UTILISATION OF WOOD WASTE – CHALLENGES FOR THE SECTOR

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Abstract

Three main wood waste streams have been identified, harvesting residues, wood processing residues and wood waste going into landfills. The main stakeholders for wood waste utilisation have been identified as the wood processing industry, the waste management sector and the energy sector. It is found that all the stakeholders need to be involved in handling the three wood waste streams but each have a different role to play.

The wood processing industry already handles the wood processing residues and a high degree of wood waste is utilised. To increase the use of this resource for energy both the waste management and the energy sector need to get involved. For utilising the wood waste going into landfills the waste management sector is the key player, but it will need cooperation from the wood processing industry and the energy sector to increase the degree to which the wood waste can be utilised.

Although the advantages of an integrated wood waste management strategy are obvious it is a challenge to increase the use of wood waste. But if the various stakeholders focus on their strengths then the goal can be realised. Another important reason that needs to be addressed is the economic and regulatory climate need to change to encourage greater uptake of renewable, green house gas reducing bioenergy resource.

More weight needs to be given to the national good in the application of plans and the RMA. (ie the concept of NZ Incorporated). Bioenergy must capture the benefit of CO_2 reduction due to the displacement of fossil fuel use and this can possibly be achieved through the governments' "Projects Mechanism" or other appropriate mechanisms. MFE must create national policies and district and regional councils will have to follow them if renewable energy sources are to be incentivised.

The sector challenge and opportunities

A large amount of wood waste is produced in our society. Exact quantities are unknown and difficult to determine but the amount of wood waste dumped from forest processing is in the order of 1 M tons a year (Gifford et al, 2002). The amount of demolition waste going into landfills, is estimated to be 0.1 m^3 per capita per year, some of which is contaminated and the amount of garden waste is estimated to be around 1.5 M tons per year (Ministry for the Environment, 2002). Paper and paperboard is estimated to be 0.6 M tons per year. Therefore the wood waste stream is a significant part of total waste stream and represents a significant potential energy resource or a resource stream that can be used for other purposes.

Wood is a natural material and 100% renewable. There is no part of the tree that cannot be used in some way and trees form an important part of our ecosystem. Wood is an excellent vehicle through which to increase sustainability of our lifestyles, if we are able

to utilise wood in a sustainable way. Manufacturing wooden components requires less energy than alternative materials, such as aluminium or steel. In addition, 50% of the energy source used in wood processing is from wood residues and therefore renewable. Wood products can be reused, recycled, easily disposed of as wood is biodegradable and can be burnt to produce clean, green renewable energy that not only substitutes for fossil fuel use but also reduces the volume sent to landfill.

The New Zealand Waste Minimisation Strategy (Ministry for the Environment, 2002) includes 30 targets of which 15 relate to the Forestry Industry and wood waste such as the following:

- By 2003 all territorial local authorities have instituted measurement programmes to identify existing organic waste quantities, and set local targets for diversion from disposal
- By 2010 the diversion of commercial organic wastes from landfills to beneficial use will have exceeded 95%
- By 2005 full cost charging policies are established and cleanfills comply with guidelines
- By 2010, waste minimisation and management programmes have been adopted by 25% of industries
- By 2010 all sub-standard landfills are closed or upgraded.

One opportunity for diverting the wood waste stream is by meeting the various challenges faced by the energy sector including the renewable energy target (Energy Efficiency and Conservation Authority and the Ministry for the Environment, 2002), and the preferred climate change policies, (The New Zealand Climate Change Project, 2002), which aim at increasing the use of renewable energy, including bioenergy. Some of the opportunities are summarized in Table I and include increasing competitiveness of bioenergy due to rising prices of natural gas and bioenergy technologies becoming price competitive to natural gas technologies. In addition, modern bioenergy solutions are increasingly comparable to the use of natural gas in terms of convenience and reliability.

Bioenergy residues from the forestry and wood processing industry are often deemed as a waste product that incurs transport and disposal costs. The opportunity cost from avoiding disposal is an important factor for the economics of any bioenergy system. However, at the moment there is no significant "market" for biofuels so it is difficult for the wood waste producers to realise the opportunities available.

The carbon cycle

Climate change is a significant driver for the increased uptake of bioenergy as burning wood for energy is carbon neutral, in contrast to fossil fuel combustion, which is a one-way release of emissions. This is explained in Figure 1.

Trees utilise sunlight, carbon dioxide and other gases from the air, and together with water and soil nutrients, grow from a seed into a useable material for fibre and fuel. Trees remove carbon dioxide from the atmosphere via photosynthesis retaining carbon in biomass. An expanding forest is a carbon sink (carbon sinks are any natural or man-made systems that absorb and retain greenhouse gases, mainly carbon dioxide). Carbon absorption continues until a forest reaches a steady state (maturity) when the carbon balance stabilizes. Thus the forest acts as a carbon reservoir, even if individual stands are continually harvested and replanted.

Table I: Opportunities for increased use of bioenergy in New Zealand.

Issues	Opportunities
Rising natural gas prices	- Wood burners have always been economically competitive to domestic use of natural gas. - Modern wood pellets systems are economically competitive to natural gas systems. - Modern technologies using wood chips or wood pellets are close to being competitive to natural gas for institution, schools and small businesses. - Future of the natural gas supply is uncertain. - Electricity prices are set to increase
Renewable energy target	- A focus towards the wood processing industry to increase the use of bioenergy. - A focus towards other economic sectors to take up modern bioenergy solutions. - A project fund to support initiatives.
NZ Waste minimisation strategy	- 95% organic waste recovered. - levy on waste going into landfills.
Public perception	- Public support is substantial, solutions are not well known.
Wood Processing Strategy	- A significant and growing volume of wood waste available to produce energy. - Encouragement to process increase yields from bioenergy.
Climate change	- Carbon tax on fossil fuel use. - CO_2 credits available. - Joint Implementation Project funding. - Project fund to support initiatives.

Wood products produced from sustainable yield forests are also carbon stocks as about half the dry weight of wood is carbon. At the end of the product's lifetime, carbon is released back into the atmosphere as carbon dioxide or methane when disposed via combustion, or landfill decomposition, respectively. Once released back into the atmosphere the carbon cycle continues with trees absorbing carbon. Combustion of wood products effectively releases the carbon that was absorbed during growth and therefore biofuels are carbon neutral. There is an additional advantage that burning of waste residues prevents landfilling and the production of methane, which may arise from anaerobic decompostion of wood products. Mehtane has a greater global warming potential compared to carbon dioxide.

Wood waste occurs at two stages in the wood product life cycle, during manufacturing stage as in-forest residues from harvesting and at mills during wood processing and secondly when products are withdrawn form service (i.e. from disposal of wood products themselves). The lifetimes of the wood fibre varies but in the end they can all be used as fuel so long as they are not contaminated. For example forest and processing residues can be used for energy at the mill in which case the carbon in the wood is released into the atmosphere as CO_2 in a short period of time. Similarly paper will have an average lifetime of one year after which it is recycled, disposed to landfill or burnt. Recycling prolong the product lifetime, but eventually paper will be disposed of and either produce carbon dioxide if burnt for energy or landfill gas (mainly methane). The same applies for timber framing but the cycle occurs over a longer time frame.

How can the various stakeholders in our society optimise the benefits of the carbon cycle and move towards a more sustainable society? Some grow the forests, some produce wood; some handle wood waste; some build timber-framed houses; others recover paper; some handle demolition waste and landfills; some utilise wood for energy; and others use

that energy for production purposes. **In New Zealand and especially in Rotorua, there is a unique opportunity to capitalise on the drive toward renewable energy sources through interested parties working with the cluster of forest industry related businesses within the area.**

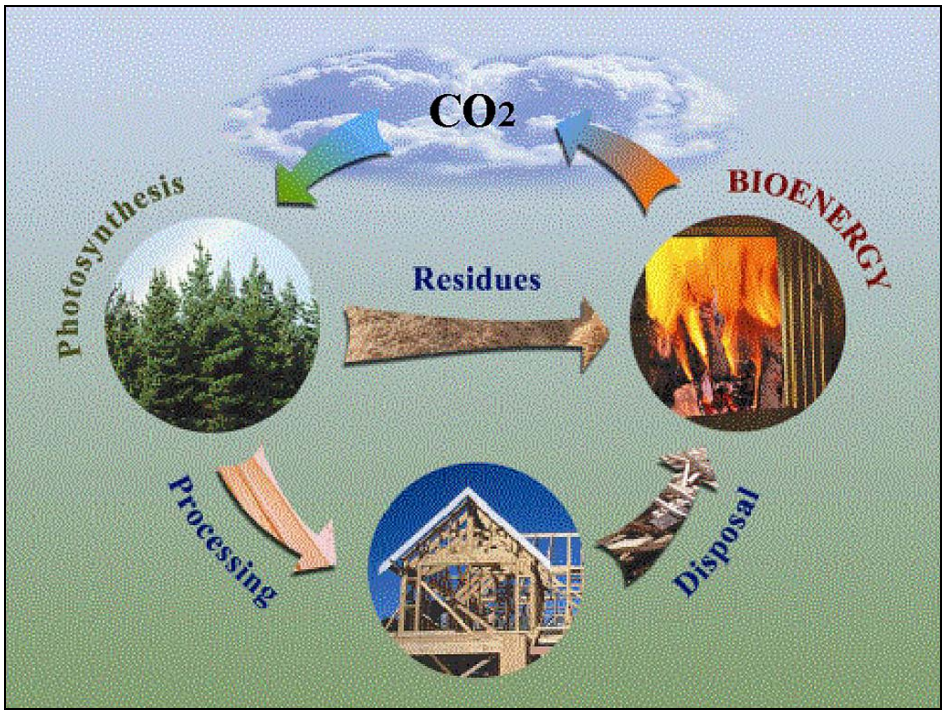

Figure 1: The carbon cycle for wood fibers.

Quality
Wood is used for many purposes and therefore it is transformed into many products. The variety of wood products results in an inhomogeneous waste stream. The various sources of wood waste materials can be categorised as different grades of "fuels" (see Table II). Fuel categorisation is according to the European "A-B-C" system based on the level of contamination. A+ is only wood and which has had no chance for contamination, A is clean wood, B is contaminated (but non-treated wood materials) and C is treated wood.

Value
The value of wood waste varies depending on the quality and how many different applications it may have. If wood waste from a sawmill is used for on-site energy and replaces other energy sources it is of high value, as it avoids disposal costs and purchasing other fuels. If the wood waste is sold for non-energy purposes or for energy purposes to other users, its value decreases considerably, unless sold for reconstituted board production or pulp. Indicative costs are provided in Table III. To optimise the profitability of wood waste a sawmill will require a detailed study as costs vary between regions and are sensitive to handling and transportation requirements. For example in the central north Island (i.e. areas close to Rotorua) the forestry sector is a major industry and hence the volume of wood waste used for energy and the volume of wood waste being landfilled would be higher than in other regions of New Zealand.

In the following a simple model is introduced to describe the sector challenge (Figure 2). On the left side are the various wood waste sources. In the middle we have the market which handles the wood waste. Only the wood-processing residues is a mature market at

present. On the right side outputs are shown, which are energy, non-energy uses and direct disposal at landfills. The non-energy uses of the wood waste may eventually go to the landfill and landfill gas may be captured as an energy source. Mighty River Power produce 71,000,000 kWh of electricity from three landfill based plants, which is sufficient energy to power 8000 households.

Table II: Wood waste streams categories as fuels.

Type of fuel	Specific group	Typical source	Grade
Firewood	Boxwood	Radiata pine cut overs from sawmill	A-A+
	Split wood	Various wood sources from skids	A-A+
	Garden wood	Cutting from private gardens and public areas	A-A+
Densified fuels	Briquettes	Dry shavings and sawdust	A-A+
	Fuel logs	Dry shavings and sawdust	A-A+
	Wood pellets	Dry sawdust	A-A+
Wood chips or forest arisings	Thinnings	Whole trees chips from plantation forests	A+
	In-forest harvest residues	Whole trees chips from plantation forests	A+
	Slab wood	Log offcuts at sawmills	A+
Wood processing residues	Bark	Debarking at sawmills and pulp and paper mills	A+
	Shavings	Wet and dry shavings from sawmills	A-A+
	Wet sawdust	Sawdust from sawing logs at sawmills	A+
	Dry sawdust	Sawdust form sawing dry timber at sawmills	C-A+
	Sander dust	Sawdust from finishing a number of different products	C-A+
Wood being landfilled and cleanfilled	Green garden waste	Leaves, grass, and branches from private gardens and public areas.	A
	Demolition timber	Timber from demolition of houses	C-B
	Contaminated timber	Left over timber from construction sites, various number of mixed materials	C-B
Waste from pulp production (only applies to chemical pulped mills)	Black liqour	Production sludge Black liquor (lignin)	C

Table III: Estimated values for different uses of wood waste.

Sawmill options for wood waste	Comments	Estimated value
Use for on site energy	Substitution of other energy sources	$30-40/tonnes
Use for other non- energy purposes	Pulp, remanufacturing products, landscaping, farm material (litter)	$5-60/tonnes
Sold for energy at other industries	Substitution of other energy sources	$0-30/tonnes
Dumping at cleanfill	Transportation costs	-$15-25/tonnes
Dumping at landfill	Transportation and fee	-$30-80/tonnes

Many sawmills utilise a large proportion of their wood waste so it will not enter ‘the market’. It should be noted that consenting of bio-energy plants including wood waste energy recovery is more difficult than non-renewable, fossil burning gas plant. However, revision of the Resource Management Act is underway at present, and this issue may be addressed as part of a wider coverage of climate change issues in the Act.

Stakeholders

One of the aims with this paper is to determine the role that each of the stakeholders has in minimising the wood waste stream. In Table IV, the strengths of the various contributors to this paper are evaluated for an indicative role in wood waste utilisation.

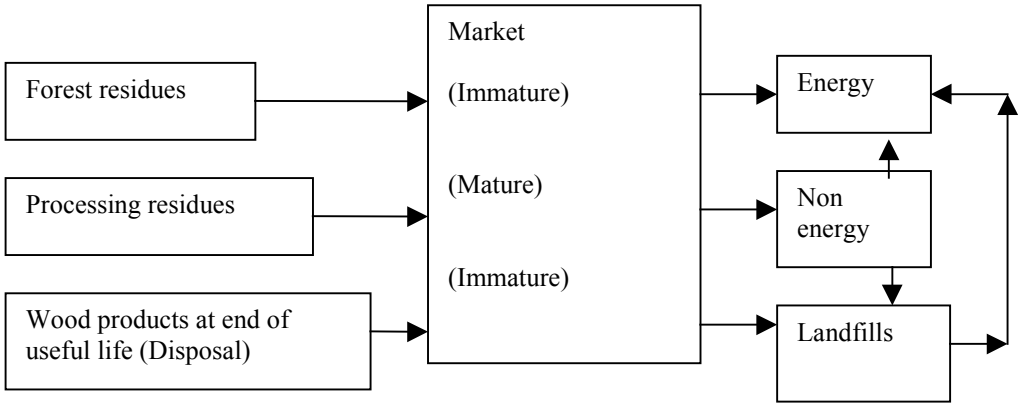

Figure 2: A simple model for wood waste management.

There are over 200 larger wood processing industries in NZ that are waste producers and sometimes waste users. Recovery of in-forest residues is purely dependent on economics and the price contractors obtain. Who would have an interest in recovering this material? The forest owner would recover the material if it was beneficial for its main product stream. If it only has a value as an energy resource the forest owner may not recover these residues, even though it might be economic viable, simply because it is not part of their main business. The energy company would not have any interest in fuel collection, but might be interested in point source materials, if it is a competitive fuel. As long as it is left in the forest it is outside the waste management sector and there is (at present) no limitations to volumes of residues left in the forest. The waste management sector may as part of their business collect and sell the wood waste stream to the users. Looking at wood processing residues, the wood processing industry increasingly is aware of waste management to reduce costs. Although efforts to reduce waste and use it on site are increasing, some still enters the waste management sector.

Wood waste sent to landfill covers all the different materials outlined in Table III. It is therefore not an easy task to manage. At the Rotorua landfill waste separation occurs for clean wood processing waste, green waste, clean demolition waste and contaminated wood waste. However separation is, and has to be, approximate to keep handling cost down. It means that if a load of garden waste or sawdust is contaminated by a small fraction of other waste, the whole lot must go into the landfill and thus clean part of the wood waste is not separated and recovered. At present there is no price differential to encourage recycling but this may change in the future and encourage increased separation and recovery. A good example is that green waste disposal is cheaper than landfill waste at a domestic level in many metropolitan areas.

Table IV: Stakeholder evaluation of wood waste production, handling and treatment processes.

Stakeholders	Role	Strengths
Forest research institution	To enhance the understanding of beneficial use of biomass for energy	- General knowledge of stakeholder interests - High technical knowledge on energy conversion - High technical knowledge on environmental issues - High knowledge on biomass projects internationally - Relatively high political influence - Good knowledge on potential resources, extraction and processing technologies and fuel characteristics - High technical knowledge of the carbon cycle
The sawmill	To ensure disposal of wood residues is done in such a way that it maximises profits of the mainstream operations	• Good knowledge of wood residues streams from processes • Excellent application for plants to convert wood residues to energy • In house skills for procurement and securing of wood residue streams for alternate applications • Industry and equipment contacts • Large capital project management skills • Experience and depth in running wood residue to energy plants • Excellent skills in building business cases & understanding economics of projects & operations
The energy company	To commercialise opportunities coming from research or new process development. To process the fuel supply (biomass) into a higher-grade energy (thermal or elect). To bring energy sellers and buyers together in a transaction or project. To sell energy at a profit for the company shareholders	- Understanding of consumer and project energy costs. - Technical knowledge of conversion technologies. - Ability to evaluate economics of project. - Potential Equity investor or project sponsor where project funding is employed. - Ability to manage large technical projects. - Ability to integrate energy into existing market. - Have existing commercial, industrial and retail customers
The waste management company	To collect and process the waste stream resources	- Access to the residual waste stream (net of site bioenergy) - Access to the urban forest - Ability to apportion some of the costs to the generator of the waste - Ability to manage complex waste management projects
The district council	To solve waste problems in the community	- Accepted by the public to have a public liaison role - It generally obtains support from local businesses - Able to attract other funding sources local, regional and national, public as well as private - Responsible for local policy development - Potentially strong linkages to the various industrial sectors - Obligations to the Kyoto Protocol - Obligations to the National Waste Minimisation strategy - Owns a large number of building - Politics set by politicians

The role the "market" is playing in Figure 2 is not very clear at the moment and it may be concluded that there is no "market" for wood waste. But the fact that only a small fraction ends up at the landfills, means that wood waste is either disposed of elsewhere, or used by the producer or another wood processing industry or a non-energy market has been found for it. The latter is assumed because there is no market at present for trading wood waste outside the forestry sector, except for firewood, briquettes or wood pellets.

Interaction with the energy sector

In converting the wood waste into energy the energy sector is currently standing on the sideline. One reason has been the historically strong focus towards electricity generation. For the wood processing industry the main interest is the production of process heat and electricity production is a side benefit. Although bioenergy technologies, which convert wood into both heat and electricity, have been around for many decades, fossil fuel alternatives were easier to handle in large centralised systems and hence fossil fuel technologies were cheaper. Only when other issues are taken into account, like disposal costs of the wood waste and environmental benefits (carbon neutrality) or when alternative resources become scarce that bioenergy technology become competitive in producing electricity.

The focus in the energy sector has changed during the last decade with two of the three cogeneration plants in operation developed from a partnership between the wood processing industry and the energy sector. One challenge for the energy sector is to evaluate projects on both heat and electricity production, but the other challenge is that meeting heat demand in general means a number of smaller generating units, which again is different from the normal operation in the energy sector. Wood volumes need to be sufficiently reliable to support the investment in plant. There are technical issues with fuel variability, moisture content, collection, storage and handling, which can be overcome by the introduction of a sophisticated fuel supply operation.

Although it is difficult to say what the future will be, involvement of the energy sector is necessary if the wood waste is to be converted into electricity. The energy sector has the skills to be a strong partner but it will probably only happen with strong political encouragement and clear priorities between processing requirements and energy generators.

Meeting local and national targets

Through national policies in both the waste and the energy sector the district councils have a role to play to make bioenergy happen. The district councils have obligations both in the national waste minimisation strategy and the national energy policy, first to encourage waste minimisation and secondly to encourage the use of renewable energy sources like wood waste. Regional and district plans need to facilitate renewable and bioenergy technologies rather than disadvantage them compared to gas burning plant. National policy initiatives from MFE, EECA and MED need to translate into national benefit objectives and policy statements need to direct the RMA to facilitate renewable policy options.

On the other hand, the councils do play a very important role as catalysts in the local community. So if the council does not take action and interact with the wood waste producers as well as the wood waste user, including bioenergy users, it is very likely that little progress will be made. The networking capacity of the local councils is very valuable and should not be underestimated.

Discussion

The main stakeholders in the wood waste sector are the wood processing industry, the energy sector and the waste management sector. Each play a different role but all need to be involved. The waste management sector appears as a likely candidate for increasing the demand for

harvesting residues and the recovery of wood waste going into landfills. Similarly, the wood processing industries could gain more from on-site utilisation of wood processing residues and treating the waste resource as part of their core business. This will reduce their material handling costs and assists in positioning their business as sustainable. The energy sector will only become a strong participant if there is fuel certainty and energy price levels or other incentives that improve the profitability to potential energy projects. Therefore a combination of forest owners, harvesting operators, mills, energy sector and waste managers could provide the required combination of interests and skills.

Wood processing residues are in the hands of the wood processing industry and only if there are specific economic or environmental reasons will it leave the site. However the waste management sector can still be involved in optimising the use of the wood waste especially in identifying the high quality wood waste in the wood processing industries, which may have a much higher value on the market, than being used in the large boilers on site. The energy sector may also play a role, in this case as a partner to operate the energy plant. In most cases, the waste provider and energy buyer are the same people, therefore if there is not sufficient take-up, then there are clearly issues with the economics.

Utilising the wood waste stream going into landfill obviously is in the hand of the waste management sector, adopting specific management plans the waste management sector can increase the value of the waste stream by separation. The energy sector can be involved in two ways; either by utilising the landfill gas which comes from the landfill, which is happening in many places in New Zealand or by securing a market for the high quality wood waste products.

The councils and national government do play a very important role as catalysts for all the potential activities to happen. It is likely that if the council and the national government do not take action and interact with the wood waste sector little progress will be made.

Conclusions

Three main wood waste streams have been identified, harvesting residues, wood processing residues and wood waste going into landfills. The main stakeholders for wood waste utilisation have been identified as the wood processing industry, the waste management sector and the energy sector. It is found that all the stakeholders need to be involved in handling the three wood waste streams but each have a different role to play.

At present there is little interest in handling harvesting residues, mainly for economic reasons. The most obvious organisation to handle this waste stream is the forest owner or operators, but they currently have no interest in doing so. In future the waste management sector might be the sector that takes on interest in this waste. The wood processing industry already handles the wood processing residues and a high degree of wood waste is utilised. To increase the use of this resource for energy both the waste management and the energy sector need to get involved. For utilising the wood waste going into landfills the waste management sector is the key player, but it will need cooperation from the wood processing industry and the energy sector to increase the degree to which the wood waste can be utilised.

Although the advantages of an integrated wood waste management strategy are obvious it is a challenge to increase the use of wood waste. But if the various stakeholders focus on their strengths then the goal can be realised. Furthermore, there are many reasons why this is not happening, which however as not been the focus of this paper. These stakeholders need to be encouraged by national and local authorities to get involved to reap multiple benefits from turning waste into an energy resource. Another important reason that needs to be addressed is the

economic and regulatory climate need to change to encourage greater uptake of renewable, green house gas reducing bioenergy resource.

More weight needs to be given to the national good in the application of plans and the RMA. (ie the concept of NZ Incorporated). Bioenergy must capture the benefit of CO_2 reduction due to the displacement of fossil fuel use and this can possibly be achieved through the governments' "Projects Mechanism" or other appropriate mechanisms. MFE must create national policies and district and regional councils will have to follow them if renewable energy sources are to be incentivised.

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