WoodScape Study – Summary Report

February, 2013

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REPORT INFORMATION SHEET

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WoodScape
Mapping the future for New Zealand's forest products

woodco
WOOD COUNCIL OF NZ INC

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EXECUTIVE SUMMARY

The Woodco strategy aims to increase the volume of wood processing in New Zealand; doubling exports to $12 billion by 2022. The WoodScape study was commissioned by Woodco to identify pathways forward for the sector to realise the aims of its strategy.

WoodScape is a national-level financial modelling analysis and market review to assess the potential of a range of traditional and emerging wood processing technologies. The key results of the study are summarised in this report.

Increased wood processing has a key role in New Zealand's economic growth
WoodScape found that most wood processing options can make a significant contribution to GDP. A number of the options also look attractive for investment, based on their return on capital (>20%), cash flow and the market opportunity for their products. Several wood-processing options show a labour productivity greater than $200 per hour of employment, comparable to the highest performing sectors of the economy.

The Way Forward: *Compete*
There are limited growth opportunities for some of the traditional primary processing options. Establishing a new sawmill in New Zealand needs to cope with domestic markets being fully supplied and current export prices giving low or negative returns. Many New Zealand wood processors are small scale, and have limited funds for export market development. There is a need for a collaborative approach to market intelligence and development work, potentially in partnership with government. Primary solid wood processing is a vital component of the wood processing sector because many other processing options rely on their residues for their input feedstock. Without profitable primary processing of high quality logs the supply of feedstock for manufacturers who use residues is at risk. To realise the Woodco strategy and benefit the economy from greater wood processing, New Zealand needs to markedly increase the global competitiveness of sawmilling operations. WoodScape identified three critical areas for improvement:

- increase the value of New Zealand products in export markets
- increase the scale of processing plant to take advantage of economies of scale
- increase productivity through capital investment

The Way Forward: *Transform*
The current forest sector exports approximately half of its harvest as unprocessed logs. In order to realise the Woodco strategy greater onshore processing of these logs is required. The majority of these logs are A and K grade of lower quality than S grade sawlogs but superior to pulp logs. These large volumes of knotty logs are a significant issue as there are currently very limited options for profitable processing of this material. To achieve significantly greater on-shore processing requires two approaches:

- a focus on implementing processing technologies that can utilise K and A grade logs such as industrial plywood
- where profitable relocate overseas processing of log exports (a significant proportion of which is used for industrial plywood) back to New Zealand.

The Way Forward: *Innovate*
A substantial section of the current wood processing industry is not adding much value to its inputs with a value-add ratio of less than 3. In contrast, for many of the emerging wood processing technologies, this ratio is around 4 to 6. WoodScape identified two promising areas showing solid returns (above 10%) and potential to add value. These are:

- engineered wood products

- fuels and chemicals.

Fuel and chemical processing options rely on residues from primary processing. The focus for New Zealand forest product stakeholders in this area should be: reducing technical risk, improving the competitiveness of the facilities, developing new higher-value products and opening up new markets. This requires strong partnerships between research and industry.

Address Global Risks
Supplying international markets exposes New Zealand companies to higher market risks than the domestic market. The most significant risks that need to be addressed are: foreign exchange (a 15% change in the US exchange rate can shift return on capital employed by up to 10% for some technologies) and market knowledge. Market knowledge would include identifying potential competitors in and into potential export markets.

The implications of these key messages for Woodco's strategy are summarised in table 1.

	Markets and Products	**High-value Processing and Manufacturing**	**Research and Innovation**	**Operating Environment**
Compete Issue: Limited export options for sawmills	Identify export market opportunities that value New Zealand products Diversify markets and products	Increase scale and capital productivity	Understand and exploit international markets	Collaborative marketing strategy Primary solid wood processing is a vital component – a more integrated approach required
Transform Issue: Large volume of K and A grade log exports	Relocate overseas processing of NZ export logs (70% industrial plywood) to New Zealand Understand overseas final end user needs and consumer trends Implement technologies that can process K and A grade logs		Develop and / or find new technologies that can process K and A grade logs	Onshore processing - greater GDP impact than log exports Mitigate exchange rate risks
Innovate Opportunity: High value-add from emerging technologies	Diversify into new markets for engineered wood products Understand the chemical industry markets for fuels and chemicals (establish partnerships)	Engineered wood products Fuels and chemicals	Reduce technical risk and improve competiveness Investigate fibre-focused forestry regimes Reduce need for large scale	High GDP impact and labour productivity Fuel and chemicals rely on residues from primary processing

Table 1: Key results from the WoodScape Study and their relation to the Woodco Strategic Action Plan (SAP). Row headings correspond to the three themes of the WoodScape study, column headings to those of the SAP.

Next Steps

The areas identified for further work (and parties best placed to lead this work) using the WoodScape financial model include:

1. Interested companies and investors exploring site specific wood processing options – Scion/individual companies.
2. Undertaking a comprehensive study of options for K & A grades – Woodco led.
3. Undertake further analysis of fuel and chemical options to validate the opportunity and look at more technology options – Scion led.
4. Alternative approaches to sawmilling –make sawmilling sustainably profitable –Woodco led.
5. Investigate the benefits of integrated industrial clusters of primary solid wood processing with residues going to secondary or reconstituted products processing – individual companies/regional councils.

WoodScape Study – Summary Report

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Strategic Context

The Wood Council of New Zealand (Woodco) has developed a Strategic Action Plan for the New Zealand forest and wood processing industry. The aspirational vision of this plan is to significantly increase the volume of wood processing in New Zealand, resulting in doubling the value of exports from the forestry sector to around $12 billion by 2022. This vision is based on profitably processing more of the current and future log harvest onshore and developing new products and building systems.

The WoodScape study is aimed at informing the Woodco strategy by identifying pathways forward for the sector. WoodScape assesses the economics of different wood processing technologies taking into account markets and the forest resource.

WoodScape Study Overview

The WoodScape study is a national level analysis of wood processing options. It takes a financial modelling and market review approach to assess the potential of a range of traditional and emerging technologies. The primary metric used for assessing financial performance was Return on Capital Employed (ROCE). This metric reflects how attractive to investment the technology is. In addition to ROCE, another metric is: Earnings Before Interest, Tax, Depreciation and Amortisation (EBITDA) per oven dry tonne (ODT) of input feedstock - a measure of cash flow. Other considerations were technical readiness of the process and the market opportunity for the product.

This study also included macro- and socio-economic metrics such as GDP and employment. An analysis of the markets for existing and new products and an analysis of some selected New Zealand regional wood processing options were considered.

The methodology used was developed in the Canadian BioPathways study. This approach was adapted to New Zealand’s forest resource, economic environment and export markets.

The study was contracted by Woodco to Scion and governed through a Woodco appointed board. It was funded by the Wood Processors Association (WPA), Pine Manufacturers Association (PMA), New Zealand Forest Owners Association (NZFOA), Ministry for Primary Industries (MPI), New Zealand Trade and Enterprise (NZTE), and Scion.

The study was carried out by a team from Scion and FPInnovations. Indufor contributed to the market analysis. The study team was guided by a Technical Working Group made up of industry and government experts, who provided both data and information and a detailed review as the study progressed. Workshops were held in the five wood supply regions studied: Northland, Central North Island, East Coast, Nelson/Marlborough and Otago/Southland, to obtain input and feedback from forest growers, wood processors and regional councils.

The outputs are three reports, a summary presentation and the WoodScape model. The current report provides a summary of the key results of the study for Woodco’s strategy. Other reports include:

- WoodScape Study - Technology and Markets: a detailed description of the individual technologies and markets for their products.
- WoodScape Study – Regional Wood Processing Options: an analysis of wood processing opportunities in five regions throughout New Zealand.

- WoodScape Study – summary presentation (Powerpoint).

An important outcome of the study was the WoodScape model which can now be offered by Scion on a commercial basis to work with individuals, companies, regional councils, Iwi and investors to provide more site-specific assessments of wood processing technologies or groups of technologies.

Technologies

The study considered a comprehensive, but not exhaustive, list of 39 different wood processing technologies (expanded to 63 options when plant size variations are included). The technologies covered a wide range of potential wood processing options including:

- sawmilling
- engineered wood products, e.g. laminated veneer lumber
- secondary wood products, e.g. remanufacturing
- pulp and paper
- heat and power and
- fuels and chemicals.

Eighteen traditional and 21 emerging technologies were included in the study. “Traditional” technologies were defined as technologies for which plant could be purchased today, and “Emerging” technologies as first of a kind. The cut off point for including emerging technologies was that they had to be at least at pilot scale stage. More details on the technologies included in the study can be found in the WoodScape Technology and Markets report.

Reliability of data differed significantly for traditional and emerging technologies. Traditional technologies had the most reliable New Zealand-specific data and review by industry experts. Some data for emerging technologies were based on a single pilot plant or were provided by a developer. Due to this difference in input data the likely error range of the results is greater for the emerging technologies than for the traditional ones.

Some technologies of interest could not be included in WoodScape due to a lack of data. There is potential to add to the list of technologies in the WoodScape model for future analysis.

WoodScape Model

The process used to develop the financial model in this study (the WoodScape model) is summarised in figure 1. With assistance from the technical working group (TWG), the team developed a short-list of wood processing technologies relevant to New Zealand. Financial models of these technologies were created based on a wide range of data sources. Data for the technologies, such as capital and operating costs, came from a variety of sources including contributions from approximately 20 industry participants and technology suppliers.

Market prices were from a variety of public and private sources, including a commissioned report by Indufor[1]. The technology data sheets and results were put through a rigorous review process by the team, the TWG, technology suppliers and industry participants. Data sheets and results were presented at five regional workshops throughout New Zealand.

[1] http://www.indufor.fi/

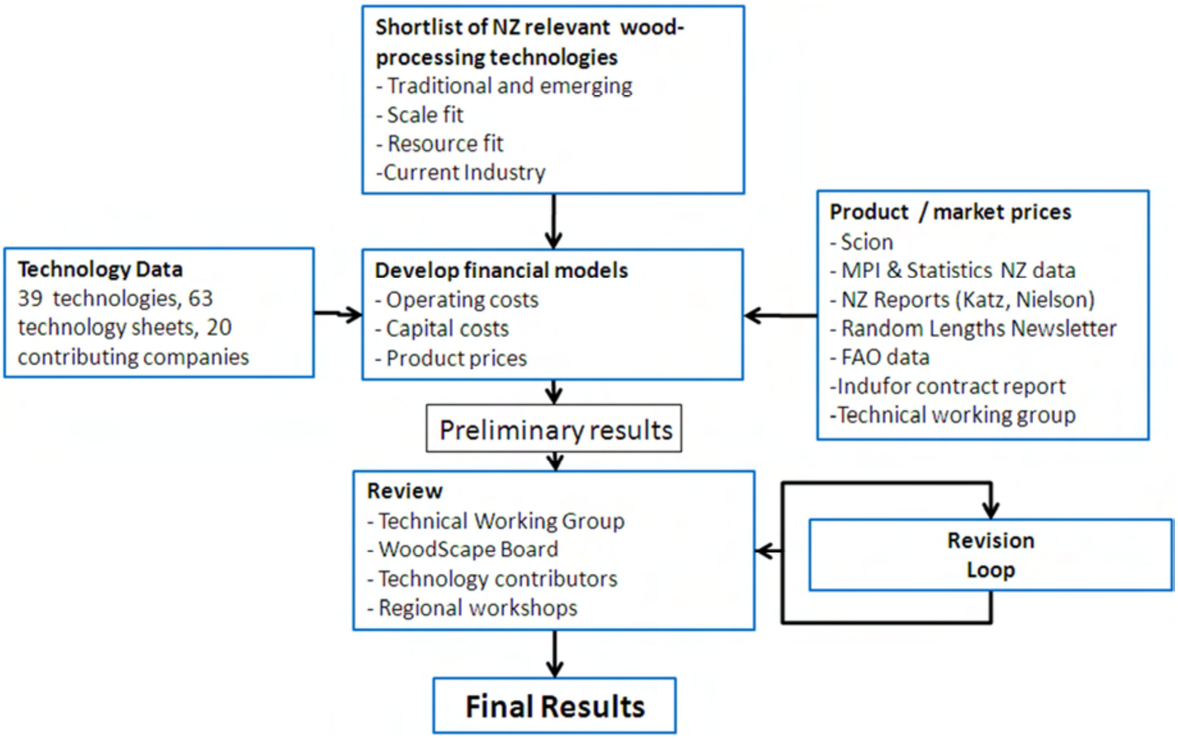

Figure 1: WoodScape model development process. (**FAO** = Food and Agriculture Organisation).

The fundamental assumptions underlying the WoodScape modelling approach were:

- markets are available for all products produced (100% operating rate)
- feedstock to the technology is appropriate to the process (7 different categories of feedstock were considered)
- capital costs assumed new plant built in New Zealand (there were also two retrofit options; dissolving pulp at a Kraft mill, wood fibre plastic (WFP) composites at a MDF mill)
- product prices and imported consumables were linked to the USD

The key assumptions behind the base case were:

- product prices were based on annualised 2012 figures (Indufor report, Random lengths Newsletter, FOA, TWG, MPI/NZ Stats)
- the exchange rate was set at 1NZD = 0.82 USD
- log prices were based on Agrifax 2012 annual average.
- energy prices - MED Energy Data File (commercial and Industrial averages for 2011)

Note that some of the data provided by the wood processing industry to enable this study was confidential and only high level summary data is able to be presented. Detailed reporting of all of the cost inputs and product prices is not possible due to commercial sensitivity and protection of confidential information.

The WoodScape model was used to generate financial and socio-economic metrics for the technologies. It was also used to test the sensitivity of the results to changes in product price, feedstock price, energy prices, capital, foreign exchange rates and labour. The sensitivity analysis highlighted areas where the results depended strongly on input assumptions.

Wood processing metrics were modelled on the assumption that the feedstock going into the technology will be appropriate to their process. Seven categories of feedstock were analysed, each with different costs. Most technologies are sensitive to feedstock costs, and supply of the appropriate log grade or residue feedstock at an average 2012 price is assumed in the base case analysis. The log and residue prices assumed in the base case are in Appendix A.

ROCE was the principal measure used to rank the performance of the technologies. The ROCE required to make an investment attractive will vary with the degree of risk (technology, market and product price) associated with each one. An absolute minimum would be 4% as this is the risk free rate of return available on investments in New Zealand (http://www.treasury.govt.nz). This study is based on the assumption of a new plant and the reported ROCEs do not reflect the earnings of existing wood processing plants. The results of this financial modelling were combined with a separate market analysis (which included a broad market analysis carried out by Indufor) and forest resource analysis, and used to develop the conclusions of this report.

Wood processing investment decisions are inherently complex. They take into consideration a wide range of issues such as; market factors (price, demand, competition, future trends), wood quality, log grades, volumes available over time, supply and sale of processing residues, economic scale, and process specific economics. The information provided in this report serves as a high-level assessment guide and starting point for detailed due diligence of specific investment options.

Forest Resources

Wood supply assumptions in the model are based off Ministry for Primary Industries (Formerly Ministry of Agriculture and Forestry) National Exotic Forest Description (2012) and relevant regional wood supply forecasts (2007, 2008 and 2009). Nationally and regionally there is increasing wood supply. Processing capacity does not exist to take all of the current supply. As the wood supply increases and decreases over time based on the age class distribution of the crop, a long term estimate of a realistic increase in processed volume was made for each region. This analysis suggests a processing opportunity of 8 million tonnes across the five regions studied, rising to 12 million tonnes by 2040.

Increased Wood Processing has a Key Role in New Zealand's Economic Growth

The central aim of the Woodco strategy is to significantly increase the amount of domestic wood processing to add value to the large volume of log exports from the forestry sector (Woodco, 2012). This strategy has significant benefits for the New Zealand economy. Figure 2a shows the average of the direct GDP per oven dry tonne (ODT) of the processing technology categories in the model in comparison to the GDP for log exports. The direct GDP contribution (which is a measure of value added) was calculated for each technology based on EBITDA and salary and wages. Figure 2a shows the value added from more wood processing to the New Zealand economy over and above log exports[2]. Note that the log export market currently plays an important role in New Zealand forestry providing an outlet for grades not consumed in New Zealand and providing an outlet for fluctuations in wood availability.

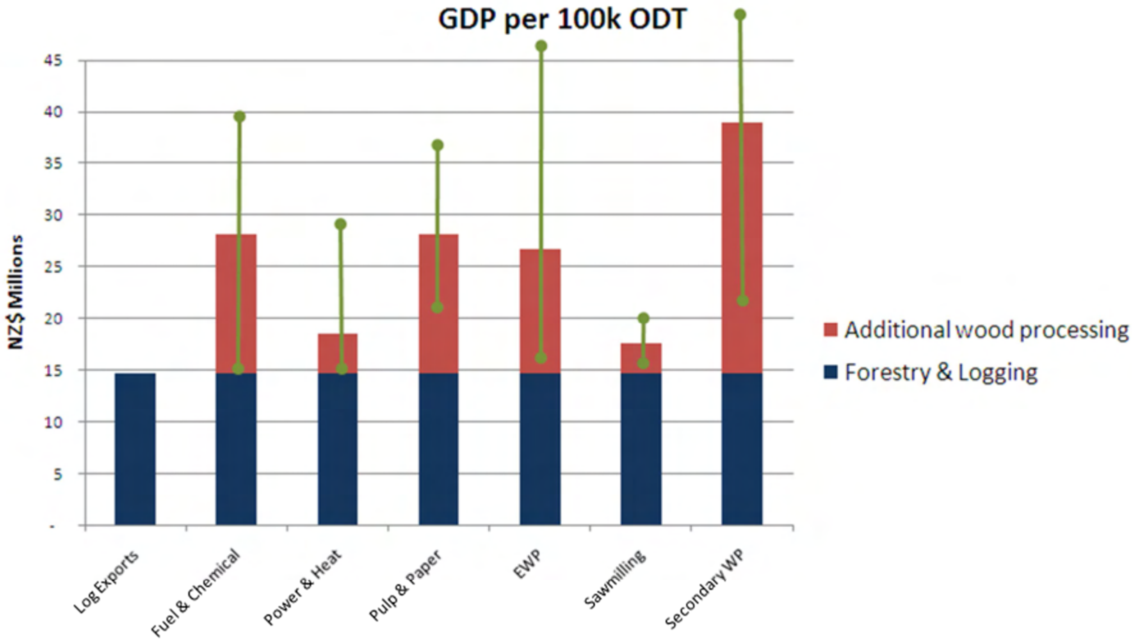

Figure 2a: Average direct Gross Domestic Product **(**GDP) per 100,000 oven dry tonne (ODT) of log input for different categories of wood processing options in comparison to log exports. The range of results within the category averages is shown with the green bars.

In contrast to direct GDP, total GDP is the sum of direct, indirect and induced GDP calculated for each technology based on direct GDP contribution and a multiplier appropriate to the technology. WoodScape used BERL updated manufacturing multipliers (BERL 2011) that are a measure of the value-added to the economy through increased consumer spending from the additional on-shore processing and increased production through the supply chain. Figure 2b[3] shows the total GDP impact of a range of wood processing technologies.

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[2] This assumes the increase in value added from additional transport, associated with more onshore wood processing, would negate the value lost in wharfage from less export volume. Furthermore these values would be minor in comparison with GDP contribution from the 'forestry and logging' and 'wood processing' sectors

[3] In all bar graphs in this report green columns indicate an emerging technology and the numbers following a technology name indicate (product out per tonne or m^3 / log volume in m^3). Blue columns indicate "traditional" technologies.

To measure the overall impact on the New Zealand economy, the GDP/tonne values needs to be multiplied by the scale of production. Different technologies have very different scales of production and potential market sizes[4].

Note that GDP per ODT of feedstock was used in these graphs as there are a wide range of product outputs (lumber, panel, fuels, chemicals and heat) with very different conversion factors from log to product. Basing the comparison on the volume of infeed allows for a more consistent comparison across the range of technologies.

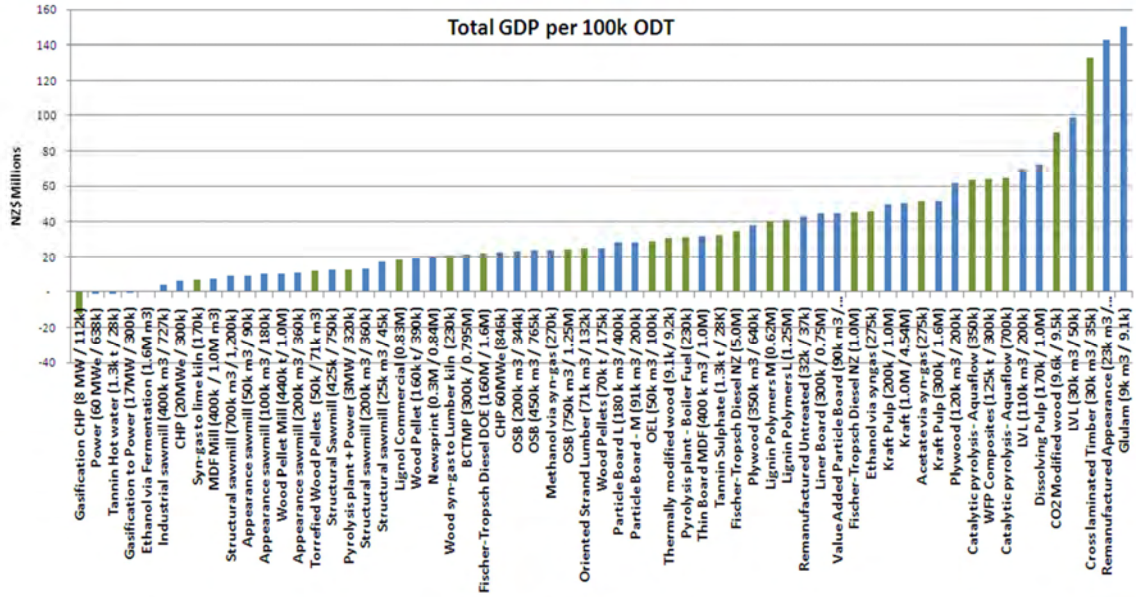

Figure 2b: Total GDP $million per 100k ODT of log input for types of wood processing options. Note; blue indicates a traditional technology and green an emerging technology.

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[4] Indufor market report for WoodScape study

A number of the wood processing technologies assessed also have large export markets and attractive returns (see figure 3).

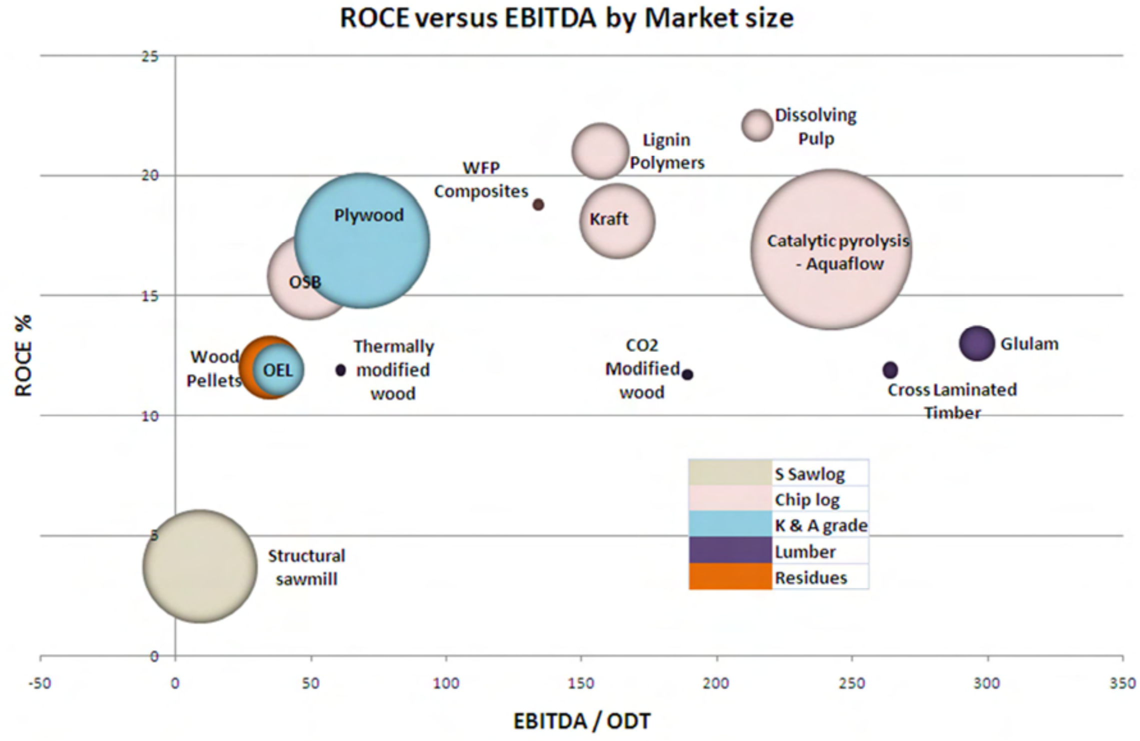

Figure 3: ROCE, EBITDA/ODT (a measure of cash flow) and international market size[5] (comparative; represented by bubble size) of the top 10 technologies plus a structural sawmill for reference. The different colours represent the feedstock assumptions of the assessment.

Many of the technologies that have attractive ROCEs rely on a plentiful supply of residual fibre from primary processing at $130 to $145 per ODT ($55 to $60 per green tonne). The price and available supply of this residual fibre need to be taken into account in any investment decisions

Figure 4 provides a comparison of New Zealand sector level productivity with the firm and inter-industry level productivities from the WoodScape model. Note that many of the technologies assessed in the study do not currently exist in the forestry and wood processing sector. Several of the wood-processing technologies assessed in this study have a labour productivity comparable to the highest productivity sectors in the New Zealand economy[6]. They are therefore an important part of a high-value manufacturing strategy for New Zealand. Comparable industries, such as mining and gas, are dependent on non-renewable natural resources and reduce New Zealand's natural capital reserves.

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[5] Note fuel options assume a market size equivalent to New Zealand's current fuel demand.

[6] 'Electricity, gas, water supply productivity would be high due to high returns from an industry that is not labour intensive. This, however may be slightly overestimated due to slight differences between ANZSIC96 and ANZSIC06 classifications

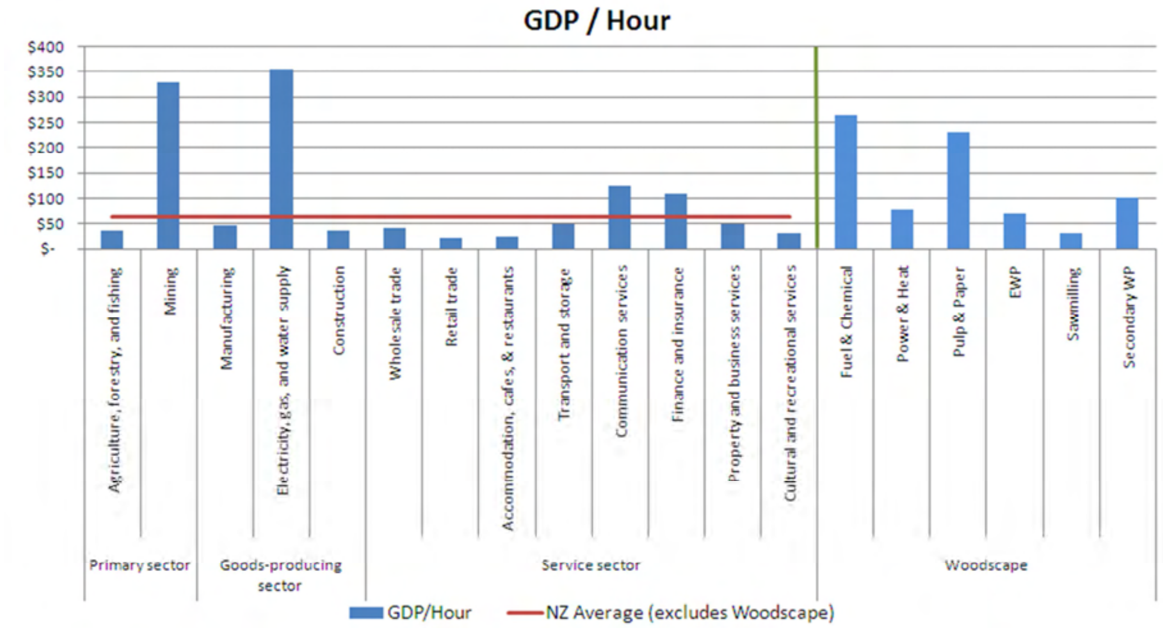

Figure 4: Labour productivity (GDP/hour of employment) of technologies assessed in the WoodScape study (on right) compared with other New Zealand sectors (on left). New Zealand average from measured sectors is $63/hour.

The following sections set out three strategies to increase the level of processing within New Zealand.

The Way Forward: Be Globally Competitive

The New Zealand wood processing industry has faced tough times over the last several years due to the impact of the global recession on construction activity, demand and prices. A number of plants, especially sawmills, have closed (Neilson, 2010). The difficulties facing the industry are illustrated by the investment returns for new plant for a number of the types of wood processing options currently operating in New Zealand (figure 5). The return on investment from primary processing options such as sawmilling is particularly low. These returns are based on new plants and may not represent the returns to current operations, as existing plant would have lower book value and may have different operating parameters.

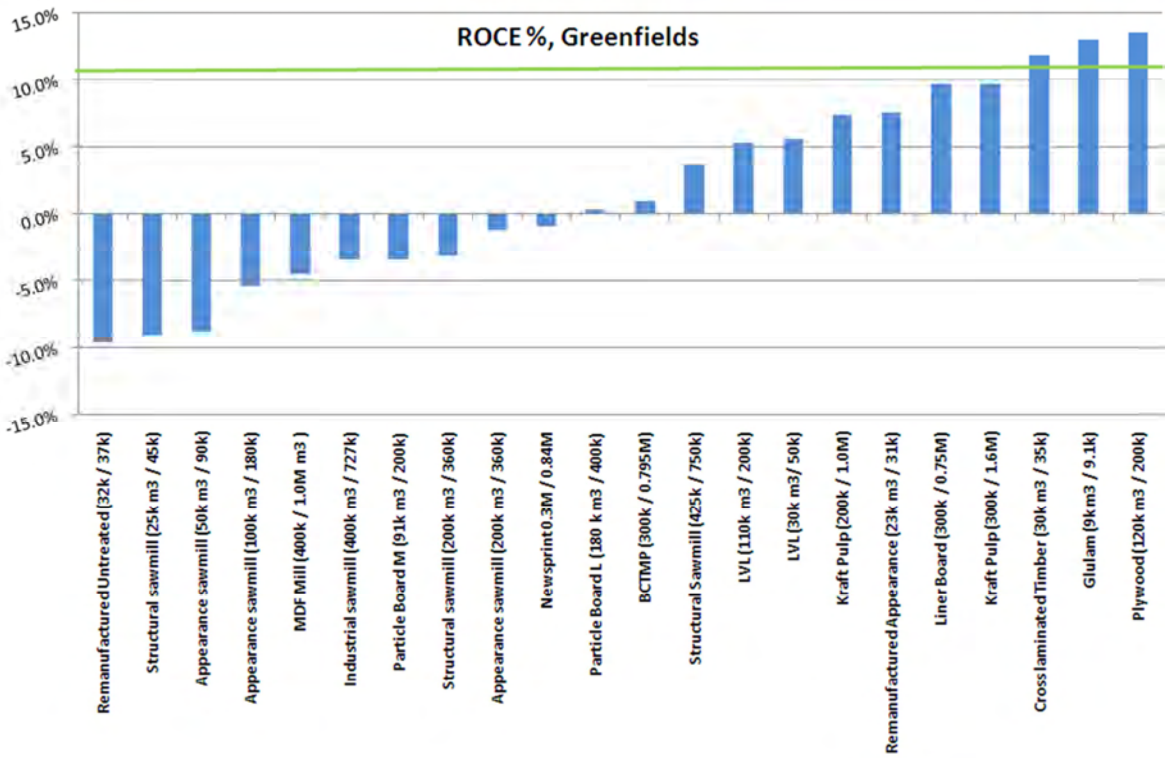

Figure 5: Investment returns (Return on Capital Employed) for a range of wood processing technologies currently established in New Zealand. These results are based on the capital costs of new plant, not returns from existing plant.

Primary processing technologies, such as sawmilling, are a vital component of the wood processing industry as they take higher quality, high price logs and then sell their residues (such as chip) to other processors as illustrated in figure 6 (indicative values used). Without the primary processing sector many of the other secondary processing options are less viable. Figure 6 is a very simplified picture of the wood processing industry which is strongly integrated and interdependent. A fuller picture of the interdependency of the industry is given in Appendix B.

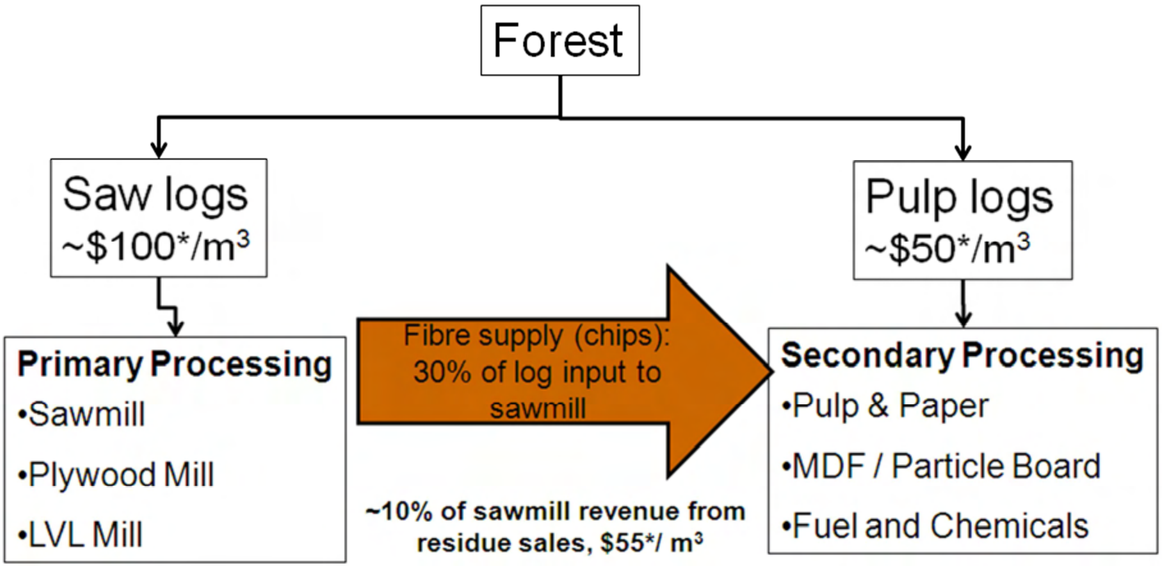

Figure 6: Simplified model of the wood processing industry showing the interdependency of primary solid wood processing and secondary reconstituted wood processing.*$ values are indicative only.

The majority of products produced by the wood processing industry are global commodities; to compete in this market, these facilities need to be globally competitive. The WoodScape study has identified three approaches to increase the competitiveness of the current industry:

1. increase scale: move to larger scale plant to exploit economies of scale
2. identify the right export markets: identify the right export opportunities where New Zealand radiata pine is valued and is of sufficient size for the industry
3. achieve international best practice by using capital to drive efficiency

Increase Efficiency

Comparisons to international best practice[7], indicates that some New Zealand wood processing plants have higher labour inputs due to older plant with lower automation. There is room for labour productivity improvement through capital investment to automate some sub-processes.

Capital utilisation is also an issue for existing sawmilling facilities. There is currently significant latent sawmilling capacity due to mills not working as many hours or days as they could. For example, in the Central North Island (CNI), there is currently (2012) as much as 1.0 million m^3 of unutilised processing capacity. It is critical for new mills to utilise all of their capacity to maximise capital efficiency. Building a new mill and running it for four days per week (as opposed to six or seven), can reduce the return on capital employed by up to 40%.

Increase Scale

New Zealand's current wood-processing plants have a wide range of scales. For example, New Zealand sawmills range from 3000 m^3 to >700,000 m^3 of log input (figure 7). Many (58) small mills combined process less than the three largest (Neilson, 2010).

[7] FPInnovations, 2010

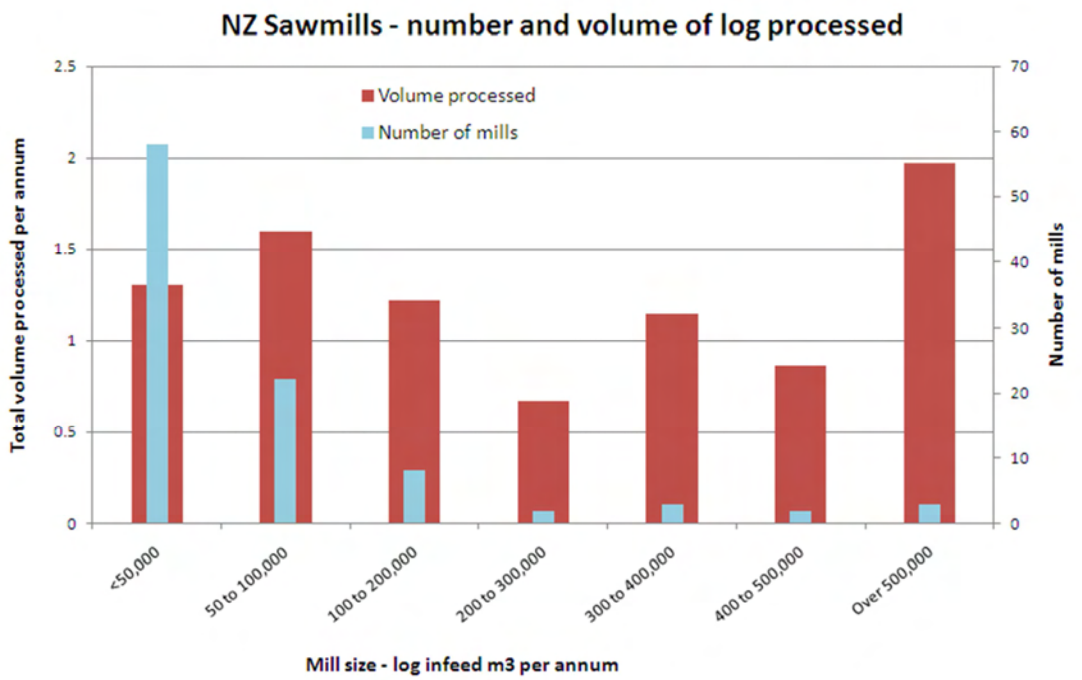

Figure 7: Number of plants and volume produced as a function of mill size.

The WoodScape study shows that investment returns have a strong dependence on scale, with larger plants having a significant advantage. Figure 8 shows a graph of ROCE for a wide range of both traditional and emerging technologies. The increase in return with scale shows a similar trend across these technologies. In general, these economies of scale are driven by shifting productivity from labour to capital, increased throughput per unit of capital and spreading the fixed costs over a larger production volume. This has the net impact of increasing the margin per unit of product produced.

The current sawmilling industry structure of many small plants is at odds with the findings of the study and to take advantage of these economies of scale, the industry may need to consolidate and rationalise.

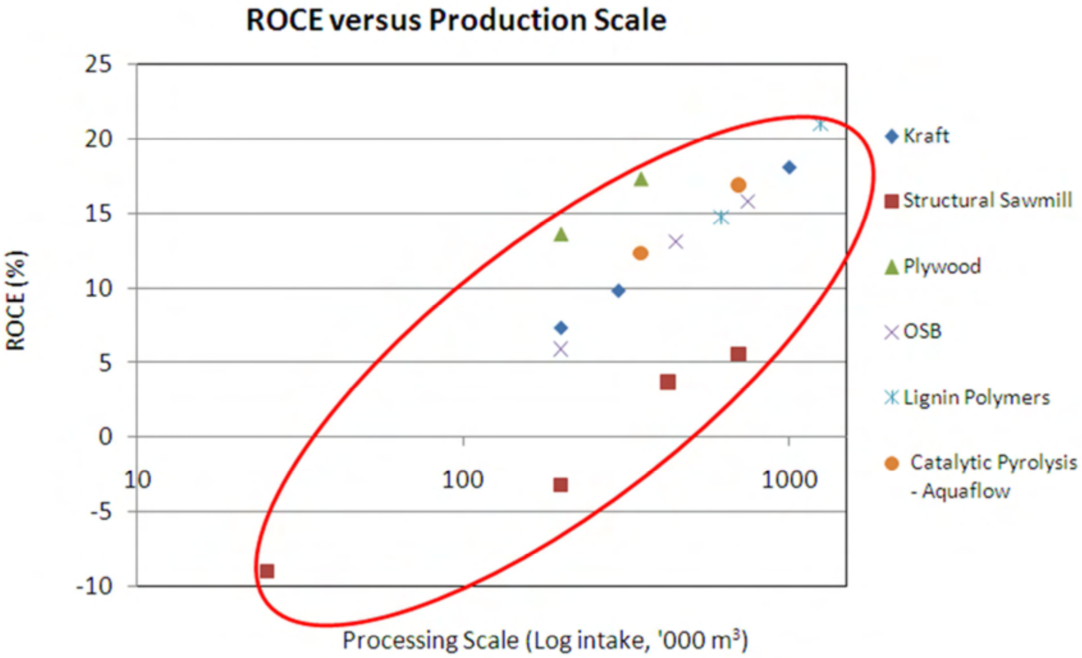

Figure 8: Influence of plant scale on return on capital for a variety of wood processing technologies. X axis is a logarithmic scale.

There is a limit to the benefits of increasing scale due to the requirements of feedstock procurement from an increasingly larger catchment. Beyond a certain scale, feedstock costs will increase due to the greater transport distances. The WoodScape model has allowed for this by increasing feedstock costs for plants above a certain scale by assuming a premium on, or a change in wood supply as plant size increases. This has the effect of making certain technologies less favourable as scale increases. For example, smaller wood pellet plants have a higher ROCE than the larger ones as a smaller plant is assumed to be able to source its feedstock from primary processing residues at a lower unit cost than the larger plants which will need to buy chip grade logs to meet the level of wood supply they demand. The higher in feed costs outweigh the other gains from economies of scale.

There is also another caution regarding scale. Efficiencies from increased scale only result if production is maximised. In order to maintain production, the operator can become a price taker to maintain the volume over the plant. This analysis assumes that all product of larger scale plants are sold at market price. If not all product can be sold at market price then the ROCE is lower. This will be discussed further in the section titled Address Global Risk.

Create Export Markets

The domestic market for solid wood products (especially sawn lumber) is fully supplied[8]. To increase the capacity of domestic solid wood processing new or expanded existing export markets for New Zealand products are needed, especially structural lumber. This would require a co-ordinated approach from the sawmilling industry, perhaps in partnership with government.

[8] Industry comment.

Some New Zealand wood products (particle board, structural lumber) do not currently have significant export markets, and where these markets exist, in some cases (structural lumber) there is not a high enough value placed on the product to make the process profitable[9]. The difference between domestic and export markets for wood products is illustrated by the returns from sawmills selling into the two markets (figure 9). Radiata pine sawn lumber that meets MSG8 can be sold in New Zealand as a structural product and attracts a higher price than the same piece of wood sold into an export market where MSG8 is not accepted as a structural product.

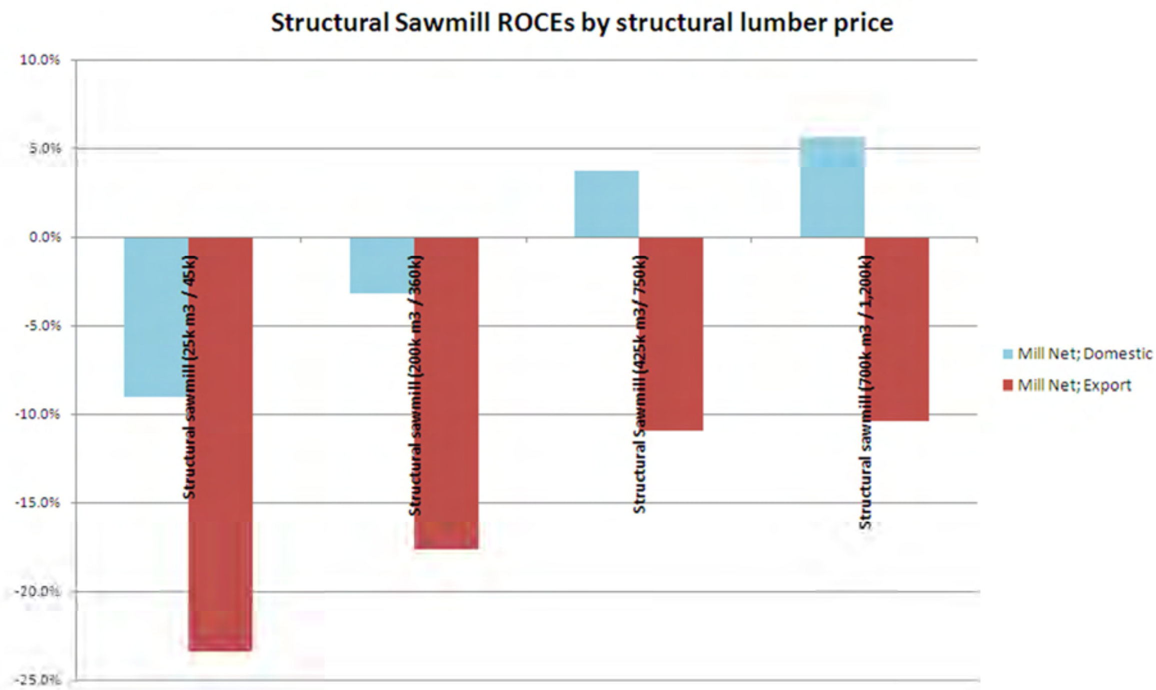

Figure 9: Difference in returns for sawmilling selling into the domestic and international markets.

To significantly increase the attractiveness of sawmilling for investors there is an urgent need to have New Zealand products accepted and valued in export markets.

The Way Forward: Transform Resource Use

The forest sector currently (2012) exports approximately half its ~26 million cubic metre log harvest as unprocessed logs (~13 million m^3). The majority of these logs are A grade (50%) and K grades (40%) grades (Ministry for Primary Industries, 2011, 2012 and personal communications). The breakdown of export logs is shown in figure 10.

[9] Industry comment.

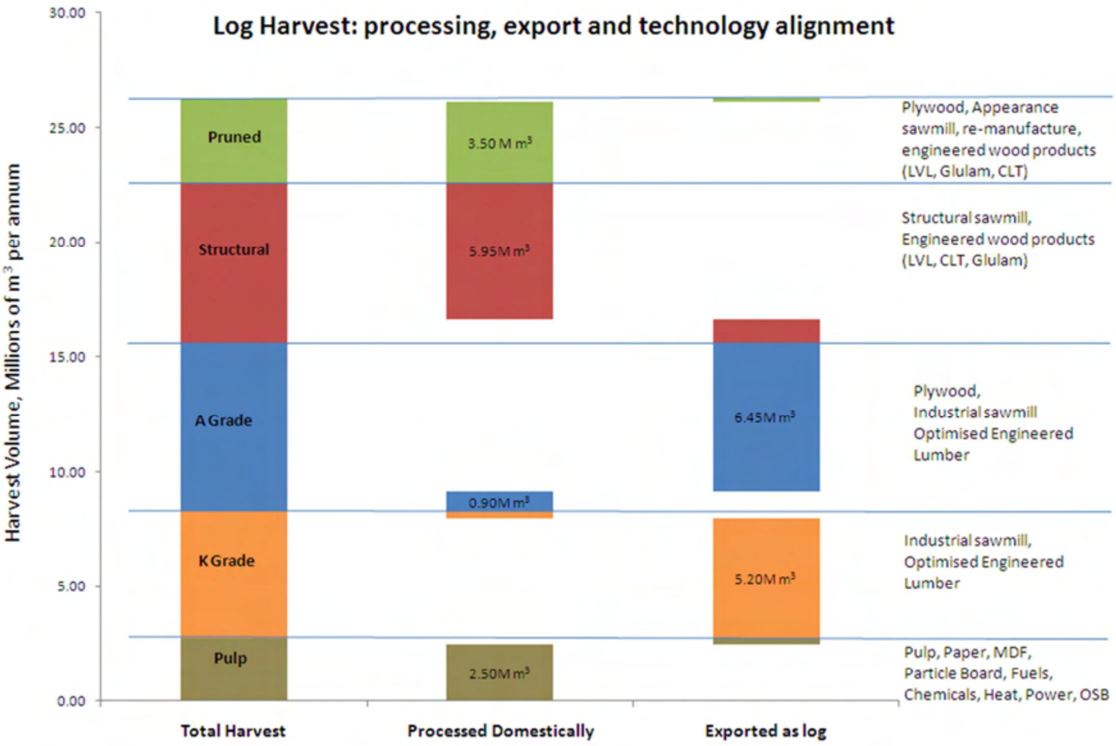

Figure 10: Current log harvest and exports by log grade – key point is volume of A and K grade being exported

Figure 10 shows that the current wood processing industry is focused on processing the high (pruned and structural) and low (pulp) value logs. High quality, high value logs are used in sawmilling, plywood and engineered wood products; low quality, low value logs for pulp, paper and MDF and particle board. In order to significantly increase domestic processing and realise the Woodco strategy, more of the mid-range A and K grade logs that are currently being exported need to be processed onshore. These A and K grade saw logs are typically smaller diameter than P and S1/S2 logs and have larger knots. KI grade is considered to be similar to a chip/pulp log.

The WoodScape study suggests two approaches to increasing domestic processing:

1. implement new technologies for processing A and K grade logs that create value
2. implement the same processes used to process low grade export logs overseas in New Zealand if it can be done profitably.

Technologies for Processing K and A Grade Logs

The technology options in the WoodScape study that are able to take A and K grade logs as feedstock are shown in figure 11. While industrial plywood and OSB demonstrate reasonable returns, the technologies considered in the model were limited and there is a need to expand the options available by a wider search for (or development of) technologies that can achieve viable returns from processing A and K grade logs. Optimised Engineered Lumber (OEL) is a New Zealand process that is under development and returns may change from those indicated as market prices and process costs for the product are confirmed. This technology is of considerable interest as it is focussed specifically on taking knotty K grade logs and creating a higher value structural product.

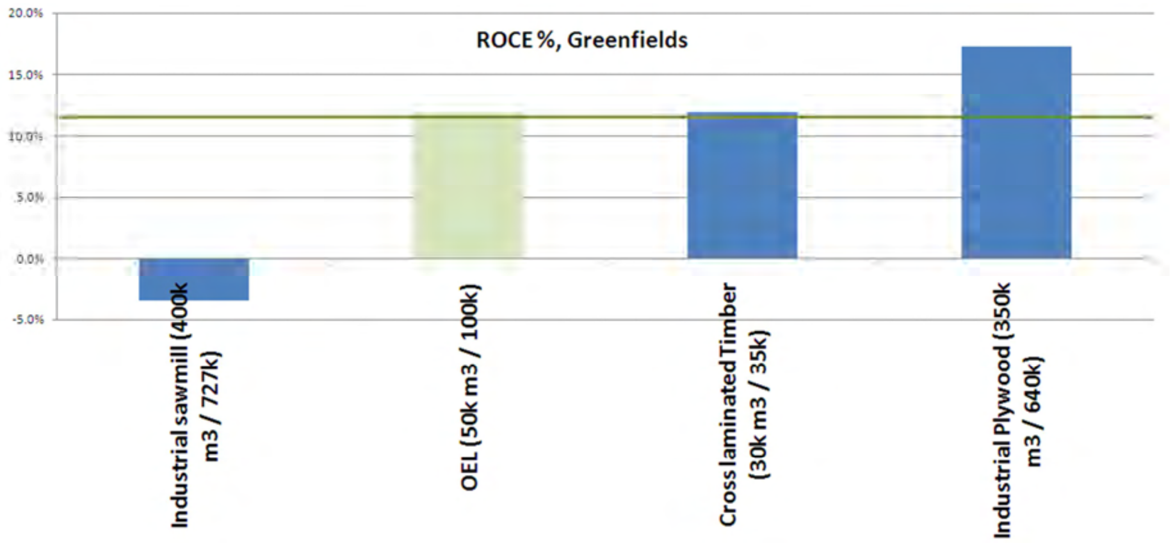

Figure 11: ROCE% for technology options for A and K grades.

Increase Processing of current export logs in New Zealand

An alternative strategy to that described above is to consider what processing is occurring overseas using New Zealand log exports, and (where this can be done profitably) to relocate that processing to New Zealand.

Figure 12 shows a breakdown of log and wood product exports to China as estimated by Indufor[10]. A large proportion of New Zealand log exports are used to make industrial plywood, the rest are processed into sawn timber products. The fate of the residuals from the primary processing is unknown. The figure also shows the volume of wood product exports that are possible if this processing could be carried out domestically.

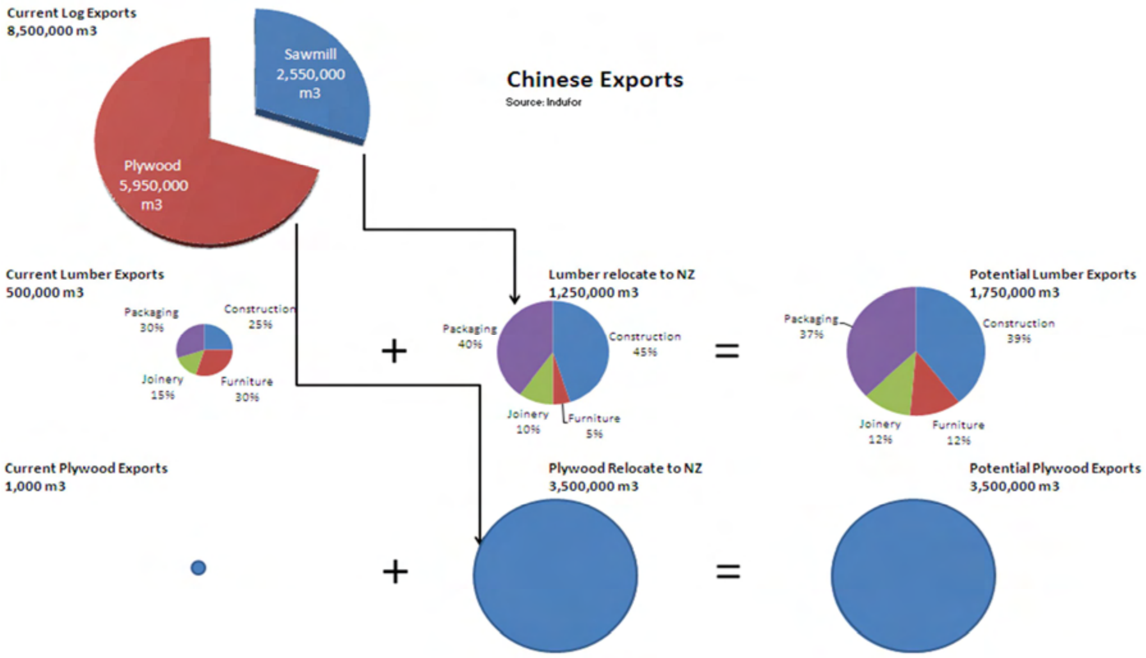

Figure 12: Breakdown of current processing uses of New Zealand log exports to China and a scenario for relocating this processing into New Zealand[11].

[10] Note that this is only an estimate as precise information on end use in China is difficult to establish.
[11] Source: Indufor.

To explore this potential scenario further, WoodScape investigated the returns from an industrial plywood mill in New Zealand. The results (figure 14) are promising as they show an investment in an industrial plywood mill would yield returns above 15%.

Significantly, if New Zealand was to achieve the processing increase outlined in Figure 12, there would be an additional ~2.9 million m^3 of log-equivalent residues in the form of cores, ply round-up, chips, and sawdust. These residues would be a feedstock for processes such as dissolving pulp, liquid fuels and chemicals, which also yield high returns.

The Way Forward: Innovate

Up to this point, we have mainly considered strategies and approaches that use traditional wood processing technologies. Here, the potential impact of emerging technologies on the New Zealand wood processing scene is considered.

Figure 13 shows the value enhancement by a range of technologies. The value-enhancement ratio is the ratio of the value of the product produced by the technology to the value of the feedstock consumed. A simple example would be; a process takes in a log at $100/m^3 and converts it into a product worth $300/m^3, at a conversion factor of 0.55, giving a value enhancement of 1.65 (excluding residue sales). A significant proportion of the current wood processing industry is not adding much value. In contrast, some of the emerging technologies show a much greater value-enhancement ratio.

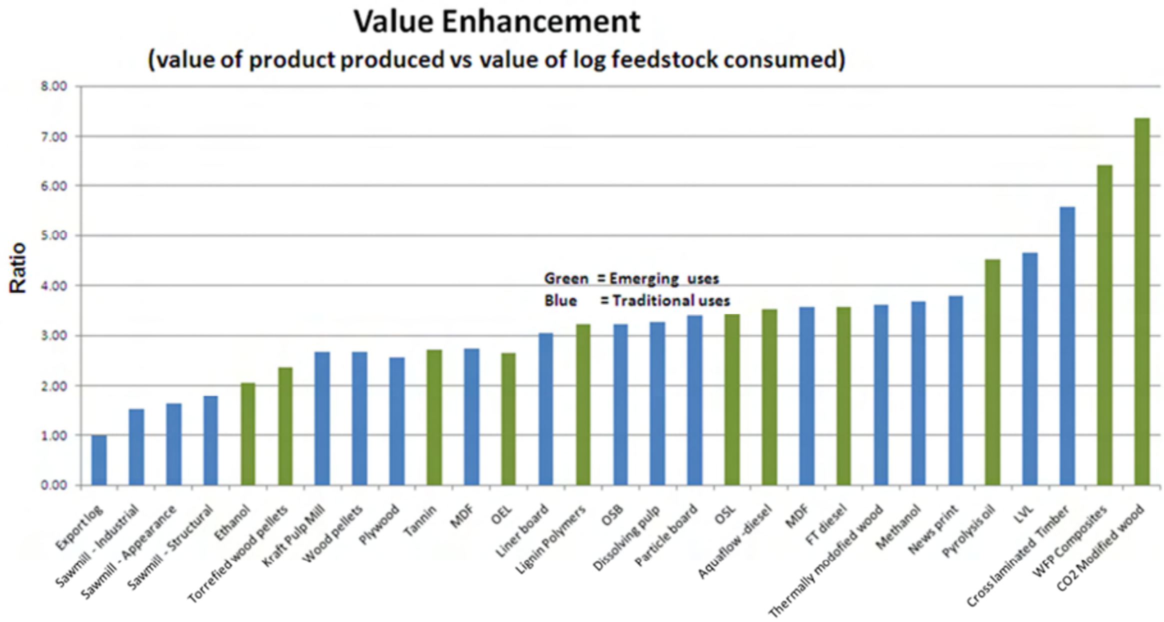

Figure 13: Value enhancement of a number of traditional and emerging technologies

Of the emerging technologies, two clear areas showed solid returns and high value-enhancement; engineered wood products (especially CO_2 modified wood and wood fibre composites) and fuels and chemicals. These two areas also showed a high labour productivity (see Figure 4).

Bio-energy options, such as electricity and combined heat and power (CHP), did not perform well financially in the base case evaluation, although there may be specific niche opportunities where they yield better returns.

Note that the scale of the power generation and CHP options considered here (20 to 60 MW_e scale) are different to those of many New Zealand bioenergy developments, which are focussed on heat production at 1 to 2 MW_{th} scale. Inclusion of more heat options at smaller scale in the model would be useful in a second phase of work. They were not considered to be a priority in this phase as their fibre demand is small and would have little impact on the goal of Woodco's strategy.

Engineered Wood Products

Engineered wood products is a promising area that adds considerable value. Figure 14 shows the return on investment for a range of engineered wood product technologies. The ROCEs are based on the best available data; for some of the traditional technologies (sawmilling) there is extensive and well understood data on costs and inputs. For some of the emerging technologies there is much less certainty around the data as it may be based on a single pilot plant.

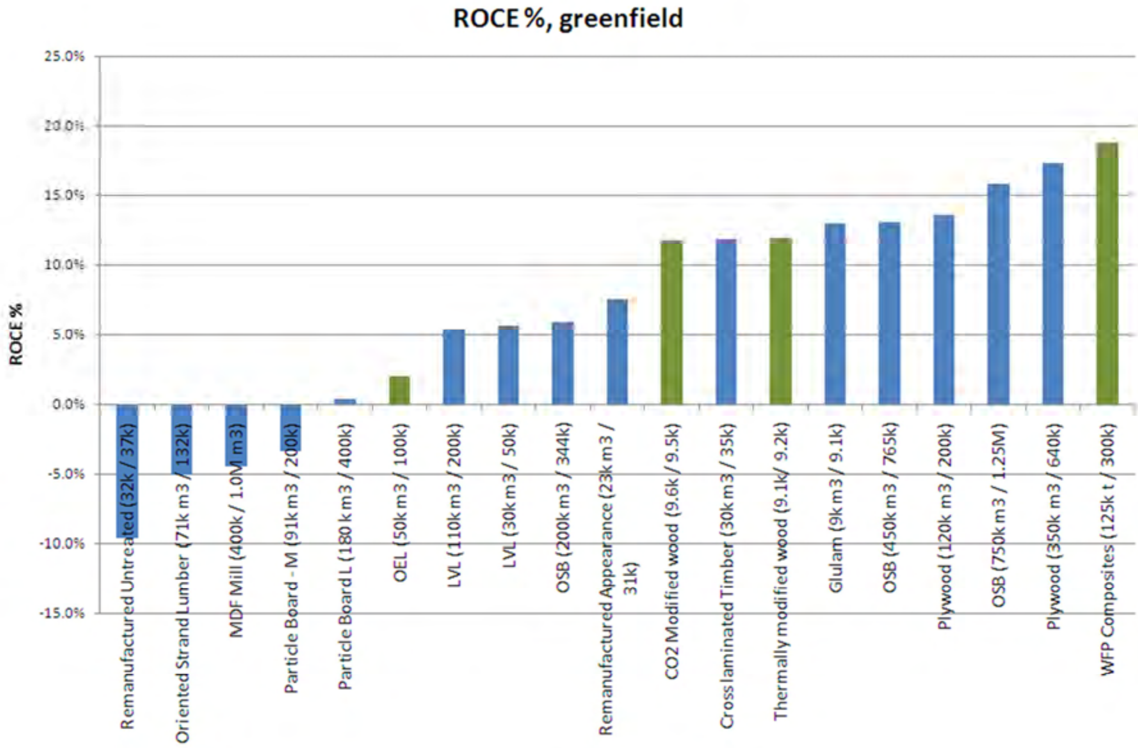

Figure 14: Estimated investment returns (ROCE %) from technologies producing engineered wood products in New Zealand.

Engineered wood products fill an important portion of the value chain within New Zealand and in other wood processing sectors of the world. In some cases, these technologies consume residual wood or low value fibre e.g. MDF. In other instances these technologies add value to products of primary processing e.g. CLT.

Continuous innovation of these technologies is important. Reducing technical risk, improving the competitiveness of facilities, developing new higher-value products and opening up new markets will all be critical to success in this area.

Fuels and Chemicals

A number of fuels and chemical technologies also add significant value to their feedstock. The investment returns from these technologies are shown in figure 15.

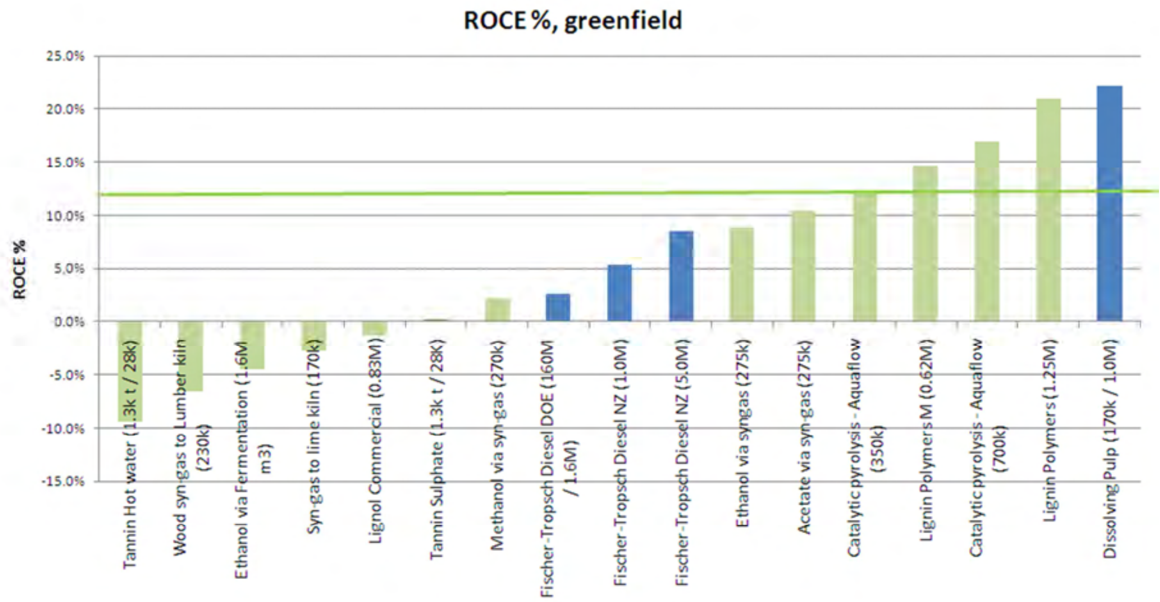

Figure 15: Estimated investment returns (ROCE %) from a number of emerging fuel and chemical options in New Zealand.

The returns from these technologies were strongest when a chemical component was being produced; although fuel production also had strong returns. These technologies are in the early stages of development and still hold significant technical risk. Our projected results suggest that fuels and chemical technologies should be monitored closely to ensure that New Zealand leverages these technologies as they mature.

As they develop, care should be taken to coordinate any fuels development within the existing wood processing and oil refining infrastructure of New Zealand, and similarly, chemicals should be developed in conjunction with the global chemical industry.

The return for these technologies is based on low cost feedstocks (using current slab chip prices) that are the residuals of a primary processing facility such as a sawmill or a plywood mill and therefore rely on the existence of these facilities.

Innovation is not limited to wood processing. Investigation by forest growers of fibre regimes with a single goal of minimised delivered cost of fibre would also appear to be warranted. This differs from current forest management regimes which are focussed on maximising volume of specific log types (Pruned, S1 etc).

Understand and Address Global Risks

The future of the Woodco strategy hinges on successfully competing in international markets. It is critically important that New Zealand companies adopt a global outlook. This approach exists in larger companies but smaller producers also need to adopt a similar approach.

Market Risk

Manufacturing products for export markets exposes New Zealand companies to higher market risks than when focused on the domestic market. When considering the technologies in this report it is important to consider the impact of scale from a global perspective.

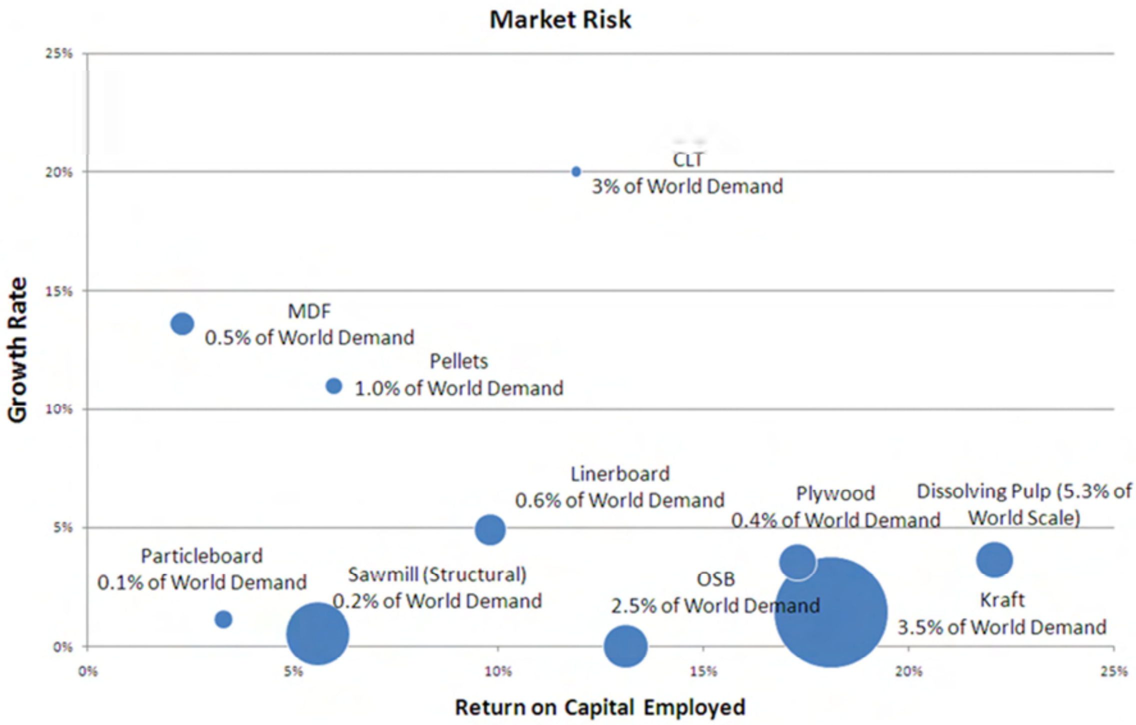

Figure 16: Commodity processing technology scales versus market growth rate (Indufor 2012, RISI, and FPInnovations 2010) and ROCE. Bubble size indicates fibre-in to a single plant (odt per annum)

While the benefits of scale of production are clear, this factor needs to be considered in relation to the size of the international market. Some of the primary production technologies are very large in scale and represent a significant portion of world capacity and demand. Markets for these products may have slow growth rates, which means increases in scale will need to utilise technologies that compete on a cash cost basis, in order to compete with existing suppliers (figure 16). For example a Kraft mill at large scale has a high ROCE but a very low market growth rate, where the plant is a significant part of the global market; this plant would be at risk in a Kraft pulp market down turn. Alternatively a CLT plant does not have as high a ROCE, but is a small plant in a small but high growth market.

Foreign Exchange

The relationship between the New Zealand and US dollar proved to be one of the more sensitive drivers of the return on capital employed results in the WoodScape model. Exporting technologies are heavily impacted by any changes to the New Zealand dollar exchange rate versus the US dollar (figures 16, 17 and 18). Critical to the success of the New Zealand industry will be planning for foreign exchange fluctuations. Large exporters may have access to the knowledge and expertise to mitigate this risk, however smaller exporters will be at risk.

Figure 16 shows the base case, with the Forex rate at 0.82. Figure 17 shows the impact of the New Zealand dollar appreciating against the US dollar by 15% to 0.94 – the impact across the range is generally severe. Figure 18 shows the substantial improvement in returns on capital employed if the New Zealand dollar were to depreciate to 0.70 USD.

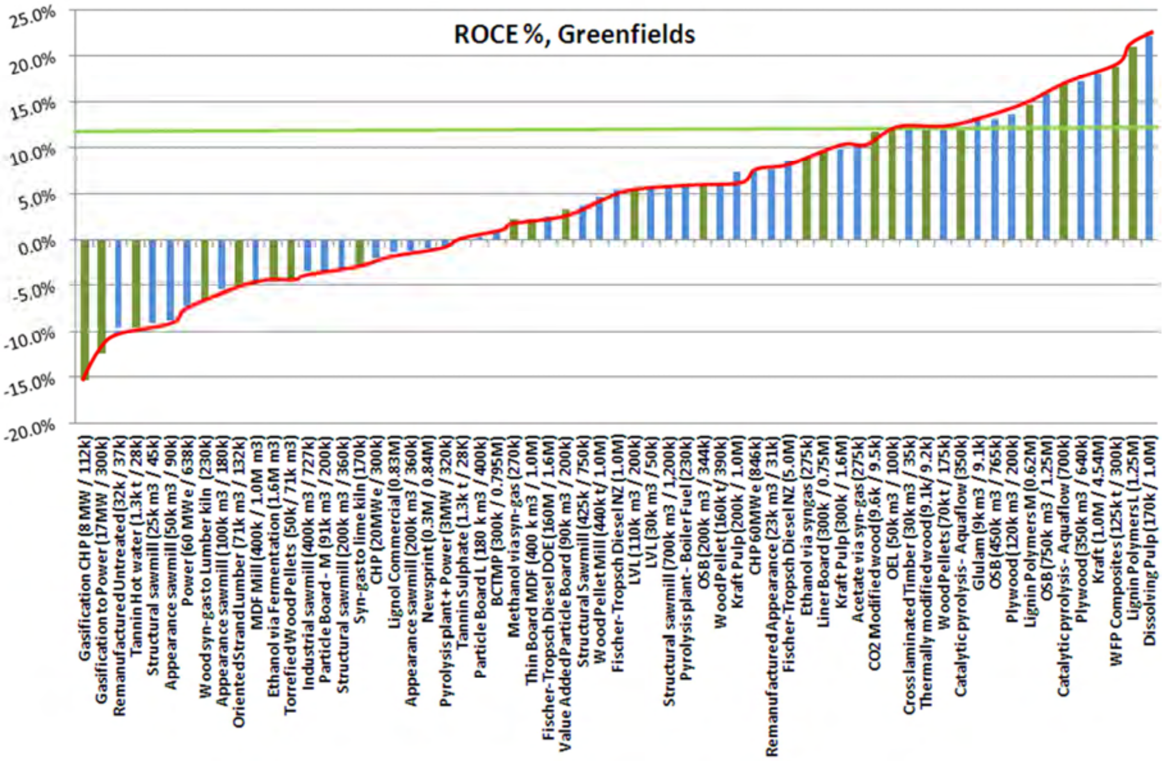

Figure 16: ROCE based on a 0.82 NZ / US exchange rate.

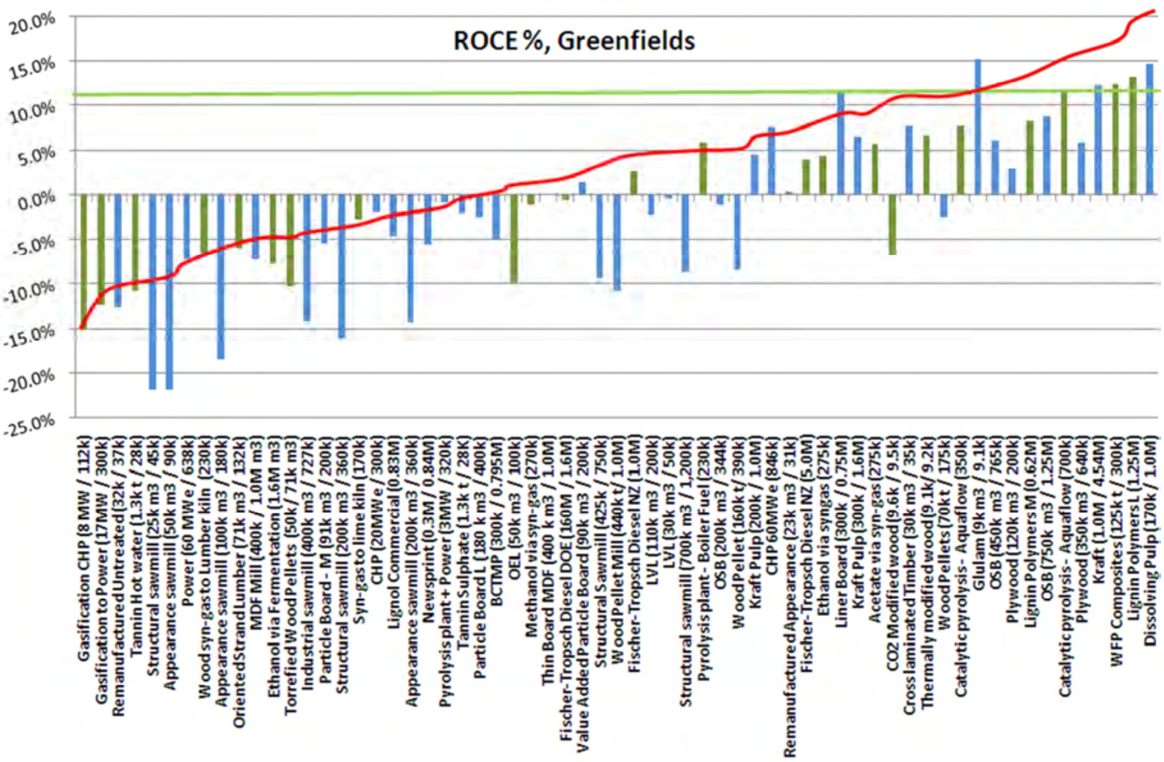

Figure 17: ROCE based on a 0.94 NZ / US exchange rate

The items which have moved significantly above the red line (Glulam and Liner board) are those that are taking a product from another process as their feedstock, as the exchange rate rises the cost of their infeed material falls, improving their returns.

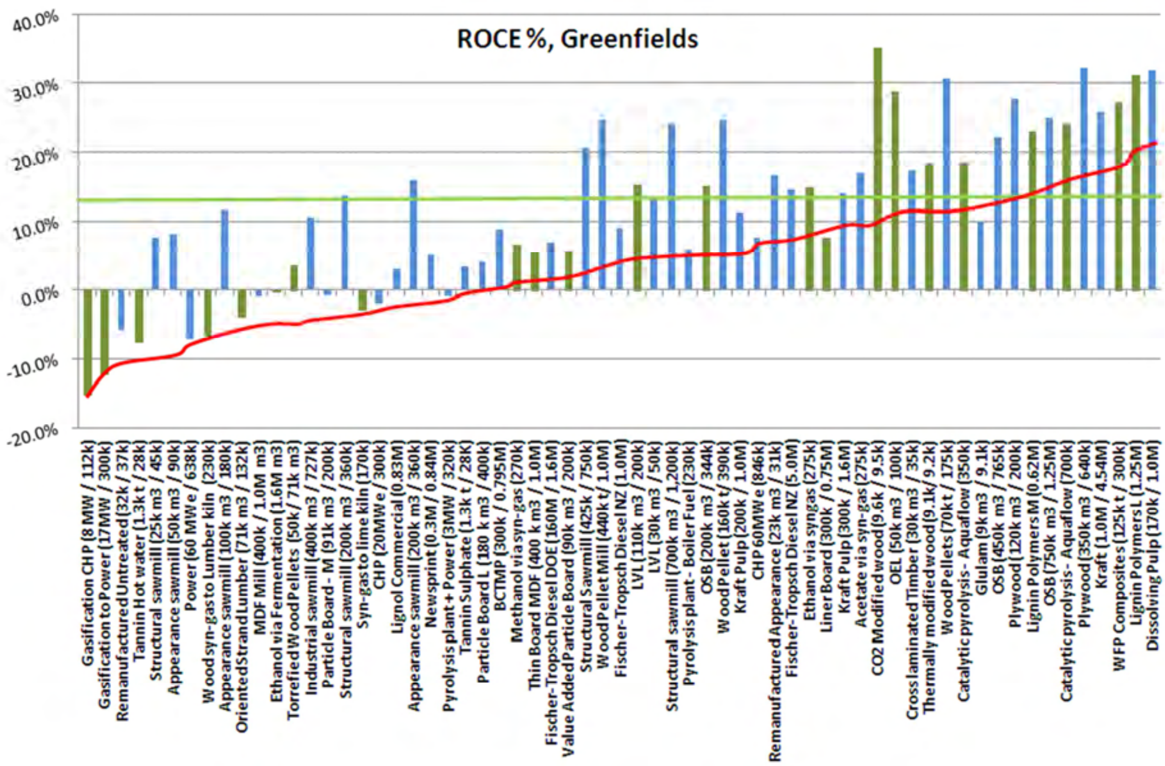

Figure 18: ROCE based on a 0.70 NZ / US exchange rate

Some technologies do not move with exchange rate, these are ones producing heat and power, where the exchange rate does not have a direct effect on the market price as they sold only into a domestic market.

A number of other changes were made to the base case assumptions to test the sensitivity of the ROCE results. A 5% change in each of; product price, feedstock costs, energy cost, labour cost and capital cost, to the base case assumptions were considered. The impact on ROCE of a 5% change on each of these costs showed that on average product price has the greatest impact; again emphasising the importance of market risk.

Feedstock cost was the second most important factor affecting ROCE, with: twice the impact of a 5% change in labour costs, four times the impact of 5% change in energy costs and three times the impact of a 5% change in capital costs.

Market Knowledge

An area of critical importance to success is an intimate knowledge of international markets. For example, when assessing wood pellets, two scenarios were considered:

1. Sales into the European market and sales into the Asian market (figure 19). The base case of sales into European markets did not provide sufficient returns to recommend wood pellet technology options.
2. Shipments into Asia saved on freight and improved returns, making them a favourable investment option.

Further market analysis indicates that pellet markets in Asia are slow to start and in some cases (country specific), the expectation is that they will be self-sufficient. They are also dependant on legislated mandates rather than pure market demand (Indufor 2012).

North

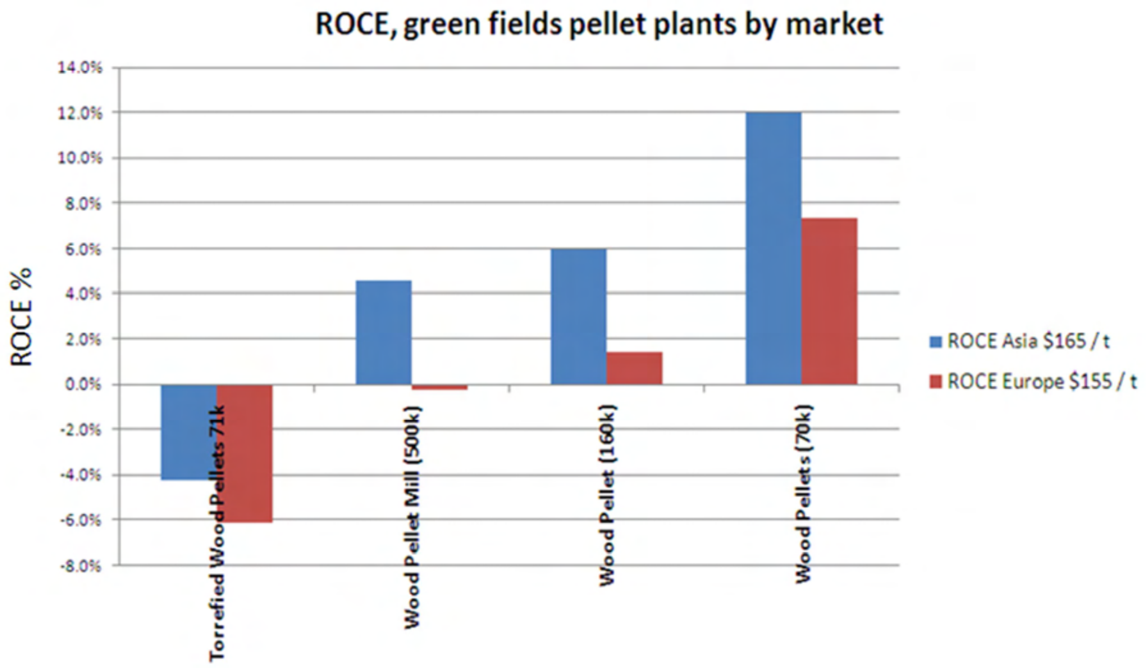

Figure 19: Improvement in Wood Pellet ROCE depending on shipping destination.

As New Zealand moves forward with the Woodco strategy, it will be critically important to ensure that domestic producers (large and small) have accurate and complete information on international market opportunities and competitor analysis, with a special focus on Asian markets.

Understand and Progress Regional Opportunities

To understand regional differences and how they might affect regional strategies, the WoodScape study assessed resource supply and wood processing options in five different regions:

1. Northland
2. Central North Island
3. East Coast
4. Nelson/Marlborough
5. Otago/Southland.

For each region, the WoodScape study:

- (i) analysed the plantation forest resources available now and in the future
- (ii) held workshops with stakeholders to explore the key factors impacting on wood processing
- (iii) carried out a tailored techno-economic assessment of wood processing technologies for the region.

Forest Resources

Differences in wood resource across the five regions mean that a different approach to developing wood processing is required in some cases.

Northland has an expected expansion in wood supply of 2.3 million m^3 per annum. The wood density of Northland's forests are generally higher than other regions meaning products such as LVL and CLT are possible based on wood quality. However, indications are that the best of the current structural resource is captured by existing processors. The resource is geographically widely distributed. A significant quantity of the log supply will be in A and K grade logs. The K grade logs do not have a natural home within the existing wood processing infrastructure.

Central North Island has the potential to harvest up to 4.0 million m^3 per annum more than it does currently. This is in addition to the very large cut (8 million m^3) that it currently has. This volume would pose some challenges if it was added to the existing export volume. There will be significant volumes of A and K grade logs. Wood quality varies by location but structural options will be possible for some of the cut.

East Coast has an increased cut of 1.5 million m^3 available for processing by 2020. Wood quality is variable. There is a higher than average proportion of pruned forests on the East Coast and as there is limited wood processing currently operating there will be significant volumes of good quality logs available. Resin content may be an issue for some appearance uses. Forest are geographically widely distributed and transport distances are longer than average so wood delivery costs are higher than for other regions.

Nelson Marlborough will have an increase in available log supply of around 1.1 million m^3. Wood quality varies between coastal and inland sites. Wood density is lower than in northern regions and structural logs are in short supply. Pulp log supply is currently also constrained. Available wood is mostly A and K grade, with improvements of structural log yields expected as forests grown with different regimes mature. There are two distinct concentrations of forests, those near Nelson and those in the Wairau Valley closer to Blenheim.

Otago/Southland also has an increase in wood supply of around 1.1 million m^3 per annum. Over time this resource changes in species from 90% Radiata pine to 50/50 Radiata / Douglas-fir. The radiata resource is low density and unsuitable for structural uses, ruling out options such as CLT and LVL. The wood tends to be lighter in colour than radiata in other regions but this feature is not being exploited. Currently chip logs and saw mill residues are used for MDF or exported.

Infrastructure

Northland has some challenges in terms of roading in the more isolated areas, but is generally well served in terms of transport. Marsden Point is a true deep water port and this could be significant in the longer term. While there are some constraints on power supply these are expected to be resolved by planned infrastructure development in the next 2 to 3 years. The presence of the oil refinery could be significant for the development of biofuels, depending on the route chosen; a technology that produces a bio-crude (lignin polymers) will need a refinery to take the product and turn it into a consumer fuel.

Central North Island has well developed mature roading infrastructure and comparatively low wood delivery costs, this means the CNI has options for large scale processing that other regions do not have. The CNI is well provided with energy infrastructure (gas, electricity, coal) and geothermal energy may also be a driver for processes that require large amounts of heat. For the large scale processing to develop they need to be done in an integrated manner in order for maximum benefit to accrue to the economy. There is significant latent capacity within parts of the wood processing industry.

East Coast; faces a number of challenges. The Port of Gisborne is restricted in draught and storage area, the rail link is in disrepair and roading is often poor with challenging topography. The electricity supply to the north of Gisborne is constrained by the lines infrastructure, meaning any large wood processing facility would need to have a CHP plant as part of its planning considerations. Currently there is limited wood processing capacity operating on the East Coast. Solid wood processing development would need to be integrated with parallel consideration of uses for the processing residues.

Nelson Marlborough Nelson does not have a rail line but the main trunk line runs past Blenheim, providing access to Christchurch. Roading is of good quality and there are two ports that can be used. There are some concerns over the potential loss of container ship visits to Port Nelson. Electricity supply is somewhat constrained and lines would need upgrading to accommodate a new large user. Water supply may be a limiting factor to some processes. Air quality in the Nelson region is also a consideration to industrial developments. There is latent capacity in existing sawmills.

Otago/Southland is well served with roads, rail and electricity. There is no pipeline gas but plentiful supplies of lignite. There are two ports but neither is deep draught. The need for break bulk shipping can be a constraint. There is latent capacity in sawmills.

Regional Opportunities Summary

The following table outlines the regional opportunities at a high level. For more detail see the WoodScape Regional Wood Processing Options report.

Northland • export of structural timber and structural engineered wood products (e.g. plywood and CLT). • biofuels and chemicals from forest and solid wood processing residuals - exploiting the presence of the Marsden Point oil refinery.	**Central North Island** • large scale integrated solid wood processing facilities. • large scale production of biofuels and chemicals. • integration of geothermal energy with wood processing.
East Coast • opportunities for new processing facilities using the wide range of log grades available. • distributed processing close to resource. • combined heat and power opportunities integrated with wood processing due to restricted electricity infrastructure north-east of Gisborne.	**Nelson / Marlborough** • establish region as a wood-product innovation centre for small-scale high-value manufacturing of engineered wood products (e.g. CLT) and remanufacturing / tertiary products (e.g. kitset houses) – (Regional Workshop). • add novel technologies to existing MDF plant (e.g. WFP Composites).
Otago / Southland • export of appearance grade timber remanufactured appearance products • exploiting the long term opportunity from Douglas-fir • building on existing processing capacity and expertise; MDF and veneer /plywood plant • fuels and chemicals	**All regions; A & K grade log export volumes, M m^3;** Northland 1.26 1.03 CNI 2.45 2.20 East Coast 0.78 0.78 Nelson / Marlb. 0.66 0.54 Otago/ South. 0.40 0.40

Conclusions

WoodScape study uses a techno-economic analysis of wood processing technology options to determine future pathways for the industry in line with the vision of the Woodco strategy to substantially increase exports, GDP and employment from the sector.

The first finding of the study was that there are significant opportunities for wood processing to make an important contribution to New Zealand's economic growth through adding value to log exports, increasing labour productivity and increasing capital investment.

The study identified the key issues and opportunities for the industry to realise these outcomes. The way forward for the industry can be summarised into three themes:

Compete

Issue: Limited options for export of sawn lumber, especially structural lumber

Actions:

Markets and Products
- find and / or create new export markets that value New Zealand products
- innovate and diversify

High-value Processing and Manufacturing
- increase scale and capital utilisation to improve competiveness

Research and Innovation
- understand and exploit international markets
- develop new approaches to sawmilling in NZ

Operating environment;
- sawmilling or other primary solid wood processing are a vital part of a highly interdependent industry
- sawmilling or other primary solid wood processing has a greater GDP impact than log exports
- co-ordinated marketing strategy required
- mitigate exchange rate risks

Transform

Issue: Large volume of K and A grade log exports

Actions:
Markets and Products
- relocate processing of New Zealand export logs (e.g. Chinese industrial plywood) to New Zealand

High-value Processing and Manufacturing
- implement technologies that can process K & A grade logs e.g. OEL.

Research and Innovation

- develop and / or find new technologies that can process K & A grade logs
- re-grade and segregate logs based on internal wood properties
- analyse opportunities for co-location of primary solid wood processing and plants that use their residuals

Operating environment;

- onshore processing - much greater GDP impact than log exports
- potential source of residues for new and/or additional processing opportunities
- mitigate exchange rate risks

Innovate

Opportunity: High-value add from emerging technologies

Actions:
Markets and Products

- diversify into new markets for fuels and chemicals

High-value Processing and Manufacturing (supported by a strong primary solid wood processing sector)

- engineered wood products
- fuels and chemicals

Research and Innovation

- reduce technical risk and improve competiveness
- investigation of fibre-focused regimes by forest growers

Operating environment

- high GDP impact and labour productivity
- integrated and co-ordinated approach required; fuel and chemicals rely on residues from primary processing

In addition to informing the Woodco strategy the WoodScape study has also has another important outcome: the development of a sophisticated financial model that can be used for further analysis of investment options in the wood processing industry. For example this model can be used for evaluating site specific investment options for individual companies and integrated regional opportunities.

Next Steps

The areas identified for further work using the WoodScape financial model include:

1. Explore options to make primary processing more profitable;
    a. use the model to determine the important drivers on plant performance
    b. assess a range of alternative sawmilling technology options that could improve returns

2. Investigate further options for processing K & A grade logs
    a. search for and assess appropriate solid wood processing technologies
    b. expanded regional studies looking at volumes and regional suitability of technology options

3. Undertake further analysis of fuel and chemical options to validate the opportunity

    a. add technologies that are currently not part of the analysis, including those that are pre-pilot plant stage
    b. understand the key drivers for high performance of these technologies
4. Investigate the benefits of industrial clusters of technologies
    a. given the importance of integration identified in the study use the model to evaluate technology clusters such as, large-scale solid wood processing with a fuel and chemical processing option

5. Site-specific studies with individual companies, investors and regional councils
    a. Scion on a commercial basis can provide individualised assessments for individual companies and investors

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References

Agrifax Log Price Surveys; 2012

Cicerno J.P. and Marano J. J. (2002). Benchmarking Biomass Gasification Technologies for Fuels, Chemicals and Hydrogen Production. U.S. Department of Energy
National Energy Technology Laboratory

FPInnovations 2010 – Transforming Canada's Forest Products Industry. Summary of findings of the Future Bio-pathways project.

FPInnovations 2010 – Biopathways Model

Global Trade Information Services; www.gtis.com/

Indufor Wood Products Market Report for the WoodScape project - Confidential

Japan Lumber Journal

Ministry for Primary Industries – Regional Wood Supply Forecasts (2007, 2008, 2009)

Ministry for Primary Industries – National Exotic Forest Description 2012 and 2011

Ministry for Primary Industries – Trade statistics; http://www.mpi.govt.nz/forestry/statistics-forecasting/forestry-statistics

Nielsen D. 2010. The New Zealand Forest Products Industry Review 2010 Edition. DANA Limited.

Random Lengths – Weekly lumber and Panel market newsletter

[1] Techno-Economic Analysis of Biochemical Scenarios for Production of Cellulosic Ethanol, NREL/TP-6A2-46588 June 2010

Statistics NZ website: http://www.stats.govt.nz/

OECD. (2001). Measuring productivity: Measurement of aggregate and industry-level productivity growth. Paris, France: Organisation for Economic Co-operation and Development.

Krugman, P. (1997). The age of diminished expectations: US economic policy in the 1990s, MIT press.

Woodco 2012. New Zealand Forest and Wood Products Industry Strategic Action Plan

Glossary

admt	air dry metric tonne
D. Fir	Douglas-fir
EBITDA	Earnings before interest, tax and depreciation
Euc.	Eucalyptus
CHP	Combined Heat & Power
CHH P&P	Carter Holt Harvey Pulp and Paper
CLT	Cross laminated timber
CNI	Central North Island
cm	centimetre
CO_2	Carbon Dioxide
GDP	Gross Domestic Product
Glulam	laminated lumber beams and columns
ha	hectare
k	thousand
m	metre
M	Million
m^3	cubic metre
MDF	Medium density Fibre board
Max.	Maximum
Min.	Minimum
MPI	Ministry for Primary Industries
MW	megawatt
MWe	megawatt electric
MWth	megawatt thermal
MSG8	Machine stress graded 8 (NZ structural lumber standard)
NZFOA	New Zealand Forest Owners Association
NZTE	New Zealand Trade & Enterprise
LVL	Laminated Veneer Lumber
odt / ODT	Oven dry tonne
OEL	Optimised Engineered Lumber
OSB	Oriented Strand Board
OSL	Oriented Strand Lumber
p. a.	per annum
PMA	Pine Manufacturers Association
P. rad	*Pinus radiata*
ROCE	Return on Capital Employed
Radiata	*Pinus radiata*
sed	small end diameter
SWP	Solid wood processing
SWOT	Strengths, Weaknesses, Opportunities & Threats
t	tonne
Wood pellets	pelletised wood from sawdust – used for fuel
Wood fibre dice	wood fibre similar to MDF formed into dice – used in plastics reinforcing
WPA	Wood Processors Association
A grade	Sawlog; unpruned, min. sed 30 cm, max. knot 10cm, min length 3.7 to 6.1 m
K grade	Sawlog; unpruned, min. sed 20 to 34 cm, max. knot 15 cm, lengths vary 3.6 to 12 m.
S grade	Sawlog, unpruned, min. sed 30 to 40 cm, max knot 6cm, lengths vary 4.8 to 6.1 m

APPENDIX A – LOG GRADES AND PRICING

The log grades and pricing are outlined in the table below. Pricing is based off Agrifax data.

Log Grade	**Grade Acronym**	**Uses**	**NZ $ per green tonne**	**NZ $ per m^3**	**Max. knot Size (cm)**
Peeler	P1 / P2	Appearance sawmill, & appearance plywood	124	129	0
Structural Sawlog	S (1, 2, 3)	Structural sawmill, plywood	97	101	6
Industrial Sawlog	A	Industrial plywood /sawmill	85	89	10
Industrial Sawlog	K, KS, KI	Industrial plywood /sawmill	85	89	11, 20, 25
Pulp	Pulp	Pulp, paper, MDF, particle board, fuel and chemicals, OSB etc	50	52	No Limit
Chip	Chip	Pulp, paper, MDF, particle board, fuel and chemicals,	54	56	N. a.
Sawdust and shavings	Mill residues	Heat & power, fuel & chemicals	18	19	N. a.

Allocation of logs to end uses is complex and does not have clear boundaries. Most S grade logs are consumed in New Zealand as structural or appearance sawlogs whilst some are exported. A and K grades are effectively export grades.

One of the key differences across log grades is knot size; this has a significant effect on potential end uses. Other variables such as log length and diameter have an effect on yield and desirability and affect the price, whereas knot size dictates wether a log can be used in a particular process.

APPENDIX B – NEW ZEALAND WOOD FLOW