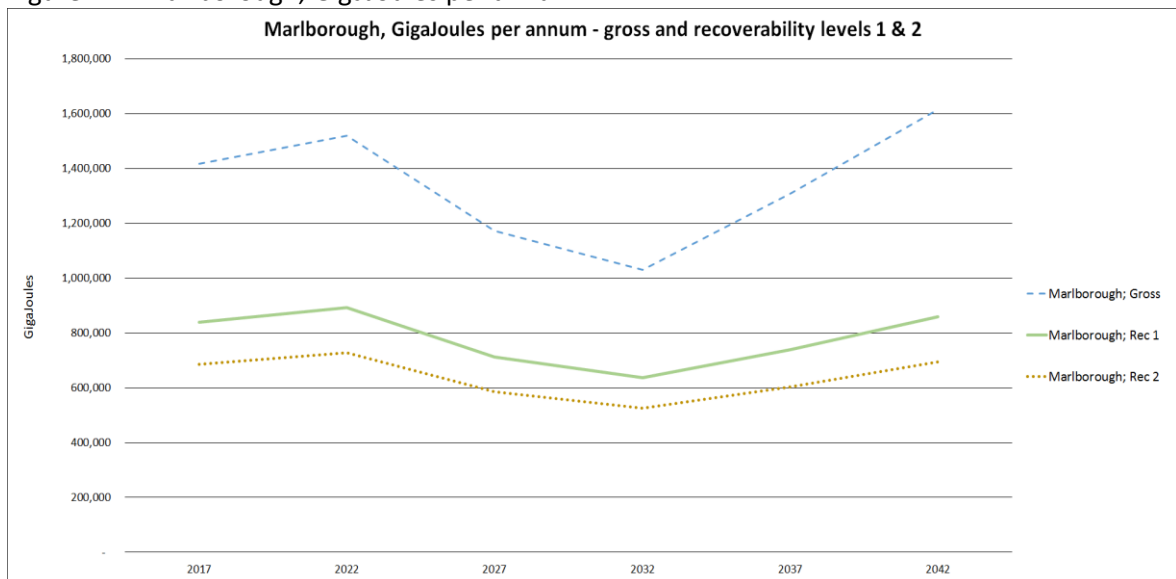


Figure 22 - West Coast; tonnes per annum

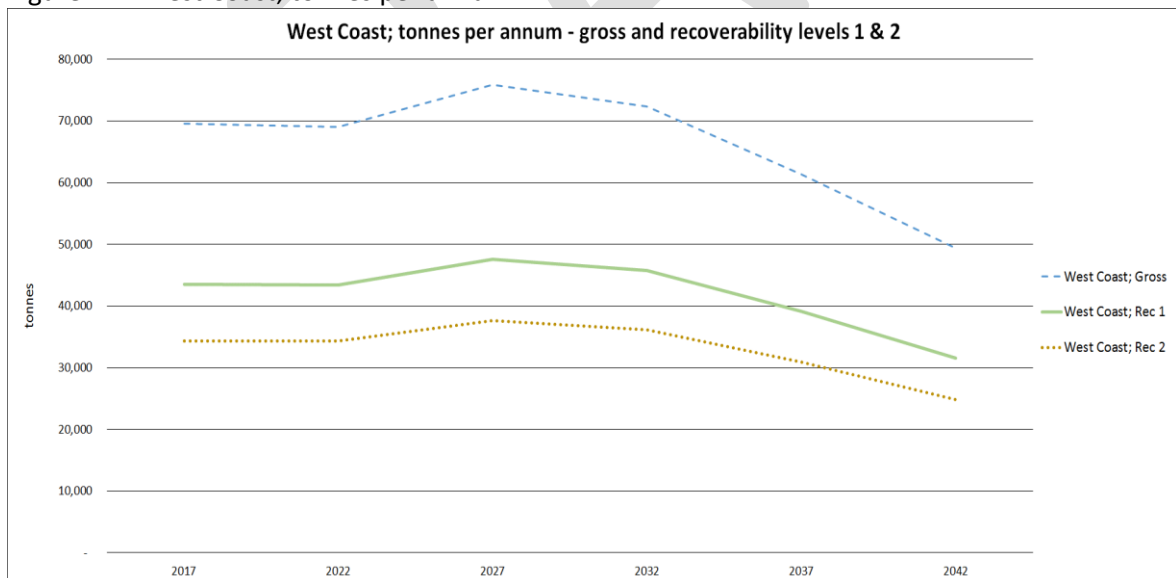


Figure 23 - West Coast; Gigajoules per annum

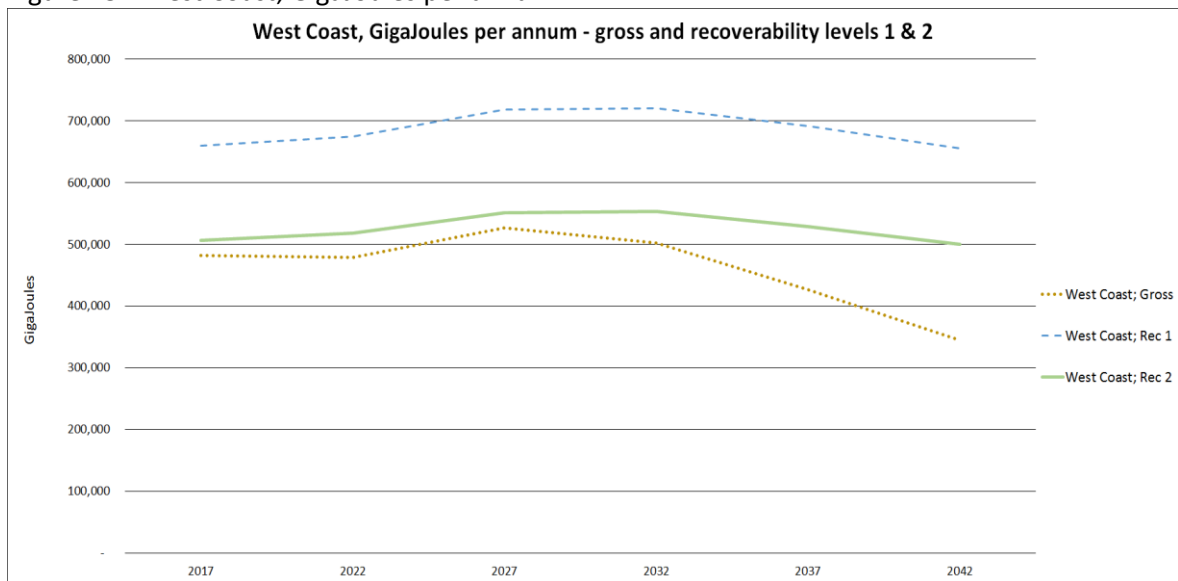


Figure 24 - Canterbury; Tonnes per annum

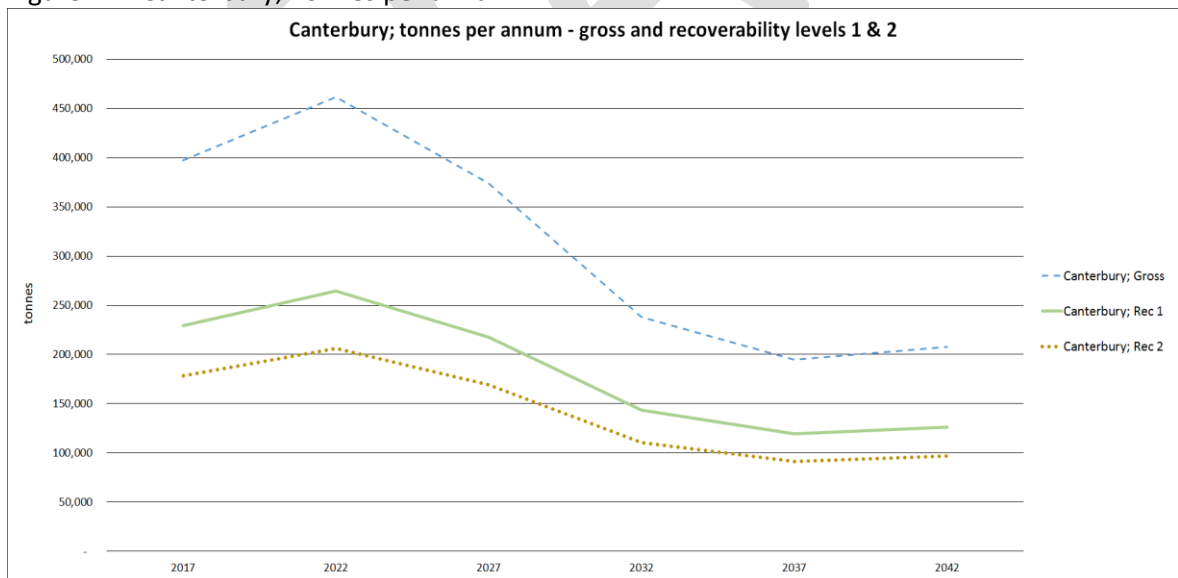


Figure 25 - Canterbury; Gigajoules per annum

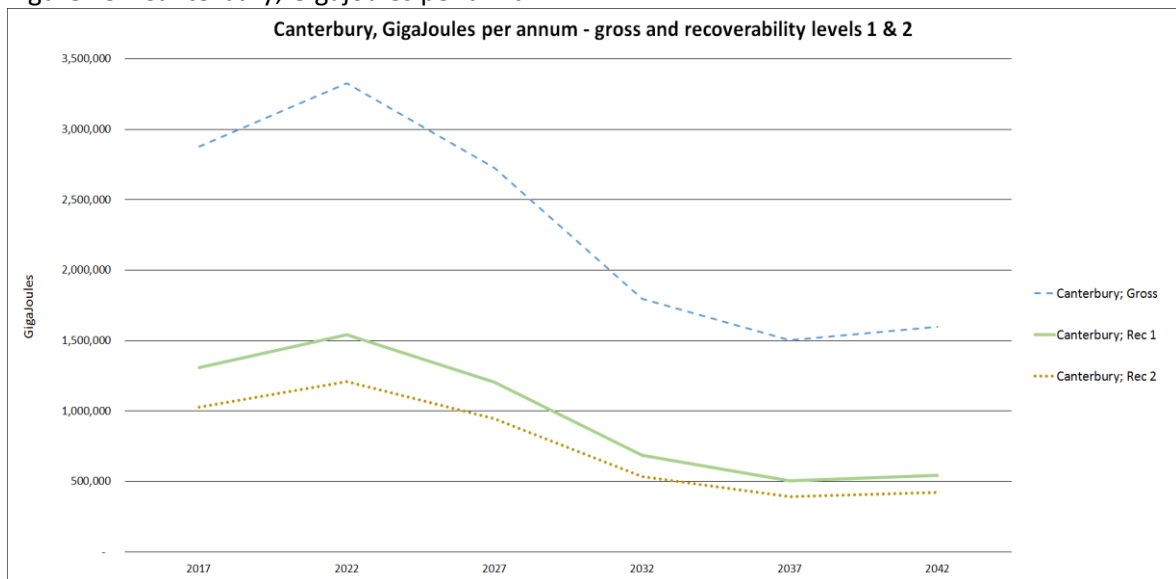


Figure 26 - Otago; tonnes per annum

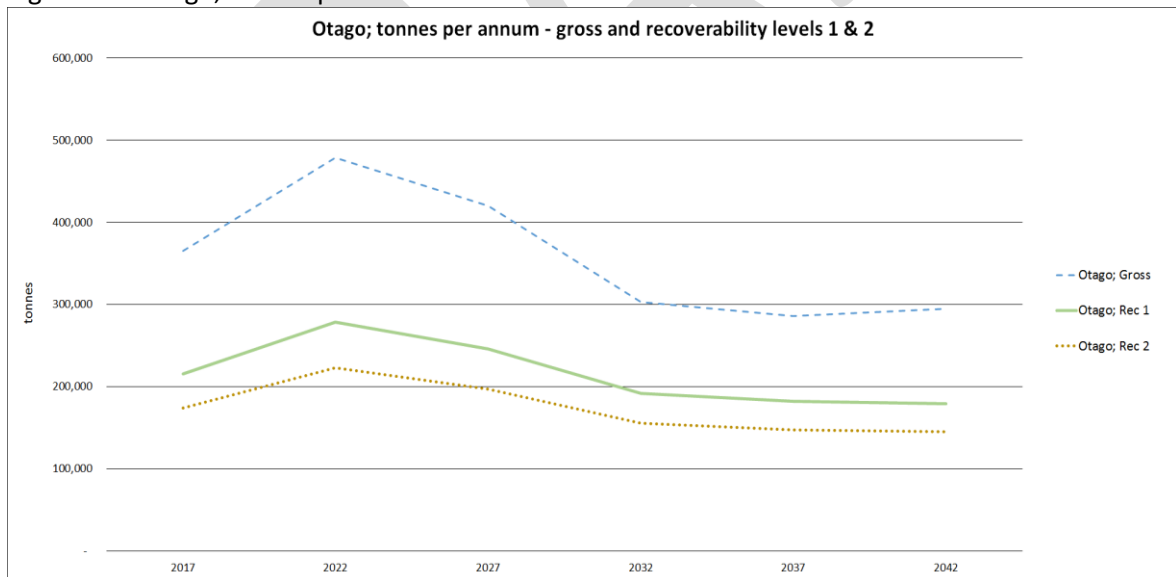


Figure 27 - Otago; Gigajoules per annum

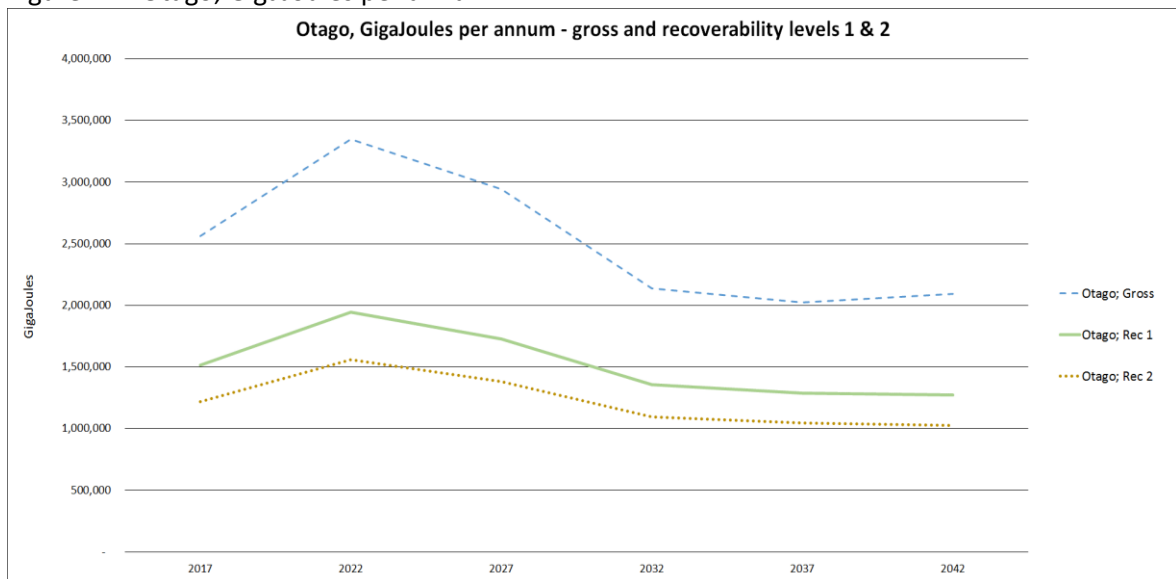


Figure 28 - Southland; tonnes per annum

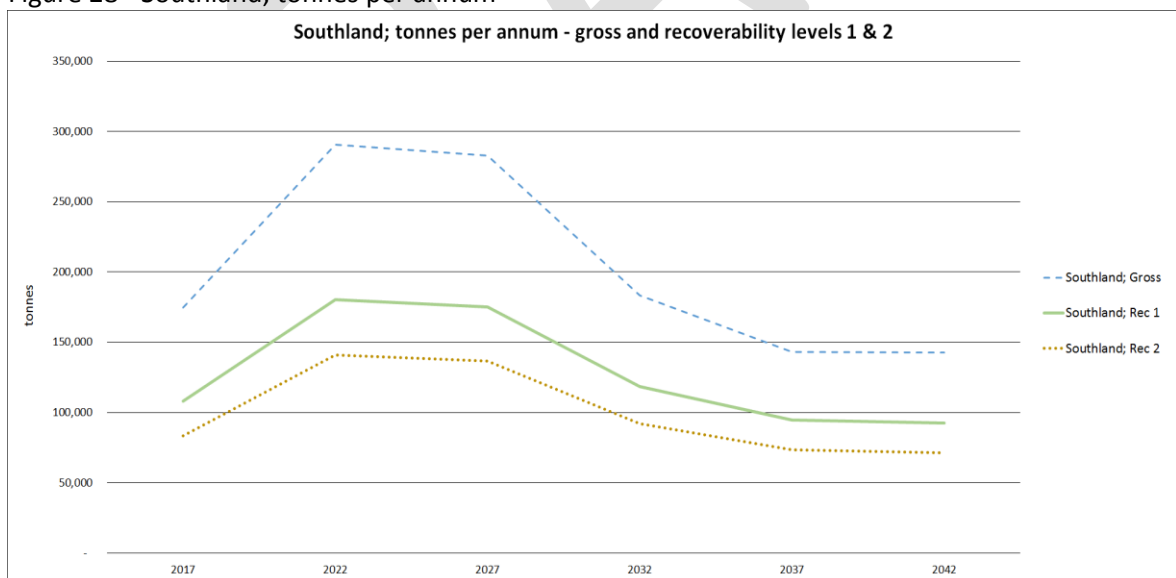


Figure 29 - Southland, Gigajoules per annum

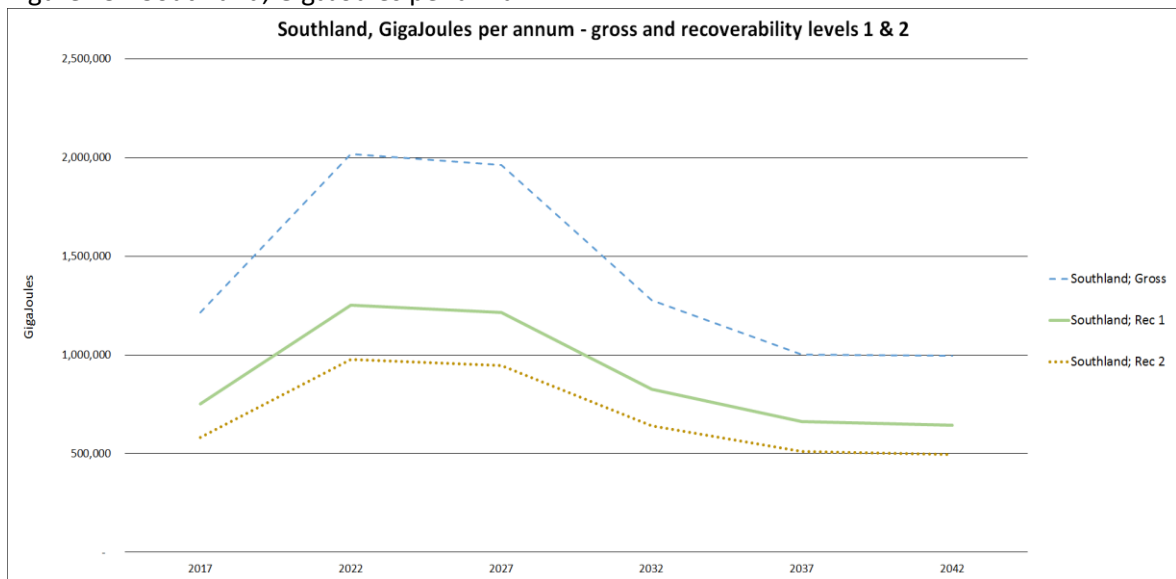


Figure 30 - New Zealand; tonnes per annum

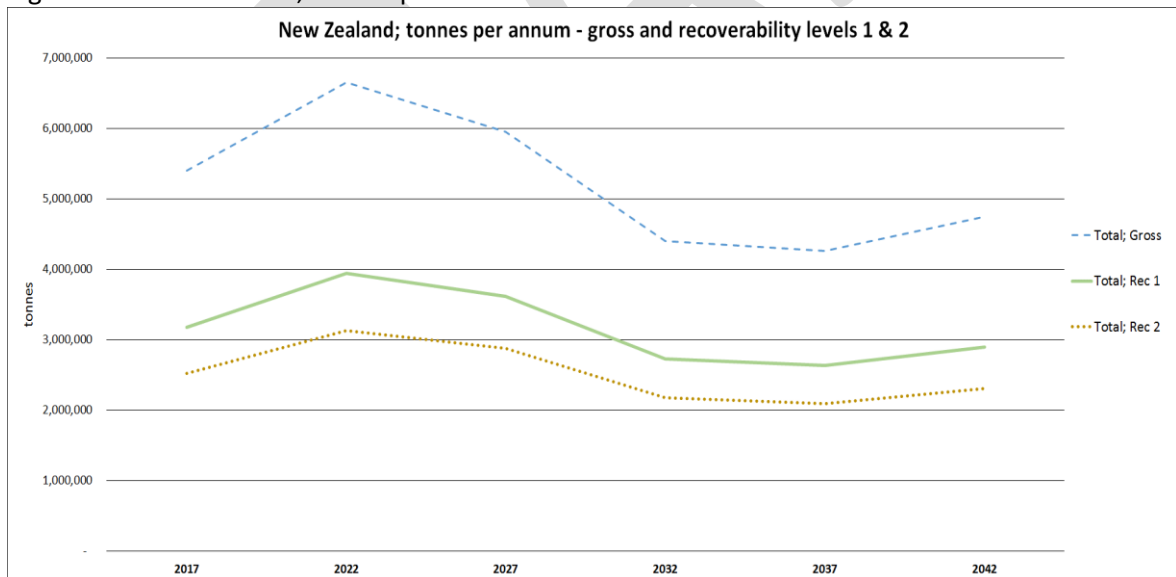


Figure 31 - New Zealand; Gigajoules per annum

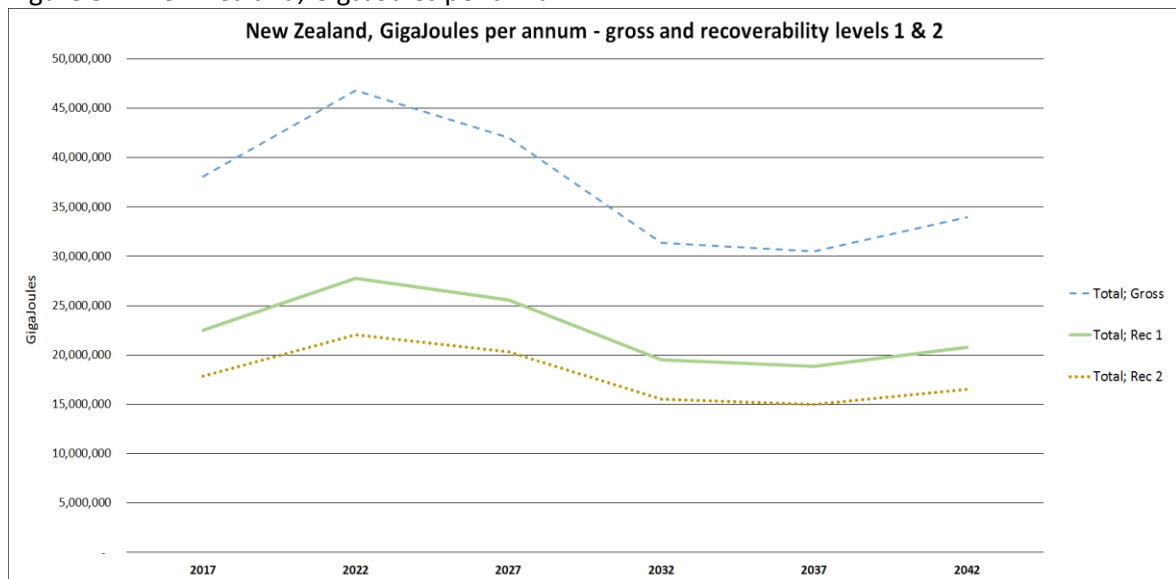


Figure 32 shows the total biomass (green tonnes) under recoverability level 1, by region and resource type for the period 2032 to 2037. This period is chosen as it represents the low point in supply in the 25 year period assessed.

There are some standout items; in-forest residues occur in all regions - in proportion to the size of the forest estate and the slope of the land on which those forests occur. Hence the Bay of Plenty has a large volume of residues available as it has a large forest resource, much of which is on flat to rolling terrain.

Canterbury is the one region that has a substantial resource coming from agricultural straws. Several other regions have small quantities of this material

There are several regions where the wood processing residue volume is negative - this is in regions where there are several energy intensive (LVL, MDF, pulp and paper) wood processors.

Auckland and Waikato have large quantities of municipal wood waste - which is largely population driven.

Residuals from orchards are only prominent in Hawkes bay, Tasman/Nelson and Marlborough

Figure 32 - regional biomass availability (green tonnes per annum) by type in 2037

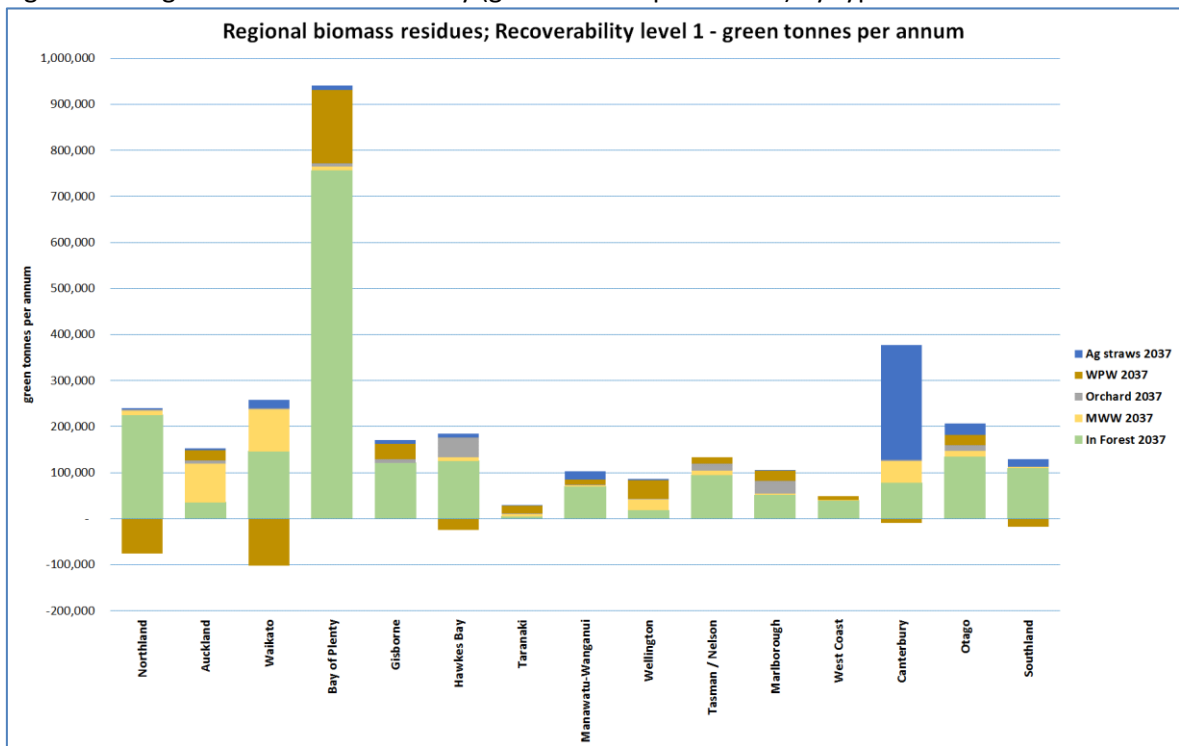
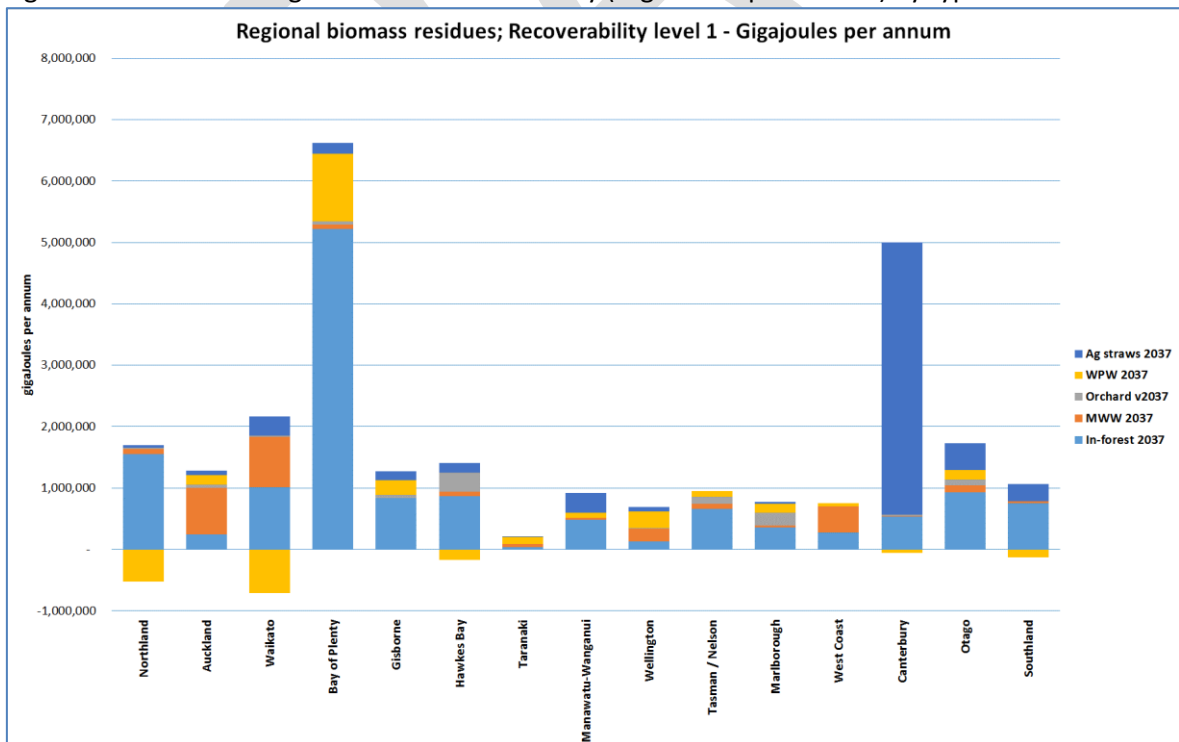


Figure 33 - estimated regional biomass availability (GigaJoules per annum) by type in 2037



The data on volume and costs can be combined to give an indicative cost supply curve for tonnes of woody biomass at a national level (Figure 34). A similar chart can be generated for the cost per

unit of energy (GJ, Figure 35). Figures 36 to 339 provide cost supply curves for the two different levels of recovery by tonnage and energy.

Figure 34 - gross residual woody biomass supply; by tonnes per annum and cost

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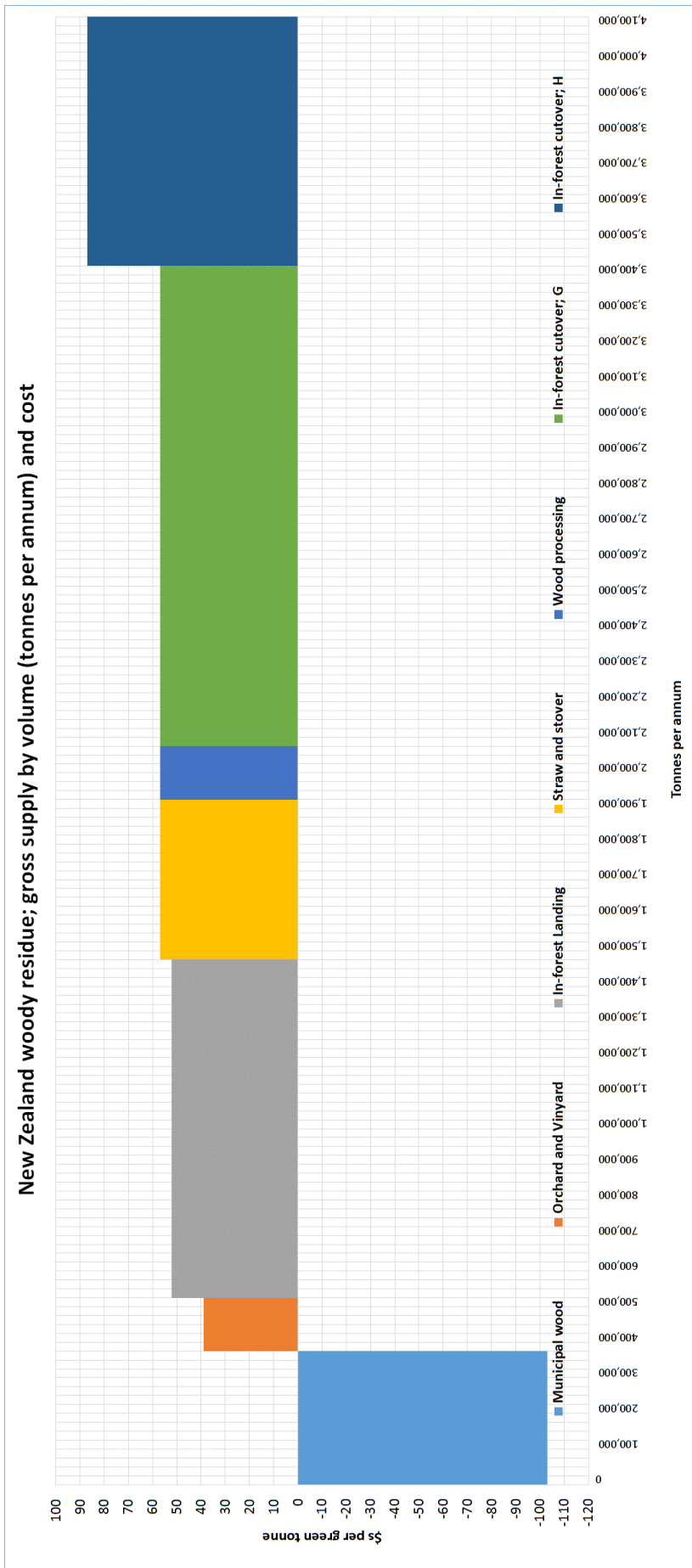


Figure 35 - gross residual biomass supply; by energy (GJ p.a.) and cost

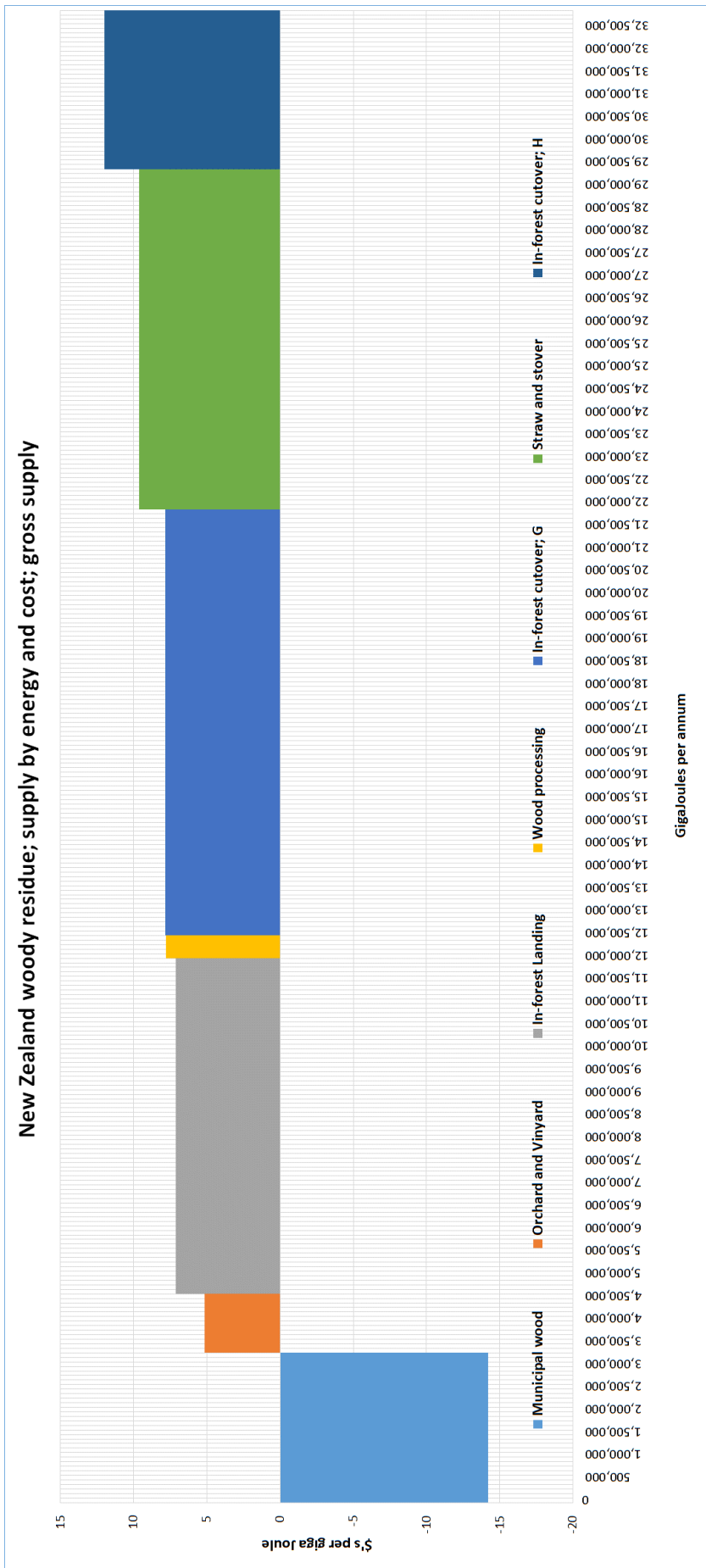


Figure 36 - Recoverability level 1; by tonnes per annum and cost

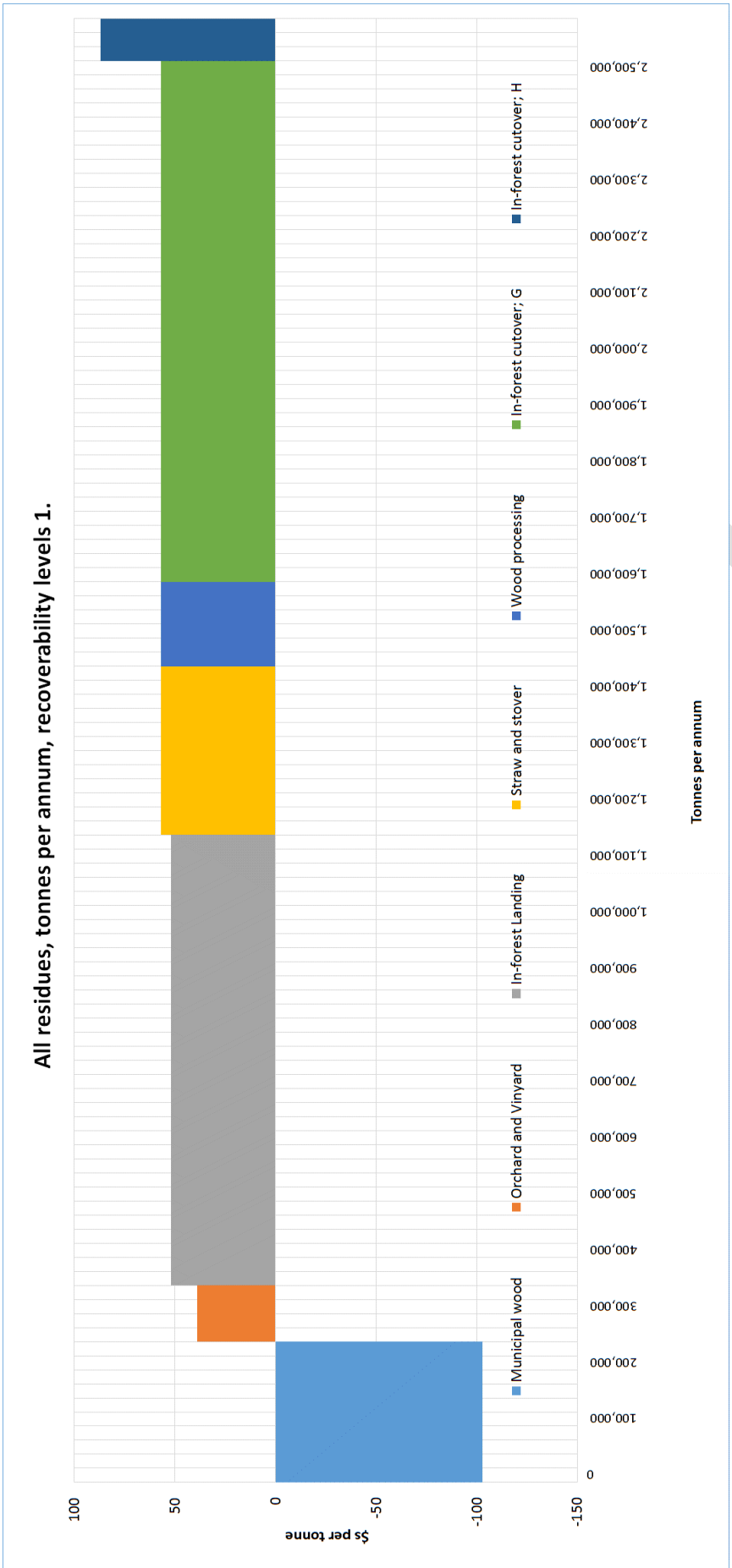


Figure 37 - Recoverability level 1; by energy (GJ per annum) and cost

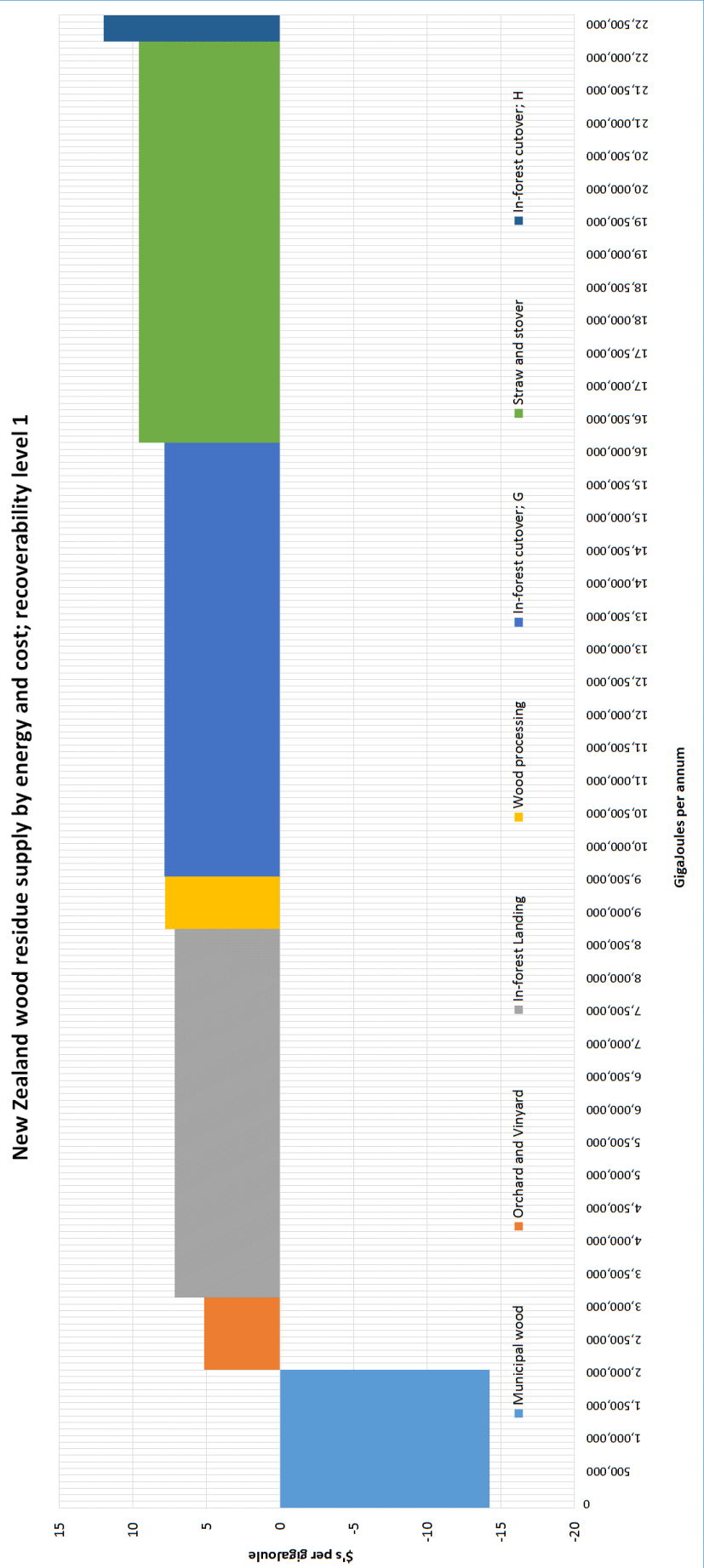


Figure 38 - Recoverability level 2; by tonnes per annum and cost

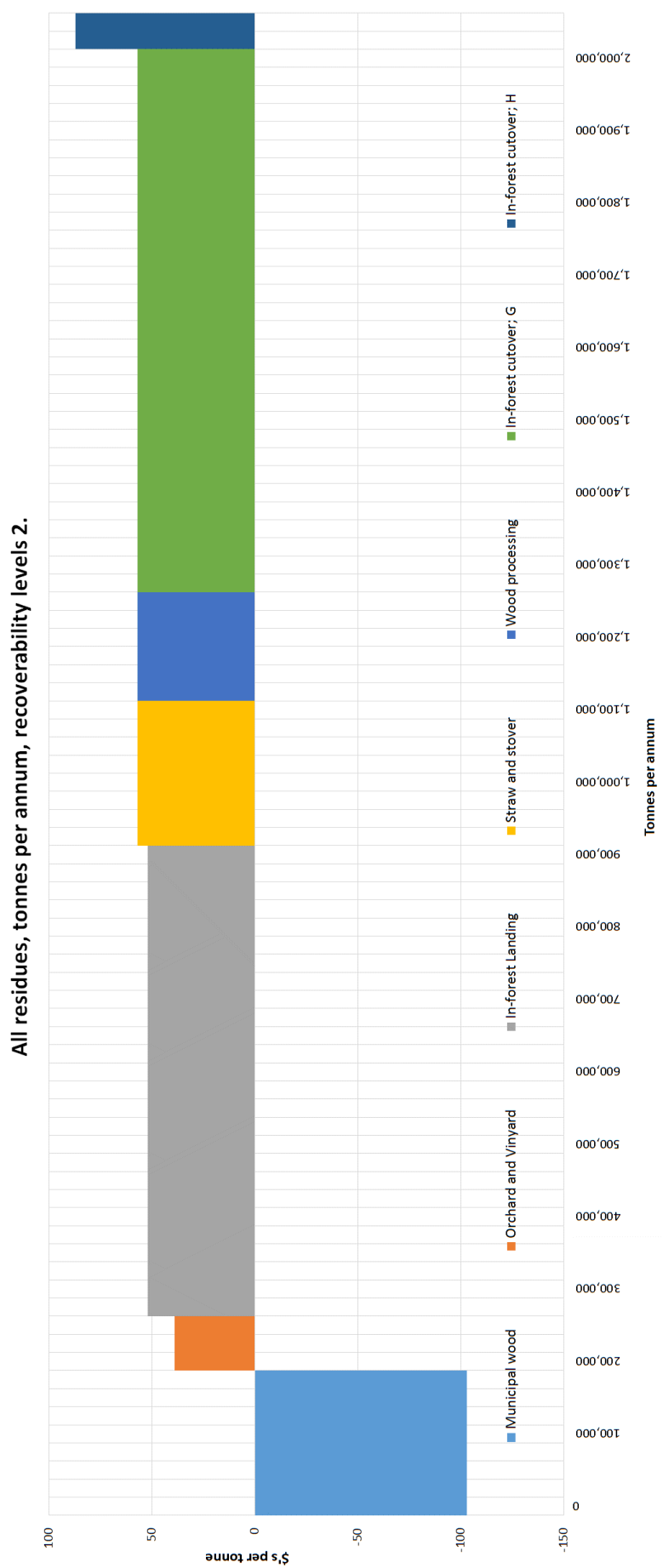
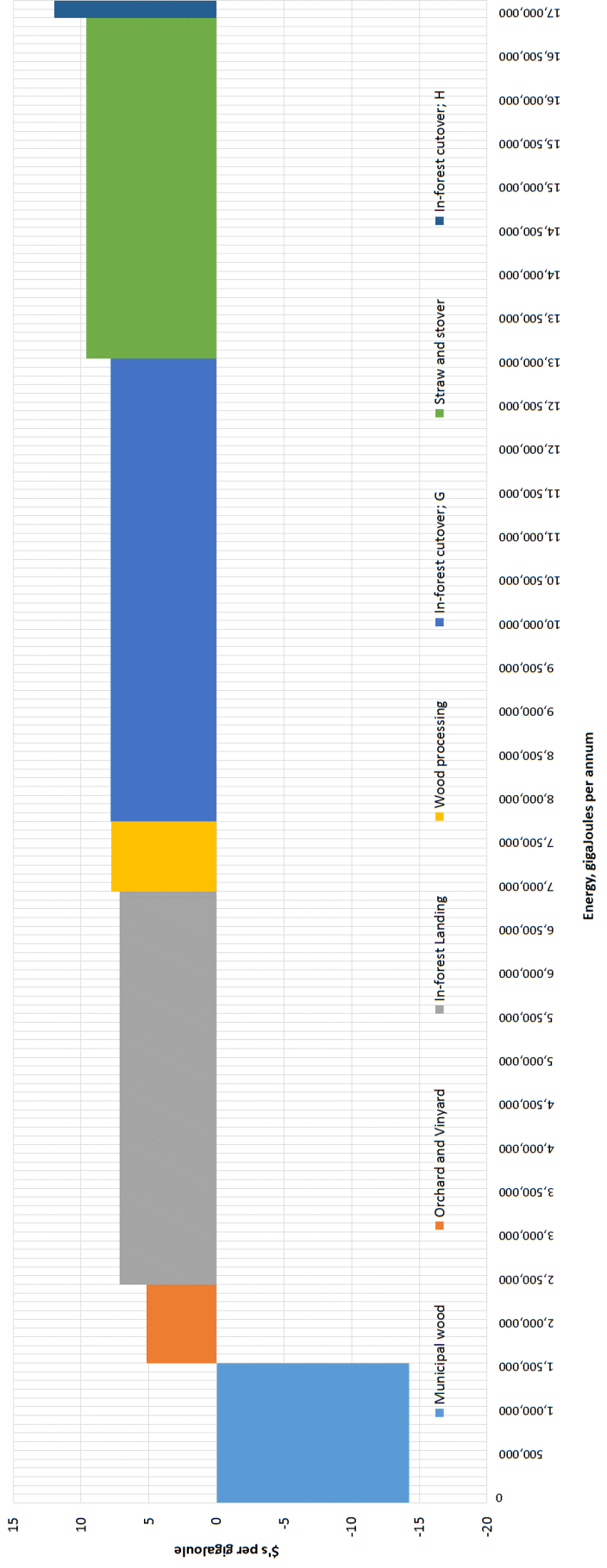


Figure 39 - Recoverability level 2; by energy supply (GJ per annum) and cost

New Zealand wood energy by cost and energy supply; recoverability levels 2



Other resources

Port derived bark

There is a potential resource of bark that is generated at log export ports around New Zealand. Currently this material is generally removed and used for landscaping, mulch and compost. The \$ per tonne return on this to the port is generally very low.

Bark at the ports is derived in two ways;

- deliberate debarking
- collateral bark removal during log handling

The material in the second category is usually contaminated with dirt as it falls on the ground and has to be swept up, along with all the other debris that is on the wharf.

The amount of bark produced is proportional to the amount of logs exported, but there is limited data on the amounts port by port and only some ports debark deliberately, and only some logs are debarked.

There is potential for debarking at ports or central facilities to increase the volume of debarking of export logs due to possible changes in phytosanitary requirements.

However, given the number of variables at play (variation in harvest volume, proportion of logs exported versus processing domestically, changes in harvesting practices etc.), it is difficult to predict accurately the amount of bark that might accrue port by port over time.

This is a resource that would warrant a greater focus in any review of this data.

An estimate of the volumes currently produced and exported is provided in Table 5.

Table 5 - green tonnes per annum of bark produced at and exported via New Zealand ports

	Bark at Port	Bark exported
Whangarei	41,025	40,205
Auckland	1,651	1,618
Tauranga	81,641	80,008
Gisborne	34,852	34,155
Napier	17,577	17,226
New Plymouth	4,881	4,783
Wellington	15,512	15,202
Nelson	10,071	9,870
Picton	9,968	9,769
Christchurch	7,945	7,786
Timaru	5,282	5,176
Dunedin	13,261	12,996
Invercargill	7,233	7,088
Total	250,899	245,881

Green-house gas reduction potential estimate

One of the drivers for using woody biomass as a heat fuel is that it is very low in carbon emissions in comparison to coal. If the woody biomass is used to displace coal for heat then substantial GHG emissions reductions are technically possible (Table 6).

Table 6 - Potential greenhouse gas emission reductions (t CO₂e) assuming all available biomass is consumed and displaces coal

	Gross	Recoverability level 1	Recoverability level 2
Northland	192,625	108,683	78,985
Auckland	172,099	115,312	90,802
Waikato	212,014	108,942	72,803
Bay of Plenty	897,152	613,626	505,072
Gisborne	199,419	106,887	87,094
Hawkes Bay	187,423	103,500	79,390
Taranaki	26,301	19,249	16,679
Manawatu-Wanganui	97,874	56,408	45,523
Wellington	84,685	59,254	50,086
Tasman / Nelson	63,728	0	0
Marlborough	124,629	70,362	57,424
West Coast	40,629	65,847	50,414
Canterbury	143,235	48,109	37,401
Otago	206,447	131,604	106,543
Southland	102,169	67,551	52,220
Total	2,750,428	1,652,027	1,294,227

Regional wood supply versus coal demand - matches and mismatches

New Zealand's total coal demand in 2015 was reported as 55.38PJ in total primary energy (MBIE 2016). If electricity generation and co-generation are excluded the demand is around 21.5 PJ of industrial heat. All biomass residues at a national level total 24.1 PJ at recovery level 1.

There are a number of regions where the supply of wood residues is not well aligned with the local coal demand, for example; the East Coast has a substantial wood residue resource and almost no coal demand. Waikato has coal demand well in excess of its residual wood supply whereas neighbouring Bay of Plenty has a significant wood resource well in excess of its coal demand. There is potential for region to region movement of biomass to correct imbalances in cases where the regions are close to each other. In the case of the East Coast its comparative isolation means transport costs for residues to move to another region would be high. There is potential for densification of residues into pellets, pillow briquettes or log briquettes to increase the energy content per cubic metre, thus reducing the transport cost as trucks can meet their full payload, enabling transport of wood fuels over longer distances.

However, the mismatches at a regional level (Table 7) that mean that not all the coal will be able to be replaced with wood easily, without long transport distances.

Table 7 - estimates of regional coal demand and residual biomass supply

	Coal demand GJ p. a.	Biomass GJ p.a. Recoverability 1	Biomass useable GJ p.a.
Northland	310,500	1,172,536	862,036
Auckland	531,300	1,279,833	748,533
Waikato	4,243,500	1,458,420	- 2,785,080
Bay of Plenty	2,532,300	6,621,748	4,089,448
Gisborne	-	1,273,680	1,273,680
Hawkes Bay	1,352,400	1,242,046	- 110,354
Taranaki	48,300	209,649	161,349
Manawatu-Whanganui	317,400	914,743	597,343
Wellington	207,000	693,923	486,923
Nelson	1,069,500	945,882	- 123,618
Marlborough	227,700	772,963	545,263
Canterbury	4,022,700	4,937,721	915,021
West Coast	1,462,800	756,212	- 706,588
Otago	1,918,200	1,728,139	- 190,061
Southland	5,816,700	943,871	- 4,872,829
Total	24,060,300	25,370,398	16,754,165

Note - assumes recoverability level 1 and the long term availability level.

The data in table suggests that around 70% of the coal demand for heat could be met from woody biomass.

Conclusions and recommendations

Whilst the gross levels of biomass availability are a useful start point, they should not be used as an estimate of commercially extractable biomass without further more detailed examination of the resources at a site specific level.

The first level of recoverability figures are suggested as a realistic start point for the amount of material that could be commercially recoverable.

Within any region the residuals resource is finite, and the first users to contract supply are likely to get the cheapest and / or best quality resources. Subsequent entrants to the market may find that the cost of supply is greater than the average suggested here.

As time progresses it is possible that the use of woody residues from a variety of sources will increase. This data on wood energy use needs to be captured and the information added to the data set here, so that true volumes are presented in future updates. For example, at the moment, there is very little use of in-forest residues, but if this changes and large volumes are extracted in a particular region, this should be noted so that the total availability is still accurate.

The development of new or expanded wood processing facilities will have an effect on the supply wood processing residues. These changes are difficult to predict and therefore a review of the data at a regional level on a regular basis (bi-annual) is suggested.

Better, more up-to-date data on orchard and arable crop residues is potentially available and this should be added in the next revision of this data set. The areas of arable cropping can change from year to year. Orchard areas can also change quite quickly at a regional level and this needs to be monitored and kept up to date. Forest areas are not subject to change quite as quickly as the crop rotation length is ~25 years. However, there are still changes to the data on the forest resource and the Ministry of Primary Industries provides an annual update (National Exotic Forest Description) and any major changes in this should be noted and incorporated in any updates. The methods used to generate the NEFD are being reviewed and in the next 2 years it is possible that the data will be more spatially based. Data on bark at ports should be examined in more detail.

Biomass residuals could displace at least half of New Zealand's coal demand, potentially as much as 70% with a subsequent impact on greenhouse gas emissions of ~1.1 million tonnes of CO₂e per annum displaced.

Use of biomass for heat is not limited to displacing coal, and in some circumstances biomass could substitute for gas, increasing its market penetration and volume of uptake in some regions where coal use is low but gas is used as a heat fuel (Gisborne / East Coast).

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Appendix 1 - In forest residues

All in-forest residues (smoothed) - gross tonnage (green tonnes per annum)

	2017	2022	2027	2032	2037	2042
Northland	473,017	428,259	343,866	261,702	349,134	451,133
Auckland	97,823	147,582	142,280	100,788	56,528	44,447
Waikato	340,945	510,364	418,602	234,496	240,709	278,972
Bay of Plenty	1,017,020	1,279,328	1,381,768	1,156,904	1,171,779	1,329,208
Gisborne	491,860	557,465	391,539	213,320	258,516	365,789
Hawkes Bay	370,591	528,202	422,080	302,947	237,497	245,670
Taranaki	70,989	84,221	42,873	16,847	10,443	14,758
Manawatu-Wanganui	375,157	468,019	304,027	153,240	130,390	148,780
Wairarapa	14,162	9,551	2,724	2,024	602	151
Wellington	90,939	105,844	77,808	40,501	37,535	48,236
Tasman / Nelson	308,795	357,309	291,837	270,574	224,913	189,037
Marlborough	143,264	156,976	105,536	83,703	122,656	165,607
West Coast	70,076	69,455	76,207	72,530	61,375	49,270
Canterbury	340,207	401,701	311,144	172,820	126,554	136,137
Otago	313,070	425,154	364,800	245,464	226,729	234,284
Southland	188,271	304,299	296,210	196,946	156,780	156,238
Total	4,766,149	5,990,069	5,252,685	3,663,966	3,487,449	3,933,219

All in-forest residues (smoothed) - gross energy (GJ per annum)

	2017	2022	2027	2032	2037	2042
Northland	3,263,816	2,954,988	2,372,674	1,805,742	2,409,021	3,112,819
Auckland	674,979	1,018,316	981,731	695,440	390,046	306,681
Waikato	2,352,522	3,521,510	2,888,352	1,618,021	1,660,893	1,924,907
Bay of Plenty	7,017,436	8,827,363	9,534,198	7,982,640	8,085,274	9,171,537
Gisborne	3,393,834	3,846,510	2,701,616	1,471,906	1,783,758	2,523,944
Hawkes Bay	2,557,076	3,644,591	2,912,349	2,090,335	1,638,729	1,695,120
Taranaki	489,823	581,122	295,826	116,244	72,054	101,827
Manawatu-Wanganui	2,588,585	3,229,334	2,097,786	1,057,353	899,690	1,026,581
Wairarapa	97,718	65,899	18,793	13,966	4,154	1,041
Wellington	627,481	730,324	536,876	279,455	258,994	332,829
Tasman / Nelson	2,130,685	2,465,435	2,013,673	1,866,960	1,551,897	1,304,354
Marlborough	988,521	1,083,132	728,196	577,554	846,326	1,142,691
West Coast	483,527	479,238	525,828	500,456	423,487	339,960
Canterbury	2,347,426	2,771,735	2,146,894	1,192,460	873,223	939,346
Otago	2,160,186	2,933,565	2,517,121	1,693,699	1,564,429	1,616,556
Southland	1,299,073	2,099,665	2,043,846	1,358,929	1,081,783	1,078,045
Total	32,886,430	41,331,480	36,243,524	25,281,366	24,063,395	27,139,213

All in-forest residues; recoverability level 1, green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	301,433	271,718	218,591	169,173	225,005	289,503
Auckland	60,231	91,219	88,031	62,450	35,113	27,678
Waikato	208,356	313,747	257,222	143,219	146,344	169,674
Bay of Plenty	650,963	833,790	900,685	754,312	756,486	852,511
Gisborne	231,489	262,719	184,302	100,506	121,431	171,686
Hawkes Bay	196,912	282,068	225,500	160,417	125,737	129,907
Taranaki	33,327	39,478	20,239	8,253	4,941	6,558
Manawatu-Wanganui	201,670	252,584	164,128	81,026	70,116	81,404
Wairarapa	7,809	5,328	1,503	1,136	343	85
Wellington	45,060	52,037	37,833	19,810	18,318	23,532
Tasman / Nelson	116,395	139,049	118,012	113,729	95,229	79,629
Marlborough	69,552	76,334	49,391	37,349	51,296	67,697
West Coast	44,325	44,241	48,316	46,349	39,668	31,956
Canterbury	194,866	228,751	179,714	103,951	77,714	83,007
Otago	172,754	234,092	200,749	145,734	134,440	130,424
Southland	122,747	195,047	189,638	132,989	109,336	106,851
Total	2,709,379	3,449,586	3,108,039	2,192,213	2,071,903	2,312,506

All in-forest residues; recoverability level 1, GJ per annum

	2017	2022	2027	2032	2037	2042
Northland	2,079,889	1,874,857	1,508,278	1,167,292	1,552,533	1,997,572
Auckland	415,595	629,409	607,415	430,905	242,280	190,979
Waikato	1,437,653	2,164,853	1,774,833	988,210	1,009,776	1,170,749
Bay of Plenty	4,491,642	5,753,148	6,214,724	5,204,751	5,219,750	5,882,326
Gisborne	1,597,272	1,812,760	1,271,684	693,488	837,873	1,184,636
Hawkes Bay	1,358,693	1,946,267	1,555,952	1,106,879	867,584	896,358
Taranaki	229,959	272,399	139,647	56,944	34,092	45,252
Manawatu-Wanganui	1,391,524	1,742,831	1,132,485	559,076	483,802	561,688
Wairarapa	53,884	36,763	10,371	7,837	2,364	586
Wellington	310,916	359,058	261,049	136,691	126,393	162,369
Tasman / Nelson	803,127	959,436	814,280	784,732	657,079	549,443
Marlborough	479,911	526,702	340,799	257,708	353,942	467,111
West Coast	305,839	305,260	333,379	319,810	273,710	572,749
Canterbury	1,344,574	1,578,385	1,240,028	717,261	536,229	220,497
Otago	1,192,001	1,615,238	1,385,171	1,005,562	927,637	899,923
Southland	846,956	1,345,821	1,308,504	917,624	754,416	737,273
Total	18,694,717	23,802,144	21,445,472	15,126,272	14,296,132	15,956,290

All in-forest residues; recoverability level 2, green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	240,287	216,553	174,236	135,002	179,528	230,927
Auckland	47,901	72,572	70,042	49,695	27,948	22,035
Waikato	165,656	249,570	204,600	113,863	116,315	134,872
Bay of Plenty	519,138	665,795	719,224	602,389	603,746	680,070
Gisborne	180,230	204,575	143,495	78,260	94,523	133,631
Hawkes Bay	154,948	222,053	177,529	126,199	98,917	102,192
Taranaki	25,927	30,705	15,750	6,445	3,845	5,071
Manawatu-Wanganui	158,718	198,863	129,222	63,689	55,190	64,159
Wairarapa	6,160	4,207	1,186	897	271	67
Wellington	35,228	40,656	29,530	15,472	14,305	18,376
Tasman / Nelson	88,424	106,059	90,454	87,590	73,406	61,347
Marlborough	54,385	59,701	38,483	28,958	39,490	51,978
West Coast	35,260	35,206	38,436	36,904	31,624	25,491
Canterbury	153,987	180,679	142,117	82,510	61,820	65,986
Otago	136,219	184,507	158,198	115,683	106,748	102,977
Southland	97,940	155,373	151,031	106,455	87,796	85,648
Total	2,142,429	2,730,697	2,465,717	1,740,884	1,644,544	1,833,905

All in-forest residues; recoverability level 2, GJ per annum

	2017	2022	2027	2032	2037	2042
Northland	1,657,977	1,494,214	1,202,227	931,514	1,238,747	1,593,394
Auckland	330,519	500,745	483,292	342,898	192,842	152,044
Waikato	1,143,028	1,722,030	1,411,743	785,658	802,571	930,618
Bay of Plenty	3,582,054	4,593,984	4,962,648	4,156,483	4,165,850	4,692,484
Gisborne	1,243,590	1,411,564	990,113	539,992	652,210	922,057
Hawkes Bay	1,069,142	1,532,166	1,224,948	870,770	682,524	705,127
Taranaki	178,895	211,867	108,672	44,473	26,533	34,990
Manawatu-Wanganui	1,095,154	1,372,156	891,634	439,451	380,811	442,695
Wairarapa	42,503	29,025	8,181	6,190	1,869	463
Wellington	243,074	280,529	203,756	106,756	98,702	126,793
Tasman / Nelson	610,125	731,810	624,130	604,371	506,504	423,297
Marlborough	375,254	411,939	265,529	199,810	272,481	358,647
West Coast	243,291	242,923	265,208	254,641	218,207	455,306
Canterbury	1,062,511	1,246,683	980,608	569,316	426,555	175,886
Otago	939,911	1,273,098	1,091,567	798,215	736,558	710,542
Southland	675,786	1,072,076	1,042,113	734,539	605,792	590,969
Total	14,782,760	18,841,807	17,013,451	12,012,098	11,347,351	12,653,946

Appendix 2 - Municipal wood wastes

Municipal wood wastes - gross tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	10,558	11,307	12,108	12,967	13,886	14,871
Auckland	79,860	90,442	102,427	115,999	131,370	148,778
Waikato	105,118	113,465	122,474	132,199	142,696	154,027
Bay of Plenty	8,964	9,685	10,464	11,306	12,216	13,199
Gisborne	105	116	129	143	158	175
Hawkes Bay	10,540	10,958	11,392	11,843	12,312	12,800
Taranaki	8,483	8,654	8,828	9,006	9,187	9,372
Manawatu-Wanganui	4,119	4,185	4,253	4,321	4,391	4,461
Wellington	27,585	29,512	31,575	33,781	36,141	38,667
Tasman / Nelson	14,254	14,432	14,612	14,794	14,979	15,166
Marlborough	4,018	4,376	4,765	5,190	5,652	6,155
West Coast	1,103	1,211	1,329	1,459	1,601	1,757
Canterbury	63,198	65,768	68,442	71,225	74,121	77,135
Otago	14,482	15,663	16,940	18,321	19,814	21,430
Southland	5,384	5,433	5,482	5,531	5,581	5,631
Total	357,771	385,206	415,219	448,085	484,106	523,624

Municipal wood wastes - gross energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	95,360	102,121	109,362	117,116	125,420	134,313
Auckland	721,296	816,875	925,119	1,047,706	1,186,538	1,343,767
Waikato	949,426	1,024,814	1,106,188	1,194,024	1,288,834	1,391,172
Bay of Plenty	80,963	87,476	94,514	102,118	110,334	119,210
Gisborne	948	1,050	1,163	1,288	1,426	1,579
Hawkes Bay	95,197	98,969	102,889	106,965	111,202	115,608
Taranaki	76,618	78,161	79,735	81,340	82,978	84,649
Manawatu-Wanganui	37,203	37,802	38,410	39,029	39,657	40,296
Wellington	249,148	266,557	285,182	305,109	326,429	349,238
Tasman / Nelson	128,742	130,349	131,976	133,624	135,292	136,981
Marlborough	36,291	39,522	43,040	46,872	51,045	55,590
West Coast	9,962	10,935	12,002	13,173	14,459	15,870
Canterbury	570,804	594,014	618,168	643,304	669,462	696,684
Otago	130,801	141,466	152,999	165,473	178,965	193,556
Southland	48,628	49,067	49,510	49,957	50,408	50,863
Total	3,233,405	3,481,199	3,752,286	4,049,132	4,374,486	4,731,416

Municipal wood wastes - recoverability level 1, tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	6,757	7,236	7,749	8,299	8,887	9,517
Auckland	51,110	57,883	65,553	74,240	84,077	95,218
Waikato	67,276	72,617	78,384	84,608	91,326	98,577
Bay of Plenty	5,737	6,199	6,697	7,236	7,818	8,447
Gisborne	67	74	82	91	101	112
Hawkes Bay	6,746	7,013	7,291	7,579	7,880	8,192
Taranaki	5,429	5,538	5,650	5,764	5,880	5,998
Manawatu-Wanganui	2,636	2,679	2,722	2,766	2,810	2,855
Wellington	17,654	18,888	20,208	21,620	23,130	24,747
Tasman / Nelson	9,123	9,236	9,352	9,468	9,587	9,706
Marlborough	2,572	2,800	3,050	3,321	3,617	3,939
West Coast	706	775	850	933	1,025	1,125
Canterbury	40,447	42,091	43,803	45,584	47,438	49,366
Otago	9,268	10,024	10,841	11,725	12,681	13,715
Southland	3,446	3,477	3,508	3,540	3,572	3,604
Total	228,973	246,532	265,740	286,774	309,828	335,120

Municipal wood wastes - recoverability level 1, energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	61,030	65,358	69,992	74,954	80,269	85,960
Auckland	461,629	522,800	592,076	670,532	759,385	860,011
Waikato	607,632	655,881	707,960	764,175	824,854	890,350
Bay of Plenty	51,816	55,985	60,489	65,355	70,613	76,294
Gisborne	607	672	744	824	913	1,011
Hawkes Bay	60,926	63,340	65,849	68,458	71,170	73,989
Taranaki	49,036	50,023	51,030	52,058	53,106	54,175
Manawatu-Wanganui	23,810	24,193	24,583	24,978	25,381	25,789
Wellington	159,455	170,596	182,517	195,270	208,915	223,512
Tasman / Nelson	82,395	83,423	84,465	85,519	86,587	87,668
Marlborough	23,226	25,294	27,546	29,998	32,669	35,578
West Coast	365,315	380,169	395,628	411,715	428,456	445,878
Canterbury	6,376	6,998	7,681	8,431	9,254	10,157
Otago	83,713	90,538	97,920	105,903	114,537	123,876
Southland	31,122	31,403	31,686	31,972	32,261	32,552
Total	2,068,088	2,226,673	2,400,166	2,590,144	2,798,367	3,026,800

Municipal wood wastes - recoverability level 2, tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	5,068	5,427	5,812	6,224	6,665	7,138
Auckland	38,333	43,412	49,165	55,680	63,058	71,414
Waikato	50,457	54,463	58,788	63,456	68,494	73,933
Bay of Plenty	4,303	4,649	5,023	5,427	5,864	6,335
Gisborne	50	56	62	68	76	84
Hawkes Bay	5,059	5,260	5,468	5,685	5,910	6,144
Taranaki	4,072	4,154	4,237	4,323	4,410	4,499
Manawatu-Wanganui	1,977	2,009	2,041	2,074	2,108	2,141
Wellington	13,241	14,166	15,156	16,215	17,348	18,560
Tasman / Nelson	6,842	6,927	7,014	7,101	7,190	7,280
Marlborough	1,929	2,100	2,287	2,491	2,713	2,954
West Coast	529	581	638	700	768	843
Canterbury	30,335	31,569	32,852	34,188	35,578	37,025
Otago	6,951	7,518	8,131	8,794	9,511	10,286
Southland	2,584	2,608	2,631	2,655	2,679	2,703
Total	171,730	184,899	199,305	215,081	232,371	251,340

Municipal wood wastes - recoverability level 2, energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	45,773	49,018	52,494	56,216	60,202	64,470
Auckland	346,222	392,100	444,057	502,899	569,538	645,008
Waikato	455,724	491,911	530,970	573,131	618,640	667,763
Bay of Plenty	38,862	41,989	45,367	49,017	52,960	57,221
Gisborne	455	504	558	618	684	758
Hawkes Bay	45,695	47,505	49,387	51,343	53,377	55,492
Taranaki	36,777	37,517	38,273	39,043	39,829	40,631
Manawatu-Wanganui	17,857	18,145	18,437	18,734	19,035	19,342
Wellington	119,591	127,947	136,888	146,453	156,686	167,634
Tasman / Nelson	61,796	62,568	63,349	64,139	64,940	65,751
Marlborough	17,419	18,970	20,659	22,499	24,502	26,683
West Coast	273,986	285,127	296,721	308,786	321,342	334,408
Canterbury	4,782	5,249	5,761	6,323	6,940	7,618
Otago	62,785	67,904	73,440	79,427	85,903	92,907
Southland	23,342	23,552	23,765	23,979	24,196	24,414
Total	1,551,066	1,670,005	1,800,124	1,942,608	2,098,776	2,270,100

Appendix 3 - Orchard residues

Orchard residues - gross green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	4,479	4,568	4,660	4,753	4,848	4,945
Auckland	8,219	8,383	8,551	8,722	8,897	9,074
Waikato	2,788	2,844	2,901	2,959	3,018	3,078
Bay of Plenty	8,832	9,009	9,189	9,373	9,560	9,752
Gisborne	8,161	8,324	8,491	8,661	8,834	9,011
Hawkes Bay	49,465	50,454	51,463	52,492	53,542	54,613
Taranaki	127	130	132	135	138	140
Manawatu-Wanganui	678	692	706	720	734	749
Wellington	1,443	1,472	1,501	1,531	1,562	1,593
Tasman / Nelson	17,768	18,123	18,485	18,855	19,232	19,617
Marlborough	32,201	32,845	33,502	34,172	34,855	35,553
West Coast	-	-	-	-	-	-
Canterbury	2,980	3,040	3,101	3,163	3,226	3,291
Otago	14,748	15,043	15,344	15,651	15,964	16,283
Southland	-	-	-	-	-	-
Total	151,889	154,927	158,026	161,186	164,410	167,698

Orchard residues - gross energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	32,964	33,623	34,296	34,982	35,681	36,395
Auckland	60,492	61,702	62,936	64,195	65,478	66,788
Waikato	20,520	20,930	21,349	21,776	22,212	22,656
Bay of Plenty	65,006	66,306	67,632	68,984	70,364	71,771
Gisborne	60,066	61,268	62,493	63,743	65,018	66,318
Hawkes Bay	364,059	371,340	378,767	386,343	394,069	401,951
Taranaki	936	955	974	993	1,013	1,033
Manawatu-Wanganui	4,992	5,092	5,194	5,298	5,404	5,512
Wellington	10,620	10,832	11,049	11,270	11,495	11,725
Tasman / Nelson	130,769	133,384	136,052	138,773	141,548	144,379
Marlborough	237,000	241,740	246,575	251,506	256,536	261,667
West Coast	-	-	-	-	-	-
Canterbury	21,936	22,375	22,822	23,279	23,744	24,219
Otago	108,545	110,716	112,930	115,189	117,492	119,842
Southland	-	-	-	-	-	-
Total	1,117,905	1,140,263	1,163,068	1,186,330	1,210,056	1,234,257

Orchard residues - recoverability level 1, green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	3,583	3,655	3,728	3,802	3,878	3,956
Auckland	6,575	6,707	6,841	6,978	7,117	7,260
Waikato	2,230	2,275	2,321	2,367	2,414	2,463
Bay of Plenty	7,066	7,207	7,351	7,498	7,648	7,801
Gisborne	6,529	6,660	6,793	6,929	7,067	7,208
Hawkes Bay	39,572	40,363	41,170	41,994	42,834	43,690
Taranaki	102	104	106	108	110	112
Manawatu-Wanganui	543	553	565	576	587	599
Wellington	1,154	1,177	1,201	1,225	1,250	1,274
Tasman / Nelson	14,214	14,498	14,788	15,084	15,386	15,693
Marlborough	25,761	26,276	26,802	27,338	27,884	28,442
West Coast	-	-	-	-	-	-
Canterbury	2,384	2,432	2,481	2,530	2,581	2,633
Otago	11,798	12,034	12,275	12,521	12,771	13,026
Southland	-	-	-	-	-	-
Total	121,511	123,942	126,420	128,949	131,528	134,158

Orchard residues - recoverability level 1, energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	26,371	26,899	27,437	27,985	28,545	29,116
Auckland	48,394	49,361	50,349	51,356	52,383	53,430
Waikato	16,416	16,744	17,079	17,421	17,769	18,125
Bay of Plenty	52,004	53,045	54,105	55,188	56,291	57,417
Gisborne	48,053	49,014	49,994	50,994	52,014	53,055
Hawkes Bay	291,247	297,072	303,014	309,074	315,256	321,561
Taranaki	749	764	779	795	811	827
Manawatu-Wanganui	3,994	4,073	4,155	4,238	4,323	4,409
Wellington	8,496	8,666	8,839	9,016	9,196	9,380
Tasman / Nelson	104,615	106,707	108,841	111,018	113,239	115,503
Marlborough	189,600	193,392	197,260	201,205	205,229	209,334
West Coast	-	-	-	-	-	-
Canterbury	17,549	17,900	18,258	18,623	18,995	19,375
Otago	86,836	88,573	90,344	92,151	93,994	95,874
Southland	-	-	-	-	-	-
Total	894,324	912,210	930,455	949,064	968,045	987,406

Orchard residues - recoverability level 2, green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	2,911	2,969	3,029	3,089	3,151	3,214
Auckland	5,342	5,449	5,558	5,669	5,783	5,898
Waikato	1,812	1,848	1,885	1,923	1,962	2,001
Bay of Plenty	5,741	5,856	5,973	6,092	6,214	6,339
Gisborne	5,305	5,411	5,519	5,629	5,742	5,857
Hawkes Bay	32,152	32,795	33,451	34,120	34,802	35,498
Taranaki	83	84	86	88	89	91
Manawatu-Wanganui	441	450	459	468	477	487
Wellington	938	957	976	995	1,015	1,036
Tasman / Nelson	11,549	11,780	12,015	12,256	12,501	12,751
Marlborough	20,931	21,349	21,776	22,212	22,656	23,109
West Coast	-	-	-	-	-	-
Canterbury	1,937	1,976	2,016	2,056	2,097	2,139
Otago	9,586	9,778	9,973	10,173	10,376	10,584
Southland	-	-	-	-	-	-
Total	98,728	100,703	102,717	104,771	106,866	109,004

Orchard residues - recoverability level 2, energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	21,427	21,855	22,292	22,738	23,193	23,657
Auckland	39,320	40,106	40,908	41,726	42,561	43,412
Waikato	13,338	13,605	13,877	14,154	14,437	14,726
Bay of Plenty	42,254	43,099	43,961	44,840	45,737	46,651
Gisborne	39,043	39,824	40,621	41,433	42,262	43,107
Hawkes Bay	236,638	241,371	246,199	251,123	256,145	261,268
Taranaki	608	621	633	646	659	672
Manawatu-Wanganui	3,245	3,310	3,376	3,443	3,512	3,583
Wellington	6,903	7,041	7,182	7,326	7,472	7,621
Tasman / Nelson	85,000	86,700	88,434	90,202	92,006	93,847
Marlborough	154,050	157,131	160,274	163,479	166,749	170,084
West Coast	-	-	-	-	-	-
Canterbury	14,258	14,544	14,834	15,131	15,434	15,742
Otago	70,554	71,965	73,405	74,873	76,370	77,897
Southland	-	-	-	-	-	-
Total	726,638	741,171	755,994	771,114	786,536	802,267

Appendix 4 - Straw and stover residues

Straw and Stover residues - gross oven dry tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	2,035	2,076	2,117	2,160	2,203	2,247
Auckland	4,481	4,570	4,662	4,755	4,850	4,947
Waikato	20,406	20,814	21,230	21,654	22,088	22,529
Bay of Plenty	11,592	11,824	12,060	12,302	12,548	12,799
Gisborne	9,820	10,016	10,217	10,421	10,629	10,842
Hawkes Bay	10,075	10,277	10,482	10,692	10,906	11,124
Taranaki	489	498	508	518	529	539
Manawatu-Wanganui	20,920	21,338	21,765	22,200	22,644	23,097
Wellington	4,656	4,749	4,844	4,940	5,039	5,140
Tasman / Nelson	-	-	-	-	-	-
Marlborough	2,217	2,261	2,306	2,352	2,399	2,447
West Coast	-	-	-	-	-	-
Canterbury	287,572	293,323	299,189	305,173	311,277	317,502
Otago	28,527	29,098	29,679	30,273	30,879	31,496
Southland	18,330	18,697	19,071	19,452	19,841	20,238
Total	421,117	429,539	438,130	446,893	455,831	464,947

Straw and Stover residues - gross energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	36,223	36,947	37,686	38,440	39,209	39,993
Auckland	79,753	81,348	82,975	84,634	86,327	88,054
Waikato	363,218	370,482	377,892	385,450	393,159	401,022
Bay of Plenty	206,338	210,464	214,674	218,967	223,346	227,813
Gisborne	174,796	178,292	181,858	185,495	189,205	192,989
Hawkes Bay	179,335	182,922	186,580	190,312	194,118	198,000
Taranaki	8,695	8,869	9,047	9,228	9,412	9,600
Manawatu-Wanganui	372,376	379,824	387,420	395,168	403,072	411,133
Wellington	82,868	84,525	86,216	87,940	89,699	91,493
Tasman / Nelson	-	-	-	-	-	-
Marlborough	39,454	40,243	41,048	41,869	42,706	43,560
West Coast	-	-	-	-	-	-
Canterbury	5,118,773	5,221,148	5,325,571	5,432,083	5,540,724	5,651,539
Otago	507,781	517,936	528,295	538,861	549,638	560,631
Southland	326,274	332,799	339,455	346,245	353,169	360,233
Total	7,495,883	7,645,800	7,798,716	7,954,691	8,113,784	8,276,060

Straw and Stover residues - recoverability level 1, oven dry tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	1,628	1,661	1,694	1,728	1,762	1,797
Auckland	3,584	3,656	3,729	3,804	3,880	3,957
Waikato	16,324	16,651	16,984	17,324	17,670	18,023
Bay of Plenty	9,274	9,459	9,648	9,841	10,038	10,239
Gisborne	7,856	8,013	8,173	8,337	8,504	8,674
Hawkes Bay	8,060	8,221	8,386	8,553	8,724	8,899
Taranaki	391	399	407	415	423	431
Manawatu-Wanganui	16,736	17,071	17,412	17,760	18,116	18,478
Wellington	3,724	3,799	3,875	3,952	4,031	4,112
Tasman / Nelson	-	-	-	-	-	-
Marlborough	1,773	1,809	1,845	1,882	1,919	1,958
West Coast	-	-	-	-	-	-
Canterbury	230,057	234,658	239,352	244,139	249,021	254,002
Otago	22,822	23,278	23,744	24,218	24,703	25,197
Southland	14,664	14,957	15,256	15,562	15,873	16,190
Total	336,894	343,631	350,504	357,514	364,664	371,958

Straw and Stover residues - recoverability level 1, energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	28,978	29,558	30,149	30,752	31,367	31,994
Auckland	63,802	65,078	66,380	67,708	69,062	70,443
Waikato	290,574	296,386	302,314	308,360	314,527	320,818
Bay of Plenty	165,070	168,371	171,739	175,174	178,677	182,251
Gisborne	139,837	142,634	145,486	148,396	151,364	154,391
Hawkes Bay	143,468	146,337	149,264	152,249	155,294	158,400
Taranaki	6,956	7,095	7,237	7,382	7,530	7,680
Manawatu-Wanganui	297,901	303,859	309,936	316,135	322,457	328,907
Wellington	66,294	67,620	68,973	70,352	71,759	73,194
Tasman / Nelson	-	-	-	-	-	-
Marlborough	31,563	32,194	32,838	33,495	34,165	34,848
West Coast	-	-	-	-	-	-
Canterbury	4,095,018	4,176,919	4,260,457	4,345,666	4,432,579	4,521,231
Otago	406,224	414,349	422,636	431,089	439,710	448,505
Southland	261,019	266,240	271,564	276,996	282,536	288,186
Total	5,996,706	6,116,640	6,238,973	6,363,752	6,491,028	6,620,848

Straw and Stover residues - recoverability level 2, oven dry tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	1,221	1,245	1,270	1,296	1,322	1,348
Auckland	2,688	2,742	2,797	2,853	2,910	2,968
Waikato	12,243	12,488	12,738	12,993	13,253	13,518
Bay of Plenty	6,955	7,094	7,236	7,381	7,529	7,679
Gisborne	5,892	6,010	6,130	6,253	6,378	6,505
Hawkes Bay	6,045	6,166	6,289	6,415	6,543	6,674
Taranaki	293	299	305	311	317	324
Manawatu-Wanganui	12,552	12,803	13,059	13,320	13,587	13,858
Wellington	2,793	2,849	2,906	2,964	3,024	3,084
Tasman / Nelson	-	-	-	-	-	-
Marlborough	1,330	1,356	1,384	1,411	1,440	1,468
West Coast	-	-	-	-	-	-
Canterbury	172,543	175,994	179,514	183,104	186,766	190,501
Otago	17,116	17,459	17,808	18,164	18,527	18,898
Southland	10,998	11,218	11,442	11,671	11,905	12,143
Total	252,670	257,724	262,878	268,136	273,498	278,968

Straw and Stover residues - recoverability level 2, energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	21,734	22,168	22,612	23,064	23,525	23,996
Auckland	47,852	48,809	49,785	50,781	51,796	52,832
Waikato	217,931	222,289	226,735	231,270	235,895	240,613
Bay of Plenty	123,803	126,279	128,804	131,380	134,008	136,688
Gisborne	104,878	106,975	109,115	111,297	113,523	115,793
Hawkes Bay	107,601	109,753	111,948	114,187	116,471	118,800
Taranaki	5,217	5,322	5,428	5,537	5,647	5,760
Manawatu-Wanganui	223,426	227,894	232,452	237,101	241,843	246,680
Wellington	49,721	50,715	51,729	52,764	53,819	54,896
Tasman / Nelson	-	-	-	-	-	-
Marlborough	23,672	24,146	24,629	25,121	25,624	26,136
West Coast	-	-	-	-	-	-
Canterbury	3,071,264	3,132,689	3,195,343	3,259,250	3,324,435	3,390,923
Otago	304,668	310,762	316,977	323,317	329,783	336,378
Southland	195,764	199,680	203,673	207,747	211,902	216,140
Total	4,497,530	4,587,480	4,679,230	4,772,814	4,868,271	4,965,636

Appendix 5 - Wood processing residues

Wood processing residues - gross green tonnes per annum (data in red indicates a deficit)

	2017	2022	2027	2032	2037	2042
Northland	-79,356	-79,356	-79,356	-79,356	-79,356	-79,356
Auckland	23,909	23,909	23,909	23,909	23,909	23,909
Waikato	-108,086	-108,086	-108,086	-108,086	-108,086	-108,086
Bay of Plenty	167,264	167,264	167,264	167,264	167,264	167,264
Gisborne	35,319	35,319	35,319	35,319	35,319	35,319
Hawkes Bay	-25,516	-25,516	-25,516	-25,516	-25,516	-25,516
Taranaki	17,408	17,408	17,408	17,408	17,408	17,408
Manawatu-Wanganui	12,018	12,018	12,018	12,018	12,018	12,018
Wellington	42,358	42,358	42,358	42,358	42,358	42,358
Tasman / Nelson	13,574	13,574	13,574	13,574	13,574	13,574
Marlborough	22,419	22,419	22,419	22,419	22,419	22,419
Canterbury	8,245	8,245	8,245	8,245	8,245	8,245
West Coast	-9,052	-9,052	-9,052	-9,052	-9,052	-9,052
Otago	23,228	23,228	23,228	23,228	23,228	23,228
Southland	-19,122	-19,122	-19,122	-19,122	-19,122	-19,122
Total	124,611	124,611	124,611	124,611	124,611	124,611

Wood processing residues - gross energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	-547,556	-547,556	-547,556	-547,556	-547,556	-547,556
Auckland	164,972	164,972	164,972	164,972	164,972	164,972
Waikato	-745,796	-745,796	-745,796	-745,796	-745,796	-745,796
Bay of Plenty	1,154,122	1,154,122	1,154,122	1,154,122	1,154,122	1,154,122
Gisborne	243,701	243,701	243,701	243,701	243,701	243,701
Hawkes Bay	-176,060	-176,060	-176,060	-176,060	-176,060	-176,060
Taranaki	120,116	120,116	120,116	120,116	120,116	120,116
Manawatu-Wanganui	82,927	82,927	82,927	82,927	82,927	82,927
Wellington	292,273	292,273	292,273	292,273	292,273	292,273
Tasman / Nelson	93,661	93,661	93,661	93,661	93,661	93,661
Marlborough	154,693	154,693	154,693	154,693	154,693	154,693
Canterbury	56,891	56,891	56,891	56,891	56,891	56,891
West Coast	-62,460	-62,460	-62,460	-62,460	-62,460	-62,460
Otago	160,274	160,274	160,274	160,274	160,274	160,274
Southland	-131,939	-131,939	-131,939	-131,939	-131,939	-131,939
Total	859,817	859,817	859,817	859,817	859,817	859,817

Wood processing residues - recoverability level 1, green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	-75,388	-75,388	-75,388	-75,388	-75,388	-75,388
Auckland	22,714	22,714	22,714	22,714	22,714	22,714
Waikato	-102,682	-102,682	-102,682	-102,682	-102,682	-102,682
Bay of Plenty	158,901	158,901	158,901	158,901	158,901	158,901
Gisborne	33,553	33,553	33,553	33,553	33,553	33,553
Hawkes Bay	-24,240	-24,240	-24,240	-24,240	-24,240	-24,240
Taranaki	16,538	16,538	16,538	16,538	16,538	16,538
Manawatu-Wanganui	11,417	11,417	11,417	11,417	11,417	11,417
Wellington	40,240	40,240	40,240	40,240	40,240	40,240
Tasman / Nelson	12,895	12,895	12,895	12,895	12,895	12,895
Marlborough	21,298	21,298	21,298	21,298	21,298	21,298
Canterbury	7,833	7,833	7,833	7,833	7,833	7,833
West Coast	-8,600	-8,600	-8,600	-8,600	-8,600	-8,600
Otago	22,067	22,067	22,067	22,067	22,067	22,067
Southland	-18,165	-18,165	-18,165	-18,165	-18,165	-18,165
Total	118,381	118,381	118,381	118,381	118,381	118,381

Wood processing residues - recoverability level 1, energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	-520,179	-520,179	-520,179	-520,179	-520,179	-520,179
Auckland	156,723	156,723	156,723	156,723	156,723	156,723
Waikato	-708,506	-708,506	-708,506	-708,506	-708,506	-708,506
Bay of Plenty	1,096,416	1,096,416	1,096,416	1,096,416	1,096,416	1,096,416
Gisborne	231,516	231,516	231,516	231,516	231,516	231,516
Hawkes Bay	-167,257	-167,257	-167,257	-167,257	-167,257	-167,257
Taranaki	114,110	114,110	114,110	114,110	114,110	114,110
Manawatu-Wanganui	78,781	78,781	78,781	78,781	78,781	78,781
Wellington	277,659	277,659	277,659	277,659	277,659	277,659
Tasman / Nelson	88,978	88,978	88,978	88,978	88,978	88,978
Marlborough	146,958	146,958	146,958	146,958	146,958	146,958
Canterbury	54,046	54,046	54,046	54,046	54,046	54,046
West Coast	-59,337	-59,337	-59,337	-59,337	-59,337	-59,337
Otago	152,260	152,260	152,260	152,260	152,260	152,260
Southland	-125,342	-125,342	-125,342	-125,342	-125,342	-125,342
Total	816,826	816,826	816,826	816,826	816,826	816,826

Wood processing residues - recoverability level 2, green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	-71,420	-71,420	-71,420	-71,420	-71,420	-71,420
Auckland	21,518	21,518	21,518	21,518	21,518	21,518
Waikato	-97,278	-97,278	-97,278	-97,278	-97,278	-97,278
Bay of Plenty	150,538	150,538	150,538	150,538	150,538	150,538
Gisborne	31,787	31,787	31,787	31,787	31,787	31,787
Hawkes Bay	-22,964	-22,964	-22,964	-22,964	-22,964	-22,964
Taranaki	15,667	15,667	15,667	15,667	15,667	15,667
Manawatu-Wanganui	10,817	10,817	10,817	10,817	10,817	10,817
Wellington	38,123	38,123	38,123	38,123	38,123	38,123
Tasman / Nelson	12,217	12,217	12,217	12,217	12,217	12,217
Marlborough	20,177	20,177	20,177	20,177	20,177	20,177
Canterbury	7,421	7,421	7,421	7,421	7,421	7,421
West Coast	-8,147	-8,147	-8,147	-8,147	-8,147	-8,147
Otago	20,905	20,905	20,905	20,905	20,905	20,905
Southland	-17,209	-17,209	-17,209	-17,209	-17,209	-17,209
Total	112,150	112,150	112,150	112,150	112,150	112,150

Wood processing residues - recoverability level 2, energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	-492,801	-492,801	-492,801	-492,801	-492,801	-492,801
Auckland	148,475	148,475	148,475	148,475	148,475	148,475
Waikato	-671,216	-671,216	-671,216	-671,216	-671,216	-671,216
Bay of Plenty	1,038,709	1,038,709	1,038,709	1,038,709	1,038,709	1,038,709
Gisborne	219,331	219,331	219,331	219,331	219,331	219,331
Hawkes Bay	-158,454	-158,454	-158,454	-158,454	-158,454	-158,454
Taranaki	108,104	108,104	108,104	108,104	108,104	108,104
Manawatu-Wanganui	74,634	74,634	74,634	74,634	74,634	74,634
Wellington	263,046	263,046	263,046	263,046	263,046	263,046
Tasman / Nelson	84,295	84,295	84,295	84,295	84,295	84,295
Marlborough	139,223	139,223	139,223	139,223	139,223	139,223
Canterbury	51,201	51,201	51,201	51,201	51,201	51,201
West Coast	-56,214	-56,214	-56,214	-56,214	-56,214	-56,214
Otago	144,246	144,246	144,246	144,246	144,246	144,246
Southland	-118,745	-118,745	-118,745	-118,745	-118,745	-118,745
Total	773,835	773,835	773,835	773,835	773,835	773,835

Appendix 6 - In forest by category; landing residues

In-forest landing residues - gross green tonnes per annum (100% of resource)

	2017	2022	2027	2032	2037	2042
Northland	128,626	120,930	111,504	76,012	69,900	127,720
Auckland	12,388	39,086	41,371	36,912	19,265	12,940
Waikato	62,978	131,865	167,138	77,891	56,005	82,706
Bay of Plenty	248,521	317,824	422,229	379,501	306,726	391,623
Gisborne	102,209	169,875	140,054	76,660	41,821	100,144
Hawkes Bay	43,148	174,263	138,787	111,692	67,099	73,959
Taranaki	7,253	26,044	12,680	6,231	1,838	2,592
Manawatu-Wanganui	49,678	121,877	97,034	44,654	27,457	34,512
Wairarapa	2,822	4,216	599	756	262	40
Wellington	13,920	22,893	23,969	12,665	6,581	12,407
Tasman / Nelson	33,744	84,548	64,982	78,258	77,811	55,726
Marlborough	34,369	77,400	47,362	30,135	26,237	46,302
West Coast	8,216	6,373	6,701	7,183	11,255	10,506
Canterbury	41,204	62,144	57,682	42,375	37,638	39,018
Otago	42,290	92,037	71,445	60,206	100,159	63,404
Southland	24,054	53,695	39,975	42,284	80,681	58,488
Total	1,030,054	1,478,683	1,801,682	1,289,466	1,007,055	1,187,588

In-forest landing residues - gross energy (GJ) per annum, (100% of resource)

	2017	2022	2027	2032	2037	2042
Northland	887,518	834,418	769,375	524,481	482,307	881,270
Auckland	85,475	269,693	285,457	254,694	132,930	89,284
Waikato	434,546	909,865	1,153,251	537,451	386,437	570,669
Bay of Plenty	1,714,797	2,192,983	2,913,380	2,618,554	2,116,406	2,702,198
Gisborne	705,240	1,172,138	966,372	528,957	288,562	690,992
Hawkes Bay	297,720	1,202,414	957,633	770,674	462,985	510,314
Taranaki	50,045	179,707	87,491	42,995	12,684	17,884
Manawatu-Wanganui	342,777	840,949	669,537	308,116	189,452	238,133
Wairarapa	19,472	29,087	4,131	5,215	1,810	277
Wellington	96,045	157,965	165,384	87,390	45,406	85,609
Tasman / Nelson	232,831	583,378	448,377	539,979	536,897	384,510
Marlborough	237,149	534,062	326,801	207,935	181,038	319,483
West Coast	56,690	43,977	46,239	49,565	77,659	72,493
Canterbury	284,307	428,795	398,008	292,389	259,704	269,221
Otago	291,798	635,055	492,971	415,422	691,099	437,486
Southland	165,970	370,497	275,827	291,759	556,696	403,564
Total	7,107,371	10,202,911	12,431,605	8,897,318	6,948,676	8,194,361

In-forest landing residues - recoverability level 1 (80% of gross), green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	102,901	96,744	89,203	60,809	55,920	102,176
Auckland	9,910	31,269	33,096	29,530	15,412	10,352
Waikato	50,382	105,492	133,710	62,313	44,804	66,164
Bay of Plenty	198,817	254,259	337,783	303,601	245,380	313,298
Gisborne	81,767	135,900	112,043	61,328	33,456	80,115
Hawkes Bay	34,518	139,410	111,030	89,353	53,679	59,167
Taranaki	5,802	20,836	10,144	4,985	1,471	2,073
Manawatu-Wanganui	39,742	97,501	77,627	35,724	21,965	27,610
Wairarapa	2,258	3,372	479	605	210	32
Wellington	11,136	18,315	19,175	10,132	5,264	9,926
Tasman / Nelson	26,995	67,638	51,986	62,606	62,249	44,581
Marlborough	27,496	61,920	37,890	24,108	20,990	37,041
West Coast	6,573	5,099	5,361	5,747	9,004	8,405
Canterbury	32,963	49,715	46,146	33,900	30,111	31,214
Otago	33,832	73,630	57,156	48,165	80,127	50,723
Southland	19,243	42,956	31,980	33,827	64,544	46,790
Total	824,043	1,182,946	1,441,345	1,031,573	805,644	950,071

In-forest landing residues - recoverability level 1 (80% of gross), energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	710,014	667,535	615,500	419,585	385,845	705,016
Auckland	68,380	215,754	228,365	203,755	106,344	71,427
Waikato	347,637	727,892	922,600	429,961	309,150	456,535
Bay of Plenty	1,371,838	1,754,386	2,330,704	2,094,844	1,693,125	2,161,758
Gisborne	564,192	937,711	773,098	423,166	230,849	552,793
Hawkes Bay	238,176	961,932	766,107	616,539	370,388	408,251
Taranaki	40,036	143,765	69,993	34,396	10,147	14,307
Manawatu-Wanganui	274,222	672,759	535,629	246,493	151,561	190,506
Wairarapa	15,577	23,270	3,305	4,172	1,448	221
Wellington	76,836	126,372	132,307	69,912	36,325	68,487
Tasman / Nelson	186,264	466,702	358,701	431,983	429,517	307,608
Marlborough	189,719	427,249	261,441	166,348	144,830	255,586
West Coast	45,352	35,181	36,991	39,652	62,127	57,994
Canterbury	227,446	343,036	318,406	233,911	207,763	215,377
Otago	233,438	508,044	394,377	332,338	552,879	349,989
Southland	132,776	296,398	220,662	233,408	445,357	322,851
Total	5,685,897	8,162,329	9,945,284	7,117,855	5,558,941	6,555,488

In-forest landing residues - recoverability level 2 (65% of gross), green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	83,607	78,605	72,477	49,408	45,435	83,018
Auckland	8,052	25,406	26,891	23,993	12,522	8,411
Waikato	40,936	85,712	108,640	50,629	36,403	53,759
Bay of Plenty	161,539	206,585	274,449	246,675	199,372	254,555
Gisborne	66,436	110,419	91,035	49,829	27,183	65,093
Hawkes Bay	28,046	113,271	90,212	72,600	43,615	48,073
Taranaki	4,714	16,929	8,242	4,050	1,195	1,685
Manawatu-Wanganui	32,291	79,220	63,072	29,025	17,847	22,433
Wairarapa	1,834	2,740	389	491	171	26
Wellington	9,048	14,881	15,580	8,232	4,277	8,065
Tasman / Nelson	21,933	54,956	42,238	50,868	50,577	36,222
Marlborough	22,340	50,310	30,786	19,588	17,054	30,096
West Coast	5,340	4,143	4,356	4,669	7,316	6,829
Canterbury	26,783	40,394	37,493	27,544	24,465	25,361
Otago	27,488	59,824	46,439	39,134	65,104	41,212
Southland	15,635	34,902	25,984	27,485	52,442	38,017
Total	669,535	961,144	1,171,093	838,153	654,585	771,933

In-forest landing residues - recoverability level 2 (65% of gross), energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	576,886	542,372	500,094	340,913	313,499	572,826
Auckland	55,559	175,300	185,547	165,551	86,404	58,035
Waikato	282,455	591,413	749,613	349,343	251,184	370,935
Bay of Plenty	1,114,618	1,425,439	1,893,697	1,702,060	1,375,664	1,756,429
Gisborne	458,406	761,890	628,142	343,822	187,565	449,145
Hawkes Bay	193,518	781,569	622,462	500,938	300,940	331,704
Taranaki	32,529	116,809	56,869	27,946	8,245	11,624
Manawatu-Wanganui	222,805	546,617	435,199	200,275	123,144	154,786
Wairarapa	12,657	18,907	2,685	3,390	1,177	180
Wellington	62,429	102,677	107,499	56,804	29,514	55,646
Tasman / Nelson	151,340	379,196	291,445	350,987	348,983	249,931
Marlborough	154,147	347,140	212,420	135,158	117,675	207,664
West Coast	36,849	28,585	30,056	32,217	50,478	47,120
Canterbury	184,800	278,717	258,705	190,053	168,808	174,994
Otago	189,669	412,786	320,431	270,024	449,214	284,366
Southland	107,881	240,823	179,288	189,644	361,852	262,316
Total	4,619,791	6,631,892	8,080,543	5,783,257	4,516,639	5,326,334

Appendix 7 - In-forest residues by category - Cutover residues ground-based sites

In-forest ground-based cutover residues - gross green tonnes per annum (100% of resource)

	2017	2022	2027	2032	2037	2042
Northland	297,728	258,229	233,574	161,673	144,772	258,309
Auckland	29,760	78,350	82,653	72,028	37,002	23,626
Waikato	121,621	231,933	294,932	137,074	105,944	139,804
Bay of Plenty	532,735	637,398	852,063	754,278	573,862	742,424
Gisborne	111,859	178,386	149,938	81,056	44,628	108,345
Hawkes Bay	59,969	219,228	179,704	139,044	86,108	89,282
Taranaki	11,242	37,339	21,002	10,106	2,373	5,447
Manawatu-Wanganui	109,410	237,624	192,920	87,528	47,348	70,613
Wairarapa	5,258	7,842	1,117	1,405	519	70
Wellington	21,814	33,816	35,112	18,220	8,749	16,705
Tasman / Nelson	49,728	97,318	72,623	56,357	50,469	36,196
Marlborough	19,605	34,083	22,481	16,563	14,263	31,209
West Coast	62,537	44,831	64,232	55,220	53,590	32,791
Canterbury	167,119	248,459	240,348	138,251	57,296	70,135
Otago	121,400	193,375	254,487	139,485	77,380	104,354
Southland	85,505	170,188	269,252	168,170	66,019	83,810
Total	1,807,290	2,708,399	2,966,440	2,036,457	1,370,324	1,813,120

In-forest ground-based cutover residues - gross energy (GJ) per annum, (100% of resource)

	2017	2022	2027	2032	2037	2042
Northland	2,054,323	1,781,777	1,611,660	1,115,543	998,929	1,782,335
Auckland	205,346	540,614	570,302	496,994	255,316	163,019
Waikato	839,184	1,600,339	2,035,034	945,808	731,016	964,650
Bay of Plenty	3,675,871	4,398,045	5,879,236	5,204,520	3,959,650	5,122,722
Gisborne	771,825	1,230,862	1,034,573	559,285	307,935	747,579
Hawkes Bay	413,785	1,512,676	1,239,961	959,404	594,145	616,044
Taranaki	77,570	257,641	144,916	69,731	16,376	37,585
Manawatu-Wanganui	754,928	1,639,608	1,331,151	603,942	326,698	487,229
Wairarapa	36,278	54,111	7,710	9,693	3,579	480
Wellington	150,515	233,327	242,275	125,719	60,369	115,267
Tasman / Nelson	343,125	671,495	501,100	388,860	348,239	249,751
Marlborough	135,278	235,171	155,120	114,288	98,418	215,340
West Coast	431,507	309,336	443,198	381,018	369,768	226,259
Canterbury	1,153,119	1,714,366	1,658,402	953,930	395,345	483,932
Otago	837,662	1,334,285	1,755,957	962,447	533,919	720,045
Southland	589,988	1,174,297	1,857,841	1,160,374	455,534	578,290
Total	12,470,302	18,687,951	20,468,436	14,051,554	9,455,237	12,510,527

In-forest ground-based cutover residues - recoverability level 1 (80% of gross), green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	208,410	180,760	163,502	113,171	101,341	180,817
Auckland	20,832	54,845	57,857	50,420	25,902	16,538
Waikato	85,135	162,353	206,453	95,952	74,161	97,863
Bay of Plenty	372,914	446,179	596,444	527,995	401,704	519,696
Gisborne	78,301	124,870	104,957	56,739	31,240	75,841
Hawkes Bay	41,978	153,460	125,793	97,331	60,276	62,497
Taranaki	7,869	26,138	14,702	7,074	1,661	3,813
Manawatu-Wanganui	76,587	166,337	135,044	61,269	33,143	49,429
Wairarapa	3,680	5,490	782	983	363	49
Wellington	15,270	23,671	24,579	12,754	6,124	11,694
Tasman / Nelson	34,810	68,123	50,836	39,450	35,329	25,337
Marlborough	13,724	23,858	15,737	11,594	9,984	21,846
West Coast	43,776	31,382	44,962	38,654	37,513	22,954
Canterbury	116,983	173,921	168,244	96,775	40,107	49,095
Otago	84,980	135,362	178,141	97,640	54,166	73,048
Southland	59,854	119,132	188,477	117,719	46,214	58,667
Total	1,265,103	1,895,879	2,076,508	1,425,520	959,227	1,269,184

In-forest ground-based cutover residues - recoverability level 1 (80% of gross), energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	1,438,026	1,247,244	1,128,162	780,880	699,250	1,247,635
Auckland	143,743	378,430	399,212	347,896	178,721	114,113
Waikato	587,429	1,120,237	1,424,524	662,066	511,711	675,255
Bay of Plenty	2,573,110	3,078,632	4,115,465	3,643,164	2,771,755	3,585,906
Gisborne	540,277	861,603	724,201	391,499	215,554	523,305
Hawkes Bay	289,649	1,058,873	867,972	671,583	415,902	431,231
Taranaki	54,299	180,349	101,441	48,812	11,463	26,309
Manawatu-Wanganui	528,449	1,147,726	931,806	422,760	228,689	341,060
Wairarapa	25,395	37,878	5,397	6,785	2,505	336
Wellington	105,360	163,329	169,593	88,003	42,258	80,687
Tasman / Nelson	240,187	470,046	350,770	272,202	243,768	174,826
Marlborough	94,694	164,620	108,584	80,002	68,892	150,738
West Coast	302,055	216,535	310,238	266,713	258,838	158,381
Canterbury	807,183	1,200,056	1,160,882	667,751	276,742	338,753
Otago	586,363	933,999	1,229,170	673,713	373,743	504,031
Southland	412,991	822,008	1,300,488	812,261	318,874	404,803
Total	8,729,211	13,081,565	14,327,905	9,836,088	6,618,666	8,757,369

In-forest ground-based cutover residues - recoverability level 2 (65% of gross), green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	166,728	144,608	130,801	90,537	81,072	144,653
Auckland	16,666	43,876	46,285	40,336	20,721	13,231
Waikato	68,108	129,883	165,162	76,761	59,329	78,290
Bay of Plenty	298,332	356,943	477,155	422,396	321,363	415,757
Gisborne	62,641	99,896	83,965	45,391	24,992	60,673
Hawkes Bay	33,583	122,768	100,634	77,865	48,221	49,998
Taranaki	6,295	20,910	11,761	5,659	1,329	3,050
Manawatu-Wanganui	61,270	133,070	108,035	49,016	26,515	39,543
Wairarapa	2,944	4,392	626	787	290	39
Wellington	12,216	18,937	19,663	10,203	4,900	9,355
Tasman / Nelson	27,848	54,498	40,669	31,560	28,263	20,270
Marlborough	10,979	19,086	12,589	9,276	7,988	17,477
West Coast	35,021	25,106	35,970	30,923	30,010	18,363
Canterbury	93,586	139,137	134,595	77,420	32,086	39,276
Otago	67,984	108,290	142,512	78,112	43,333	58,438
Southland	47,883	95,305	150,781	94,175	36,971	46,934
Total	1,012,082	1,516,703	1,661,206	1,140,416	767,382	1,015,347

In-forest ground-based cutover residues - recoverability level 2 (65% of gross), energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	1,150,421	997,795	902,530	624,704	559,400	998,108
Auckland	114,994	302,744	319,369	278,317	142,977	91,291
Waikato	469,943	896,190	1,139,619	529,653	409,369	540,204
Bay of Plenty	2,058,488	2,462,905	3,292,372	2,914,531	2,217,404	2,868,724
Gisborne	432,222	689,283	579,361	313,199	172,443	418,644
Hawkes Bay	231,719	847,099	694,378	537,266	332,721	344,984
Taranaki	43,439	144,279	81,153	39,049	9,170	21,047
Manawatu-Wanganui	422,760	918,181	745,445	338,208	182,951	272,848
Wairarapa	20,316	30,302	4,318	5,428	2,004	269
Wellington	84,288	130,663	135,674	70,403	33,807	64,549
Tasman / Nelson	192,150	376,037	280,616	217,762	195,014	139,861
Marlborough	75,756	131,696	86,867	64,001	55,114	120,590
West Coast	241,644	173,228	248,191	213,370	207,070	126,705
Canterbury	645,747	960,045	928,705	534,201	221,393	271,002
Otago	469,090	747,199	983,336	538,970	298,995	403,225
Southland	330,393	657,606	1,040,391	649,809	255,099	323,843
Total	6,983,369	10,465,252	11,462,324	7,868,870	5,294,933	7,005,895

Appendix 8 - In-forest residues by category; cutover residues hauler sites

In-forest hauler cutover residues - gross green tonnes per annum (100% of resource)

	2017	2022	2027	2032	2037	2042
Northland	74,623	65,898	66,384	38,585	32,462	65,103
Auckland	9,927	26,135	27,570	24,026	12,343	7,881
Waikato	47,223	86,272	108,588	51,580	40,497	56,462
Bay of Plenty	158,204	139,358	189,784	165,681	133,762	195,162
Gisborne	162,402	258,990	217,688	117,681	64,794	157,301
Hawkes Bay	49,251	195,322	149,097	125,834	76,117	82,429
Taranaki	13,222	46,877	24,498	11,229	1,916	6,719
Manawatu-Wanganui	68,763	162,963	123,620	62,297	37,196	43,655
Wairarapa	3,596	4,591	736	834	272	41
Wellington	24,080	37,032	39,765	20,437	10,301	19,124
Tasman / Nelson	122,813	229,439	165,709	145,745	132,508	97,115
Marlborough	41,971	79,099	53,525	41,003	39,204	88,097
West Coast	11,324	6,870	9,902	9,176	8,636	5,972
Canterbury	62,308	99,180	95,588	48,044	22,036	26,984
Otago	69,990	107,050	131,916	72,062	41,635	66,525
Southland	14,234	28,867	46,622	26,116	10,622	13,941
Total	933,930	1,573,943	1,450,993	960,331	664,299	932,511

In-forest hauler cutover residues - gross energy (GJ) per annum, (100% of resource)

	2017	2022	2027	2032	2037	2042
Northland	514,902	454,694	458,052	266,238	223,987	449,214
Auckland	68,497	180,332	190,235	165,781	85,165	54,378
Waikato	325,835	595,275	749,256	355,904	279,426	389,589
Bay of Plenty	1,091,605	961,571	1,309,511	1,143,196	922,955	1,346,617
Gisborne	1,120,575	1,787,029	1,502,047	811,998	447,075	1,085,373
Hawkes Bay	339,831	1,347,725	1,028,773	868,254	525,207	568,763
Taranaki	91,231	323,453	169,037	77,482	13,221	46,359
Manawatu-Wanganui	474,463	1,124,444	852,978	429,848	256,650	301,220
Wairarapa	24,810	31,679	5,080	5,757	1,878	284
Wellington	166,155	255,518	274,380	141,019	71,076	131,953
Tasman / Nelson	847,412	1,583,130	1,143,391	1,005,639	914,304	670,093
Marlborough	289,597	545,786	369,325	282,923	270,506	607,868
West Coast	78,139	47,406	68,321	63,315	59,587	41,208
Canterbury	429,924	684,341	659,558	331,501	152,050	186,192
Otago	482,930	738,644	910,219	497,227	287,284	459,025
Southland	98,214	199,179	321,689	180,202	73,292	96,191
Total	6,444,120	10,860,206	10,011,852	6,626,282	4,583,664	6,434,325

In-forest hauler cutover residues - recoverability level 1 (10% of gross), green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	7,462	6,590	6,638	3,859	3,246	6,510
Auckland	993	2,614	2,757	2,403	1,234	788
Waikato	4,722	8,627	10,859	5,158	4,050	5,646
Bay of Plenty	15,820	13,936	18,978	16,568	13,376	19,516
Gisborne	16,240	25,899	21,769	11,768	6,479	15,730
Hawkes Bay	4,925	19,532	14,910	12,583	7,612	8,243
Taranaki	1,322	4,688	2,450	1,123	192	672
Manawatu-Wanganui	6,876	16,296	12,362	6,230	3,720	4,366
Wairarapa	360	459	74	83	27	4
Wellington	2,408	3,703	3,977	2,044	1,030	1,912
Tasman / Nelson	12,281	22,944	16,571	14,574	13,251	9,711
Marlborough	4,197	7,910	5,353	4,100	3,920	8,810
West Coast	1,132	687	990	918	864	597
Canterbury	6,231	9,918	9,559	4,804	2,204	2,698
Otago	6,999	10,705	13,192	7,206	4,164	6,653
Southland	1,423	2,887	4,662	2,612	1,062	1,394
Total	93,393	157,394	145,099	96,033	66,430	93,251

In-forest hauler cutover residues - recoverability level 1 (80% of gross), energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	51,490	45,469	45,805	26,624	22,399	44,921
Auckland	6,850	18,033	19,023	16,578	8,517	5,438
Waikato	32,584	59,528	74,926	35,590	27,943	38,959
Bay of Plenty	109,160	96,157	130,951	114,320	92,295	134,662
Gisborne	112,057	178,703	150,205	81,200	44,708	108,537
Hawkes Bay	33,983	134,773	102,877	86,825	52,521	56,876
Taranaki	9,123	32,345	16,904	7,748	1,322	4,636
Manawatu-Wanganui	47,446	112,444	85,298	42,985	25,665	30,122
Wairarapa	2,481	3,168	508	576	188	28
Wellington	16,616	25,552	27,438	14,102	7,108	13,195
Tasman / Nelson	84,741	158,313	114,339	100,564	91,430	67,009
Marlborough	28,960	54,579	36,933	28,292	27,051	60,787
West Coast	7,814	4,741	6,832	6,331	5,959	4,121
Canterbury	42,992	68,434	65,956	33,150	15,205	18,619
Otago	48,293	73,864	91,022	49,723	28,728	45,903
Southland	9,821	19,918	32,169	18,020	7,329	9,619
Total	644,412	1,086,021	1,001,185	662,628	458,366	643,433

In-forest hauler cutover residues - recoverability level 2 (5% of gross), green tonnes per annum

	2017	2022	2027	2032	2037	2042
Northland	3,731	3,295	3,319	1,929	1,623	3,255
Auckland	496	1,307	1,379	1,201	617	394
Waikato	2,361	4,314	5,429	2,579	2,025	2,823
Bay of Plenty	7,910	6,968	9,489	8,284	6,688	9,758
Gisborne	8,120	12,949	10,884	5,884	3,240	7,865
Hawkes Bay	2,463	9,766	7,455	6,292	3,806	4,121
Taranaki	661	2,344	1,225	561	96	336
Manawatu-Wanganui	3,438	8,148	6,181	3,115	1,860	2,183
Wairarapa	180	230	37	42	14	2
Wellington	1,204	1,852	1,988	1,022	515	956
Tasman / Nelson	6,141	11,472	8,285	7,287	6,625	4,856
Marlborough	2,099	3,955	2,676	2,050	1,960	4,405
West Coast	566	344	495	459	432	299
Canterbury	3,115	4,959	4,779	2,402	1,102	1,349
Otago	3,499	5,352	6,596	3,603	2,082	3,326
Southland	712	1,443	2,331	1,306	531	697
Total	46,697	78,697	72,550	48,017	33,215	46,626

In-forest hauler cutover residues - recoverability level 2 (65% of gross), energy (GJ) per annum

	2017	2022	2027	2032	2037	2042
Northland	25,745	22,735	22,903	13,312	11,199	22,461
Auckland	3,425	9,017	9,512	8,289	4,258	2,719
Waikato	16,292	29,764	37,463	17,795	13,971	19,479
Bay of Plenty	54,580	48,079	65,476	57,160	46,148	67,331
Gisborne	56,029	89,351	75,102	40,600	22,354	54,269
Hawkes Bay	16,992	67,386	51,439	43,413	26,260	28,438
Taranaki	4,562	16,173	8,452	3,874	661	2,318
Manawatu-Wanganui	23,723	56,222	42,649	21,492	12,832	15,061
Wairarapa	1,240	1,584	254	288	94	14
Wellington	8,308	12,776	13,719	7,051	3,554	6,598
Tasman / Nelson	42,371	79,157	57,170	50,282	45,715	33,505
Marlborough	14,480	27,289	18,466	14,146	13,525	30,393
West Coast	3,907	2,370	3,416	3,166	2,979	2,060
Canterbury	21,496	34,217	32,978	16,575	7,603	9,310
Otago	24,146	36,932	45,511	24,861	14,364	22,951
Southland	4,911	9,959	16,084	9,010	3,665	4,810
Total	322,206	543,010	500,593	331,314	229,183	321,716

Appendix 9 - All residues

All residues - gross tonnage

	2017	2022	2027	2032	2037	2042
Northland	408,698	364,778	281,278	200,066	288,512	391,593
Auckland	209,811	270,317	277,167	249,419	220,704	226,208
Waikato	340,765	518,586	435,890	261,567	278,337	327,991
Bay of Plenty	1,202,080	1,465,286	1,568,685	1,344,848	1,360,819	1,519,422
Gisborne	535,445	601,225	435,477	257,442	302,826	410,293
Hawkes Bay	405,079	564,097	459,418	341,766	277,835	287,566
Taranaki	97,007	110,412	69,242	43,396	37,176	41,678
Manawatu-Wanganui	391,973	484,915	321,004	170,299	147,533	166,009
Wellington	162,326	179,187	153,242	118,171	117,597	131,005
Tasman / Nelson	354,390	403,438	338,508	317,797	272,698	237,394
Marlborough	201,902	216,616	166,222	145,484	185,582	229,734
West Coast	79,424	78,910	85,781	82,233	71,221	59,272
Canterbury	397,333	461,456	373,635	238,156	194,849	207,511
Otago	365,528	479,088	420,312	302,663	285,735	295,224
Southland	174,534	290,610	282,570	183,356	143,240	142,748
Total	5,400,421	6,654,813	5,950,540	4,397,848	4,260,576	4,749,153

All residues - gross energy, GJ per annum

	2017	2022	2027	2032	2037	2042
Northland	2,844,583	2,543,176	1,968,775	1,410,284	2,022,566	2,735,971
Auckland	1,621,738	2,061,865	2,134,758	1,972,313	1,807,035	1,882,208
Waikato	2,576,672	3,821,458	3,270,093	2,088,025	2,226,143	2,592,939
Bay of Plenty	8,317,526	10,135,267	10,850,466	9,307,864	9,420,093	10,516,640
Gisborne	3,698,550	4,152,529	3,008,973	1,780,638	2,093,903	2,835,542
Hawkes Bay	2,840,272	3,938,840	3,217,945	2,407,582	1,967,940	2,036,618
Taranaki	687,493	780,354	496,650	318,694	276,161	307,625
Manawatu-Wanganui	2,713,707	3,355,155	2,224,317	1,184,606	1,027,678	1,155,315
Wellington	1,179,521	1,299,986	1,125,381	888,108	889,191	987,106
Tasman / Nelson	2,483,857	2,822,829	2,375,362	2,233,017	1,922,398	1,679,374
Marlborough	1,416,504	1,519,086	1,172,503	1,030,625	1,308,601	1,614,641
West Coast	550,380	547,063	594,720	570,520	494,836	412,720
Canterbury	2,877,707	3,325,664	2,725,424	1,796,583	1,503,969	1,597,789
Otago	2,559,806	3,346,020	2,943,324	2,134,634	2,021,160	2,090,228
Southland	1,215,762	2,016,794	1,961,418	1,276,947	1,000,252	996,969
Total	38,097,557	46,812,759	42,018,695	31,376,644	30,507,754	33,964,704

All residues - recoverability levels 1; tonnage

	2017	2022	2027	2032	2037	2042
Northland	236,385	207,221	154,680	105,886	162,382	227,588
Auckland	140,630	178,522	183,139	166,381	149,021	152,869
Waikato	175,179	285,957	235,244	127,511	137,402	168,032
Bay of Plenty	822,666	1,006,096	1,073,634	927,947	930,853	1,027,660
Gisborne	271,638	303,006	224,730	141,078	162,152	212,560
Hawkes Bay	218,989	305,203	249,721	185,750	152,210	157,549
Taranaki	55,396	61,658	42,532	30,662	27,468	29,206
Manawatu-Wanganui	216,266	267,234	178,832	95,784	84,931	96,276
Wellington	104,110	112,343	99,482	82,896	82,938	89,878
Tasman / Nelson	152,627	175,679	155,047	151,177	133,097	117,924
Marlborough	119,183	126,708	100,541	89,306	104,096	121,377
West Coast	52,863	52,848	56,999	55,115	48,525	40,913
Canterbury	229,097	264,675	217,398	143,466	119,133	126,406
Otago	215,887	278,218	245,932	192,046	181,959	179,232
Southland	108,028	180,358	174,981	118,363	94,742	92,290
Total	3,178,245	3,938,440	3,618,581	2,726,317	2,631,640	2,900,164

All residues - recoverability levels 1; energy, GJ per annum

	2017	2022	2027	2032	2037	2042
Northland	1,647,112	1,446,935	1,085,528	750,053	1,141,169	1,592,470
Auckland	1,082,341	1,358,294	1,406,563	1,309,517	1,210,771	1,261,143
Waikato	1,353,195	2,128,972	1,791,367	1,061,300	1,143,893	1,370,717
Bay of Plenty	5,691,878	6,958,593	7,425,734	6,421,710	6,443,071	7,112,453
Gisborne	1,877,448	2,093,962	1,553,939	976,823	1,122,316	1,470,217
Hawkes Bay	1,543,609	2,139,422	1,757,557	1,317,153	1,086,752	1,124,650
Taranaki	393,853	437,295	305,566	223,906	202,119	214,364
Manawatu-Wanganui	1,498,108	1,849,879	1,240,003	667,073	592,286	670,667
Wellington	756,526	815,979	730,064	618,636	622,164	673,507
Tasman / Nelson	1,079,115	1,238,544	1,096,564	1,070,248	945,882	841,592
Marlborough	839,695	892,346	712,563	635,869	738,798	858,980
West Coast	725,200	739,475	783,053	785,571	756,212	720,420
Canterbury	1,309,162	1,543,946	1,206,630	684,978	505,142	542,944
Otago	1,514,810	1,946,609	1,725,695	1,355,876	1,288,428	1,271,932
Southland	752,737	1,251,882	1,214,849	824,255	661,336	644,484
Total	22,473,955	27,757,854	25,592,919	19,482,305	18,879,370	20,787,322

All residues - recoverability levels 2; tonnage

	2017	2022	2027	2032	2037	2042
Northland	176,845	153,529	111,656	72,895	117,925	169,858
Auckland	113,095	142,951	146,284	132,563	118,307	120,866
Waikato	120,647	208,603	167,996	81,965	89,493	113,528
Bay of Plenty	679,720	826,837	880,758	764,446	766,362	843,282
Gisborne	217,373	241,828	180,863	115,745	132,128	171,359
Hawkes Bay	169,195	237,143	193,483	143,039	116,664	120,870
Taranaki	45,749	50,611	35,740	26,523	24,012	25,328
Manawatu-Wanganui	171,953	212,138	142,539	77,047	68,591	77,604
Wellington	87,529	93,902	83,784	70,805	70,790	76,161
Tasman / Nelson	119,031	136,983	121,700	119,164	105,314	93,595
Marlborough	97,421	103,328	82,723	73,838	85,036	98,219
West Coast	43,210	43,208	46,494	45,025	39,813	33,755
Canterbury	178,112	206,076	168,838	110,607	91,348	97,003
Otago	173,662	222,708	197,208	155,555	147,540	144,753
Southland	83,315	140,772	136,453	91,901	73,265	71,141
Total	2,525,037	3,128,448	2,879,889	2,172,885	2,095,931	2,306,399

All residues - recoverability levels 2; energy (GJ per annum)

	2017	2022	2027	2032	2037	2042
Northland	1,232,376	1,072,286	784,213	517,667	829,340	1,188,720
Auckland	864,536	1,081,425	1,116,732	1,035,999	953,416	988,940
Waikato	940,874	1,556,329	1,285,374	701,727	764,433	941,890
Bay of Plenty	4,701,880	5,717,781	6,090,685	5,289,049	5,303,256	5,835,066
Gisborne	1,502,420	1,671,224	1,250,623	801,374	914,487	1,185,253
Hawkes Bay	1,193,021	1,662,588	1,362,079	1,014,781	833,592	863,432
Taranaki	324,385	358,110	255,682	192,266	175,125	184,397
Manawatu-Wanganui	1,190,890	1,468,245	988,081	536,263	477,993	540,254
Wellington	632,613	678,563	610,871	523,580	525,906	565,557
Tasman / Nelson	841,215	965,372	860,207	843,007	747,745	667,189
Marlborough	685,947	727,264	585,686	525,011	602,955	694,638
West Coast	568,479	579,251	613,130	614,628	590,750	561,496
Canterbury	1,025,337	1,210,262	944,990	534,557	392,715	422,452
Otago	1,217,497	1,557,213	1,382,658	1,096,761	1,043,077	1,025,593
Southland	580,383	976,883	947,133	639,774	511,243	496,638
Total	17,834,300	22,026,818	20,343,404	15,499,656	15,006,498	16,500,148