HARVESTING TECHNICAL NOTE

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Horizontal and vertical integration of biomass production: a case study of Azwood Ltd, Nelson

Summary

Commercial recovery of harvest residues from logging operations is not well established in New Zealand. What is well known is that the harvesting of pine plantations creates large volumes of residues and presents a clear opportunity for meeting renewable energy goals and making forestry more sustainable. This report backgrounds the concepts of horizontal and vertical integration in woody biomass production and highlights aspects of the business model, products, and supply chain in Europe to improve our understanding from the perspective of successfully managing a biomass recovery business. One example of a company that is recovering and processing harvest residues in New Zealand is AZWood Energy Ltd., a well-established and large-scale energy company based in Nelson. They are developing strong relationships with local forestry companies to facilitate the recovery of harvesting residues, and the development and production of multiple product lines.

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INTRODUCTION

The volume of harvesting residues generated from the harvest of commercial plantations forests in New Zealand is estimated at 4.5 million tonnes per year (about 15% of the total harvest volume). This material is generally left on the cut-over, piled near the landing, or windrowed to minimise interference with replanting operations. The large amount of residues left onsite not only represents a hindrance to further site management, but it can also constitute a hydrological hazard because heavy biomass accumulations can collapse slopes or be washed downstream during increasingly frequent extreme weather events.

On the other hand, logging residues offer an interesting opportunity for additional value recovery since they can be converted into a collateral and renewable market product. Therefore, residue utilisation would offer multiple benefits of solving a disposal problem, generating additional forest revenues, and supporting renewable energy goals.

BIOMASS DEVELOPMENTS IN EUROPE

Europe has been leading the biomass utilisation effort for several decades and offers many valuable examples of residue recovery and energy conversion systems, with a wide range of technologies under varying utilisation plant size. Biomass-fired power stations can be found in Europe in all sizes with outputs ranging from less than 1MWe (mega-watt equivalent) to over 20 MWe. Modern wood-fired heating plants have been installed in the thousands, serving from private houses to public buildings (hospitals, schools) up to entire districts or towns (district heating plants).

Depending on size and technology type, these plants can be fed with a wide range of wood fuels, including high-quality 6-mm diameter pellets, coarse industrial pellets (9-mm diameter), chips of various size and purity, as well as hog fuel. Previous FGR reports have presented the characteristics of some of these plants and a description of the supply chains and processing facilities designed to deliver and manufacture the required fuels (Harrill and Spinelli 2019). These are mature technologies, operating at a widespread commercial level in Europe, and they are already known to the New Zealand forest industry.

The newest trends over the past few years have been mainly branching off the core business of medium and large-scale fuel production and energy generation. They target two new frontiers: 1) products other than energy and 2) further integration of biomass generation with primary production.

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Biomass products other than energy, such as biomaterials and biochemicals that can be used as, among other things, paints, detergents, industrial adhesives, bioplastics, and composite materials, are outside of the scope of this report. Suffice to say that the target is to extract high-value chemicals from wood residues and turn them into bio-products supplied to many industrial sectors. These ideas have been around for decades, but their large-scale commercial application has been plagued with high project mortality rates given the complexity of the extraction and conversion technologies involved, and the difficulty to compete with well-established conventional supply chains that have the advantages of scale economy and existing global market networks.

VERTICAL AND HORIZONTAL INTEGRATION

Further integration of biomass energy generation with primary production is one of the targets of the European Union, which has promoted biomass utilisation for its large potential in terms of rural development. Therefore, the idea has always been to try and maintain as much added value as possible within rural communities and to transfer a good proportion of the eventual revenues to primary producers, such as farmers and forest growers.

Vertical integration is where a company takes complete control over more than one of the stages in the production, distribution, and marketing of a product, integrating supply of the raw material through to its conversion into a final product. The greater the control a single company has over more elements of the supply chain the higher the value of the process. This has become necessary and has justified special attention towards products and technologies that are suitable for small-size and medium-size industries, rather than large-scale industrial corporations.

Vertical Integration

1. Recovery of harvest residue
Either concurrent with harvesting operation (integrated) or post-harvest. Working with harvesting contractor to ensure quantity and more importantly quality is retained.

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2. Transportation to designated site
May include sorting categories of residues into different products for cartage

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3. Processing to higher value products
Includes physical sorting and some form of comminution followed by sorting and quality control to achieve a quality product.

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4. Storage, sales and distribution network
Ensure product demand, pricing, supply, and delivery align. At its best, this includes conversion into energy and selling to the final user.

Figure 1: Vertical Integration

At the same time, primary producers face multiple challenges, and are offered multiple opportunities, such as obtaining a whole range of different products from the utilisation of logging residues. That has justified attention to horizontal integration, which refers to acquisition of related businesses or products that are at the same level of the value chain in an industry.

An example is taking over a company that produces other products from the same raw material. Companies that seek to strengthen their positions in the market and enhance their production or distribution stage use horizontal integration.

An example of horizontal integration where the greater the range of products made from harvest residue, the higher the conversion rate and overall value is achieved. Examples of products that can be produced from typical harvest residues is shown in Figure 2.

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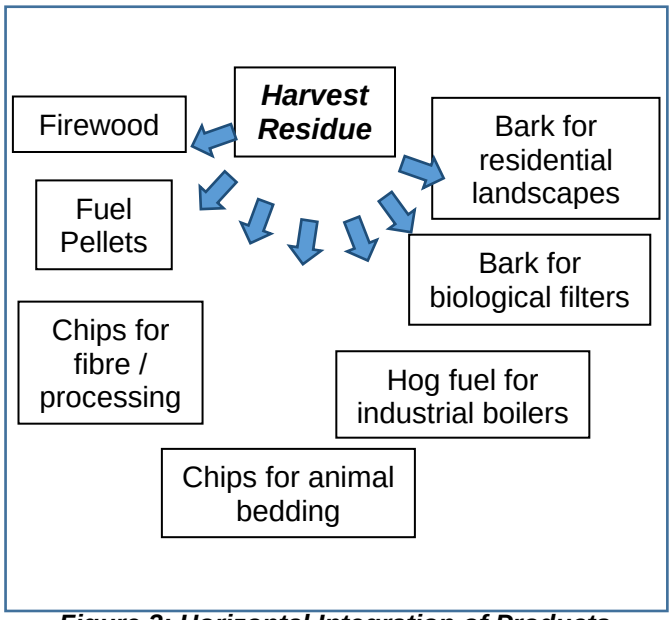

Figure 2: Horizontal Integration of Products

One interesting example of vertical integration comes from Italy and consists of the growing involvement of logging entrepreneurs with energy supply, not just in terms of raw fuel delivered to an energy conversion facility managed by a separate company, but rather in terms of service to the end user. These logging contractors and forest cooperatives have installed and are managing conversion plants so that they can supply their customers with energy. This business model is now well established and is known as ESCo (Energy Service Contracting).

For example, commissioning a small-scale wood gasification plant within their financial capability has proved to be good business, as long as green energy is subsidised by the government. Some logging contractors have even ventured into power generation for supply to the national grid. While one may debate the issue of European subsidies at length, the current dynamics in Italy highlight the possibility to get medium-size local producers involved with energy production.

THE PELLET MARKET

New and interesting developments have been spurred by the large market demand for pellets for residential users. In a temperate climate like Italy (which is comparable to the NZ climate), many users are switching to pellets which are less expensive than fossil fuel and offer the additional benefit of provisioning from multiple suppliers, rather than from a few exclusive utilities that generally issue unilateral amendments to terms and conditions of cost and service.

Many users are trying to reduce dependence on those big players - even when they offer a convenient and cost-effective service - because of the potential threat of unbalanced negotiating power. Therefore, several local wood industries have found it profitable to turn their residues into pellets by acquiring a small-scale pellet manufacturing plant (Figure 3).

Figure 3: A small-scale pelletizing plant run by a farm-forester in Central Italy.

That has also offered these industries the opportunity of using the low-quality residues that cannot be sold at a profit, which are then used for drying the higher-quality pellet material.

While the small-scale pellet boiler fuel market in Italy is immense and offers large opportunities, it also carries the disadvantage represented by the fragmentation of the customer base and the need to organise a suitable distribution network. This has been the realm of intermediaries, i.e., companies that sell the boilers, and shop owners who sell the pellets to the end-users (Figure 4).

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Figure 4: Sack of locally-produced pellets with the label "impresa boschiva" meaning "forestry enterprise" or "logging contractor".

However, retail sales is a separate business, which requires different skills and capital and absorbs resources. Reaching end-users directly and without intermediaries has been the Holy Grail for most smaller-scale rural producers in all sectors in Italy.

Local farmer markets are the traditional solution for reaching end-users in rural communities, but they typically run only once a week. The solution that appeared in northern Italy a decade ago has been the farm products vending machines. In many small towns one can now find vending machines that supply dairy and meat products, which are managed by farmers and are open 24/7 - therefore compatible with the different lifestyle of a modern urbanised society.

Approximately two years ago the same solution was adopted for sale of wood pellets. In several areas of Italy one can now find wood pellet vending machines that deliver either bags or loose pellets to any user at any hour of the day or night (Figure 5).

Figure 5: Vending machine for wood pellets (and mineral water) on a public square in Italy.

These machines are produced, sold, and installed by at least three different firms located in the north, central and southern regions of Italy, and are becoming increasingly popular. Pellet producers can order their own machines, install them in a suitable location and regularly supply them with product - collecting their revenues in the process.

Two of the largest and most established pellet vending machine producers are DAB (https://dabdistributori.com) based in Milan and Pellet Drive (https://www.pelletdrive.it), based in based in southern Italy. Both systems are remote-controlled and fully automated. Customers can pay using all major credit cards, a prepaid card released by the pellet manufacturer or via smartphone. Both companies advertise their system as plastic-free, since customers can buy their product loose and have it discharged into their own bags, with the advantage that the customer can actually see the product as it gets loaded and know that new plastic is not being generated.

This sales model is available to any company - big or small - and has the advantage of allowing direct access to all types of end users, even for small purchases, without needing to open a separate shop at an additional cost. For that reason, it could be of interest to New Zealand, as pellet consumption in New Zealand is growing and local pellet manufacturers are trying to access the local market at the lowest possible cost.

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AZWOOD ENERGY LTD

In the last 10 years, the biomass sector has undergone a relatively silent but remarkable growth in New Zealand. From a slow and cautious start around 2010, biomass has made significant inroads into the New Zealand forest economy and some of the early developments have evolved into successful business ventures - which is the more remarkable in the absence of the same extreme level of public funding support as received in Europe.

Azwood Energy Ltd. is one of these success stories, which can be taken as an example of how biomass can be turned into a viable business, capable of generating revenues and solving residue management problems at the same time.

AZWood Energy Ltd., is a well-established and large-scale energy company with its headquarters based in Stoke, Nelson and its main processing location in Brightwater. It is a New Zealand-owned and operated family business with almost 40 years' experience in the energy sector. Evolving from an earlier coal supply operation, the company founders realized the potential of biomass and made a strategic decision to leave behind coal and venture into the wood biomass sector. Current evidence shows that this decision has paid dividends, since the company is now one of the leading biomass operators in New Zealand, moving about one million cubic metres (m^3 loose volume) of biomass per year, or over 300,000 tonnes.

Azwood is a classic example of successful business integration, both vertical and horizontal. Regarding vertical integration, the company has been structured to cover the whole value chain from collection of the raw material directly in the forest, to delivery of a finished product or service to the end user. Taking stock of the many different residues streams and product opportunities available within the wider sector of wood biomass, the company has also developed multiple product lines, so that each fraction of the available residue is separated and directed to the most suitable user. That is a very efficient way to deal with the heterogeneity of wood residues and with their widespread contamination with various other material types, including bark and dirt. Turning raw residues into a commercial product requires sorting and 'cleaning', which will generate large amounts of rejects. Rather than becoming a problem, this represents an opportunity to also be turned into a collateral product.

Acting most pragmatically, Azwood has identified the opportunities and developed parallel lines of collateral products, all obtained from the processing of wood residues. In particular, the company produces and sells the following products to a wide portfolio of customers:

- Hog fuel
- 'clean' chip to board manufacturing plants
- industrial pellets
- residential pellets
- landscaping materials (bark and bark nuggets)
- compost.

Customers include large plants like the Fonterra and Synlait dairy plants in Brightwater and Dunsandel, respectively. These two companies have recently switched to co-firing wood in order to reduce their carbon footprint. Co-firing is a most practical solution that consists of mixing variable amounts of wood chips to the main coal feedstock. The main benefit of co-firing is to reduce CO_2 emissions, as well as other noxious components of the flue gas (especially sulphur), which dramatically improves the emission profile without investing in a new plant. Azwood also provides guidance on the details regarding the order of the coal and wood chip layers in the fuel mix.

Azwood has also collaborated with a number of public facilities to assist with their conversion to wood energy. That has eventually led to the commissioning of the chip-fed heating systems at Christchurch Hospital and Golden Bay High School in Takaka.

Azwood ventured into pellet production about 10 years ago in order to make the best use of the

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sawdust collected in large amounts from local sawmills. This has led to the commissioning of the pellet-fed heating plants at Kaiapoi High School in Christchurch, Logan Park High School in Dunedin, Nayland College in Nelson, and Timaru Boys High School in Timaru. Pellet production has proved to be such a successful business, that the company is currently installing a new and much larger pelletizing plant with a planned capacity of over 60,000 tonnes per year. All plants are supplied regularly by Azwood with chips or pellets quality certified according to the GoodChips® and ENPlus® schemes (Figure 6).

Figure 6: Certified chips and pellets produced by Azwood

Quality certification becomes a requirement as it removes the risk of buying a new product without a guarantee of good, consistent quality. Therefore, Azwood has submitted to an independent third-party certification scheme for both their pellets and their quality chips (respectively ENPlus® and GoodChips®). In both cases, the company has selected globally-recognised certification systems and has organized its production process so as to comply with the strict specifications of the certifying bodies.

The raw material for manufacturing these wood-based products is sourced from a variety of wood residue streams. Logging residues from forest operations are one of the main sources, but much material is also obtained from demolition operations and from sawmills, the latter in the form of sawdust, shavings and offcuts.

Processing such a wide variety of raw materials requires a comparably wide variety of equipment, and therefore Azwood has acquired two chippers of different sizes (both Morbark brand), a grinder and multiple screening machines, including a bed screen, a rotary screen, an orbital screen and a star screen. These machines are generally operated at yards and are fed with a variety of residues.

Figure 7: Harvest residues that were covering this slope below a landing have been extensively pulled back as part of the Azwood recovery operation.

Specifically for the forest industry Azwood consider they provide a service by cleaning up landings to reduce environmental risk, as well as increasing available replanting area (Figure 7). They often obtain a contribution for their landing reclaim operations, generally in the form of co-funding transportation from the forest landing to the processing yard. Logging residues are collected according to two different systems, depending on whether recovery occurs after harvest or during harvest.

Post-harvest recovery is the most common. As a first step, residues are dug up and sorted with an excavator fitted with a rake and a hydraulic thumb. Different residue types are accumulated into different piles. Discarded logs are then collected with a self-loading log truck, while the rest - binwood, slash and the bark mix - are loaded into 10-tonne bin trucks for taking to the nearest Azwood sort yard (Figure 8).

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Figure 8: Post-harvest recovery using the excavator and bin wood truck.

The frequent intermixing of residues with dirt is not the most desirable, but it offers the opportunity to collect a bark-dirt mix that is screened into separate piles of bark and wood-rich soil for selling as bark nuggets and compost to the landscaping industry. Nothing is wasted. During harvest recovery (integrated biomass recovery) is achieved by parking roll-on containers at active landings and compensating the logging contractor for filling them with offcuts.

Experience and planning is required to find a suitable place to park the containers, which must be within easy reach of the contractor's loader and must be accessible to the collector's truck at the appropriate time without causing excessive disturbance and/or incurring any safety hazards (Figure 9).

This collection model is relatively new but is gaining good acceptance and may improve collection efficiency through reduced handling. Avoiding repeated handling is one of the main goals when designing the residue recovery system. In fact, Azwood managers talk about a figurative “touch fee”, accumulating each time the same product is handled over again.

Figure 9: Recovery during harvest (integrated biomass recovery): the hook-up bin is on the left, parked at the end of the truck lane and near the loader, so that the machine can easily intercept the offcuts disposed of during log fleeting.

CONCLUSION

The business of recovering harvest residues continues to develop relatively rapidly in New Zealand. This report highlights some of the new developments from Europe, as well as presenting a case study of the successful Nelson-based Azwood Energy Company.

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