IS Kawerau – Biomass Residues Background Study

1. Background

Central North Island (CNI) forests provide approximately 45% of New Zealand's forest harvest, producing large quantities of biomass residues from forest harvesting and downstream wood processing facilities. These residues, along with municipal wood waste could provide considerable value if utilised effectively as inputs for suitable industrial operations.

Wood processing residues are often used by the processing facilities to produce energy for process heat or kiln drying, with the utilisation of this by-product helping to improve the economic viability of production [1]. Using wood processing residues in this manner also provides a cost effective alternative to land filling waste streams. Depending on the type of residue (harvest or processing) and its location; with cost effective transport and further preparation, these residues may potentially be used to manufacture increasingly higher value bio-derived products such as bio-fuels.

The biomass residue opportunity in Kawerau can be further enhanced through the replacement of wood processing residues with geothermal to produce energy for process heat and/or electricity. By doing so, processors can gain a cost effective base-load renewable energy source while conserving residues for higher value uses. This displacement suggests that residues will be of greater value to processors, either through sale to a third party or internal manufacturing of bio-derived products, than the cost of the replacement energy source.

Residue volumes are dependent on a range of external and economic factors. When international demand for forestry products is high, harvest residues will typically be plentiful due to larger harvest volumes. Domestic processing residues on the other hand depend more on an individual processor's ability to compete financially for raw logs, as well as factors like exchange rates for the export of end product. Between 2008 and 2011, the proportion of the CNI harvest processed in-region reduced from above 70% to 60%, with the difference being exported as raw logs. This demonstrates a difficult environment for domestic processors and impacts on the availability of processing residues.

2. Residues from forestry harvesting

Residues from forestry harvesting (logging) are the remnants of trees that remain after harvest. These are considered to have no realisable value in traditional forestry markets and include short sections of stem wood, bark, branches and needles. Composition varies on the location of residues and also with regard to region, forest type, terrain and harvesting methodology. Residues offer a significant and available resource without the need for new planting or use of additional land.

The volume of harvest residues can be estimated as a proportion of harvest volume and is based on typical scenarios for waste products created from various harvesting methods. Residues are typically left at two locations.

- Logging landings. Where tree stems are cut into log lengths based on log quality and price. Sections of waste created during this process include the off cuts from the base, tip and midsections, and average 4% to 6% of the extracted volume [2]. Logging landings tend to be developed at a ratio of one landing per 10-12 hectares of forest [3].
- At the tree stump (cutover). When large trees are felled they often break at approximately two-thirds to three-quarters of the tree height when hitting the ground. Broken sections are often small, of low value and are left on the cutover. Residue volumes can vary from 70-100 m^3 per hectare and can be categorised with regard to accessibility - those on flat-to-rolling terrain (ground-based harvest) and those on steep terrain (hauler logging) [2].

The greatest differences between landing and cutover residues are the cost to access and extract them, along with their composition. Landing residues are mostly stem wood with 10-30% branches, while cutover residues are typically 50-70% branches [2]. Logging landing residues are the least costly to recover due to being situated at either the road side or road end, and being made up of predominantly solid wood [2].

While cutover residues on flat to rolling terrain are estimated at 70–100 m³ per hectare, recoverable residues are estimated at 50 m³ per hectare [2], around 70% of the lower end of the band. Recovery of these residues is more expensive than landing residues due to the need to access and extract them to roadside. Steep terrain is more difficult from which to recover residues, as such those at landings and on rolling terrain are the only residues considered realistically available [2].

2.1 Central North Island Forests residues

Scion Research's (Scion) 'Logging Residues – Situation Analysis' study completed in 2007 projected that CNI harvests for the years 2011 to 2015 would be approximately 11.2 million m³ per annum, as shown in Figure 1. The CNI harvest for the year to March 2011 was 11.14 million m³ [4], showing an accurate projection. Although both the national and CNI harvests are currently trending upwards, it is thought more prudent to use the figure of 11.2 million m³ when estimating available harvest residues throughout this period. Beyond 2015 it is difficult to estimate the potential harvest, but it is commonly thought there will be an increasing available harvest through until about 2030, due to the large amount of planting that took place in the 1990s.

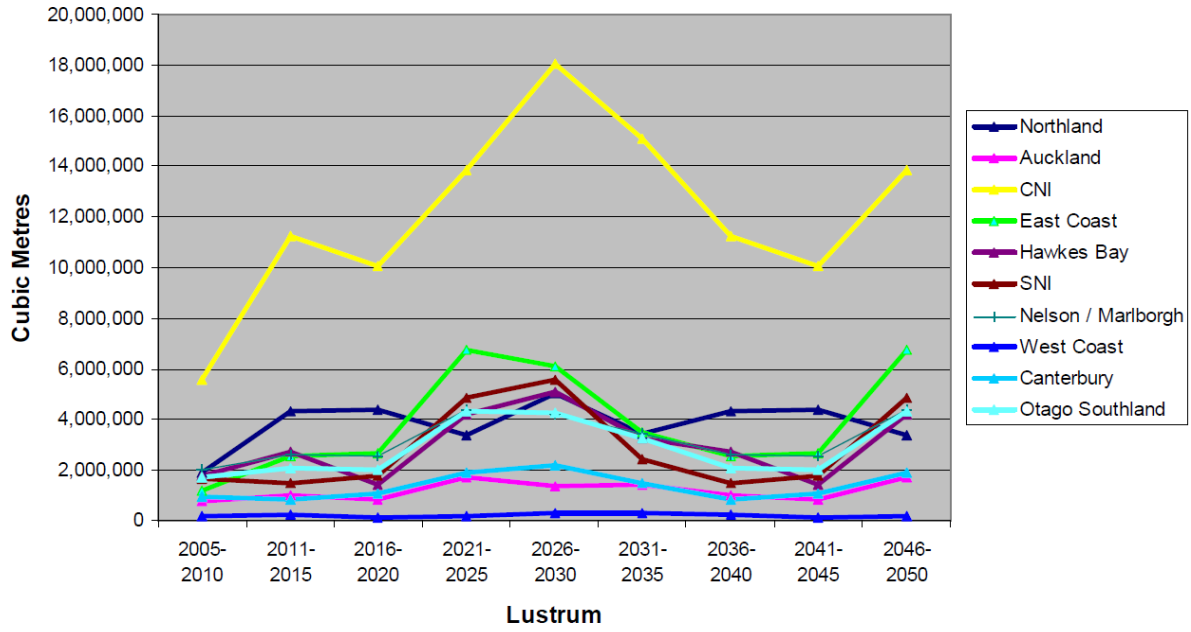

Figure 1: Regional Wood Supply projections by Scion 2007 [2]

There are of course many harvesting scenarios, with Scion's 2007 projections in Figure 1 displaying a severe peak in CNI harvests of approximately 18 million m³ per annum for the years 2026-2030. An alternative scenario is that the CNI harvest will increase to about 12 million m³ per annum by 2021 [5] and then remain fairly constant through to 2034. This is displayed in Figure 2.

Either way, the CNI region is forecast to provide New Zealand's largest supply of uncommitted forest harvest over the next 30 years, and in reality the market forces that drive harvest intentions are likely to have the greatest impact on future harvest levels. It should be noted that at current growth rates, the 2021 harvest forecast of 12 million m³ could be met well before then.

Significant afforestation over the past four decades has increased the size of New Zealand's forest estate to 1.8 million hectares [2], and it is thought this could more than double by 2035 with an estimated 3 million hectares of low productivity land better suited to trees than their current use [2]. With an increased base supply there will be further options for residue use.

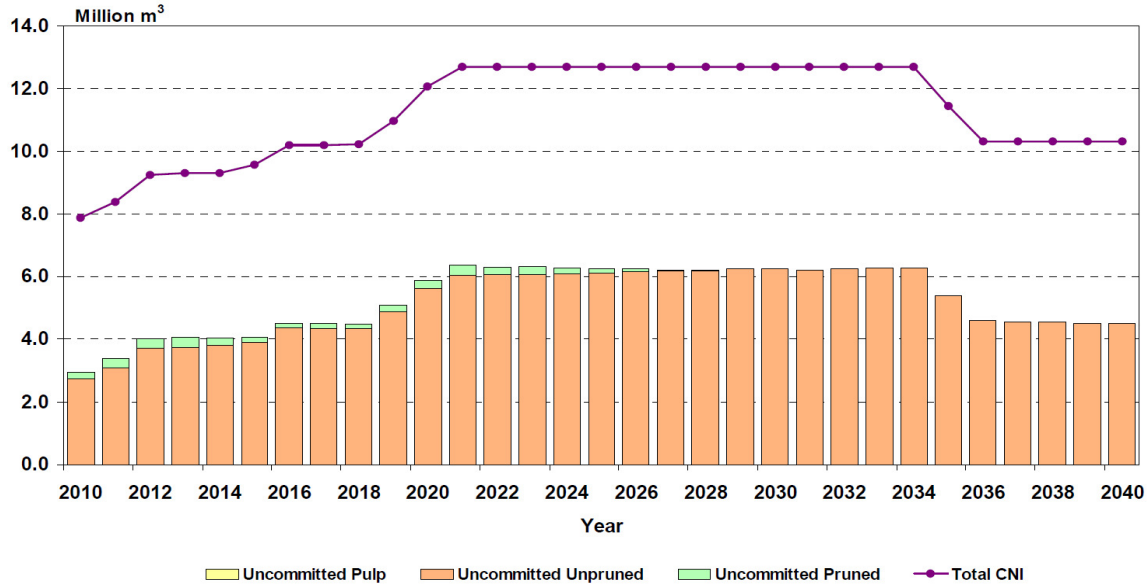

Figure 2: CNI Forecasts – Harvest & uncommitted log availability [6]

Residues follow the same pattern as harvest and become more prevalent with a greater demand for forestry products. Due to this the CNI region will continue to dominate New Zealand's future forest residue resource. Being a large, highly concentrated forest with a well developed road network also allows for greater cost efficiencies in transport when compared to other New Zealand forest regions.

The volume of residues available from logging in the CNI is significant and likely to increase with larger future harvests. Conversion factors relating to the CNI harvest between 2011 and 2015 have been estimated at: [2]

- Landing residues: 5.00% of harvest
- Ground-based cutover residues: 5.36% of harvest

This relates to total recoverable residues, not total residues. Based on the CNI harvest of 11.14 million m^3 for the year ended March 2011, landing residues would equate to 557,000 m^3 and ground-based cutover residues 597,100 m^3 - a total of approximately 1.154 million m^3 of available and recoverable residues. The figures from Scion's logging residues study suggested a harvest of 11.216 million m^3 pa for 2011 to 2015, with landing residues of 560,813 m^3 and ground-based cutover residues of 601,266 m^3 – a total of 1,162 million m^3 [2].

Regarding yield for potential bio-fuels manufacture, Scion anticipated that for each cubic metre of biomass approximately 130-140 litres of ethanol or 95-100 litres of Fischer-Tropsch diesel could be produced [7].

With growing international demand for forestry products, driven in particular by China's appetite for raw logs, New Zealand's harvest has experienced its 10th consecutive quarter of annualised growth. This demonstrates a harvest trending upwards, which if continued will mean greater levels of logging residues. And while it is possible to predict the amount of residues produced at a regional or even forest level, there will be site by site variations. Factors that affect residue production include: [2]

- quality of the stand being harvested
- logging system used

- log making system used
- ability of log maker (human variability)
- log grade cutting strategy (determined by current market)

Delivered costs of residues will vary significantly from site to site within the CNI and of course there are some barriers to increased residue recovery. Firstly, it will not be economically viable to extract and transport the whole of the CNI's residues to Kawerau for processing. Transport contributes at least one quarter of the cost of delivered residues, and at longer haul distances it is likely to be over 40% [2]. Careful planning is required to minimise transport distances and an accurate understanding of residue location and quantity is crucial to maximising efficiencies. GIS systems can be used to model costs for residue supply to selected destinations and to continuously improve the accuracy and understanding of residues from harvest. Trucks and transport equipment specifically designed for residue extraction and transport could also reduce transport costs [2].

Secondly, security of supply of residues will have a large bearing on the willingness of a potential user to invest in specialised plant for residue processing. As a by-product of harvesting, residue levels will fluctuate with market demand for logs, so large-scale investment in plants dependent on residues to manufacture higher value bio-derived products will need a base level of secured or contracted supply. The industry move away from vertical integration, which was prevalent in the 1990s, means that owners of individual assets are focused on maximising profits from these assets, rather than the full utilisation of all available resources. This can impact on downstream players.

2.2 Kawerau specific residues

In April 2010 Scion completed the report 'Volume and cost analysis of large scale woody biomass supply' for the New Zealand Parliamentary Commissioner for the Environment. This report was based on the availability of biomass relevant to two locations:

- Mataura in the south of the South Island
- Kawerau in the CNI

Although the costs are now close to two years old, thus not relevant to this specification, there is still strong Kawerau-centric information available. The analysis included residues and logs, with potential supply volumes projected for the years 2015, 2020, 2025, 2030, 2035 and 2040 at cost limits of $40, $60 and $85 per m^3 [7]. Maximum transport distances for these cost limits were reached at 80, 240 and 250km respectively [7], which limits the potential of harnessing all available residues cost effectively. The majority of potential resources relevant to Kawerau in this study were based within the Bay of Plenty region, rather than the resource of all CNI forests as described above. However, the potential use of the various biomass residues will depend on the end value of the processed product, manufacturing costs and the margins needed to show a satisfactory return on investment.

As stated, the costs are no longer relevant but the limits themselves do typically represent the type of biomass resource; being either residues, lower grade logs or higher grade logs, with additional costs in each resource stream reflecting the distance and cost of transport to Kawerau. All biomass resources available in the area were considered available for the purposes of the study.

Volumes at the lowest cost limit were mainly landing and cutover residues, with a maximum transport distance of 80km. Available volumes were estimated at 164,000 m^3 in 2015, rising to 255,000 m^3 in 2030, and then decreasing between 2035 and 2040 – following the harvesting trend depicted in Figure 3. Without a formal market for residues it is assumed that costs would be the same or similar today as at early 2010 when the report was written. The real variables in cost would relate to differences in extraction and transport, mainly around the cost of labour, fuel and equipment.

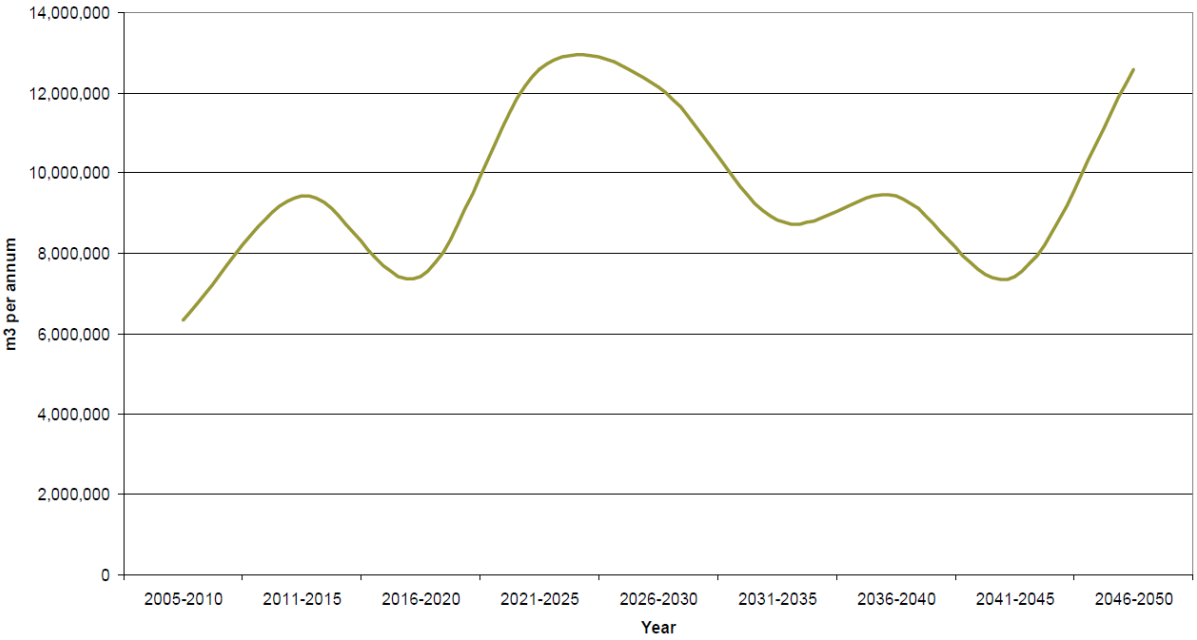

Figure 3: Recoverable log volume for the Bay of Plenty [7]

At the middle cost limit, large volumes of pulp logs become available and the maximum transport distance extends to 240km. Total biomass availability increases to 1.435 million m³ in 2015, peaking at 2.45 million m³ in 2025.

At the upper cost limit, higher grade logs become available and volumes are limited by the cost of transporting the various types of biomass to Kawerau. The maximum transport distance increases slightly to 250km, while the addition of higher grade logs increases potential volume to 4.72 million m³ in 2015. This increases to a peak of 8.97 million m³ in 2025.

Due to the age profile of the forests, supply volume is expected to peak between 2025 and 2030. However, variations in market demand combined with the flexibility of harvesting periods may help smooth the peaks and troughs shown in Figure 3.

With a harvest timeline of 26 to 32 years for radiata pine, the maintenance of peak volumes post this period would require new plantings, contributing to afforestation. Any new radiata pine plantings between 2012 and 2015 will not be available to harvest until 2038 at the earliest – indicating that if harvest trends in Figure 3 eventuate there will be a drop off in biomass availability post the 2025-2030 peak. Research into short rotation crops for energy has also been undertaken. With rotations of 3-5 years for short rotation coppice (SRC) and 12-16 years for short rotation forests (SRF), these may have the potential to supplement biomass availability from traditional forestry and also smooth out supply beyond the envisaged peak.

Potential costs have changed since this study was completed and while available biomass volumes will follow the harvest trend, the cost of residues, extraction and transportation will likely fluctuate over the next several decades. As such, the amount of biomass available will remain the same as predicted; but in a climate of rising fuel and labour costs either a greater cubic metre cost will be incurred to exploit the same level of biomass at previous cost limits, or if cubic metre costs are to remain constant a smaller proportion of biomass will become available at each limit. To this end, an update of the Scion study as it relates specifically to Kawerau would be worthwhile.

3. Residues from wood processing

Wood processing activities occur across New Zealand, but as with the forest estate there is a large concentration of processing activities in the CNI, ranging from pulp and paper mills to panel plants and saw mills. Unlike forestry planting and harvesting information, which is monitored and recorded by the Ministry of Agriculture and Forestry (MAF), it is difficult to gain an understanding of the quantities and flows of wood processing residues. The quantity of logs processed domestically not only depends on the size of the harvest, but also on the price and competition for raw logs.

With increasing demand for logs we can assume the harvest will increase, producing greater levels of landing and cutover residues. However, as seen in the period between 2009 and 2012, increased international demand for raw logs decreased the proportion of the harvest processed domestically, affecting the level of processing residues available for further use. On top of this, processing information may often be commercially sensitive, variable due to industry fluctuations and/or inaccurately recorded [8].

As stated, the CNI has the largest concentration of wood processing facilities in the country, making the largest contribution to processing residues. Kawerau itself has five major processing facilities:

- Norske Skog Tasman – Pulp and paper
- SCA Hygiene Australasia – Tissue, paper towels and hygiene products
- CHH Tasman – Bleached and unbleached kraft pulp
- CHH Woodproducts New Zealand – Structural timber
- Sequal Lumber – Dimensional timber

These facilities produce and consume a range of their own and other facilities processing residues, depending on the inputs to their industrial processes and their propensity to use residues as a fuel to create electricity and/or heat.

In the year to March 2011 the CNI produced 1.7 million m^3 of sawn timber, or 42.8% of national production [4]. At a conversion factor of 1.81 or yield percentage of 55% [4] total raw inputs would have been in the vicinity of 3.08 million m^3 – providing residues of around 1.38 million m^3. These figures relate to the CNI as a whole. It is very difficult to estimate the levels of residues available from individual facilities, what these residues are used for, what quantities may be available for higher value uses and at what price. This level of understanding would take in-depth research and contribution from individual processors in an ongoing capacity to capture the change in market conditions and end uses.

Sawmills produce the majority of available residues [8]. A two year study completed by Scion in 2007 indicated that of the 45% of raw logs that end up as sawmill residue, in the CNI approximately 32% are chips, 9% sawdust, 3% bark and 1% shavings [8]. Pulp mills are a large user of sawmill chip and much of the available supply relevant to Kawerau is spoken for by Norske Skog Tasman and CHH Tasman.

As stated previously, much of the historic use of wood processing residues has been to generate energy. This has been adopted by numerous processors to offset or displace the cost of generating energy through other fuels and/or limit the cost of dumping residues in landfill. With high levels of geothermal energy available at Kawerau, there has been an increasing replacement of wood fibre and other fuels with geothermal for energy. Further adoption of geothermal energy by wood processing facilities will increase the level of wood processing residues available for other uses, which could become an important localised resource for further development of high value bio-derived products.

References

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June 2012
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