Drivers of Woody Bioenergy in New Zealand

Report to

Forest Industries Council

and

Energy Efficiency and Conservation Authority

By

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1 Introduction

The purpose of this report is to document the commercial drivers underlying the realisation of New Zealand's woody bioenergy potential and document the priorities for Government and industry in dealing with those drivers. It is being carried out within the auspices of the Wood Processing Strategy currently being developed between the Government and the forestry sector. The report draws on existing information and the author's interpretation of the implications.

The report summarises the state of knowledge of bioenergy in New Zealand, the functions and activities of the various organisations with an interest in this area, e.g. MAF, MfE, FIEA, FIC, EECA, and BANZ. From an analysis of the specific cost drivers throughout the full bioenergy value chain, the report provides a framework for further work and an outline on how to make progress by:

- increasing the use of the best information, and
- improving the relative position of bioenergy use and investment in the New Zealand commercial environment.

The report focuses only on the microeconomics of bioenergy. Companion reports cover the market structures and macro-energy implication of energy supply and demand on future wood processing.

2 Executive Summary

The bioenergy market from woody biomass is well established with an estimated 40 MW_{th} of new and replacement heat plant being installed over each of the last three years. This activity is occurring in the more developed part of the market with medium to large wood processors and has been on a steady increase. To grow the bioenergy market further requires expansion into the smaller wood processing operations.

The bioenergy market is focused on heat, as electricity production from bioenergy is not currently economic, and is even only occasionally economic in a cogeneration situation. While the economics for cogeneration of electricity will become more financially attractive as electricity prices increase, it is unlikely that production of electricity alone from biomass will be economic for some years.

50% of the capital cost of bioenergy heat plant is in the boiler with the remainder in fuel storage and handling. There is little need for improvement in boiler plant as this is well proven and is adequately available. Substantial experience and development is needed in fuel handling and storage to improve performance and to reduce costs. This is an area where the transfer of overseas experience and knowledge would be of value.

The suppliers of bioenergy heat plant equipment are the principal providers of information to potential investors. Generally there is a high quality of advice given but investors are dependent on choosing the right suppliers from the start.

Except in the few large companies where specialist staff are available few wood processing companies have the resources to undertake significant investigation and development of bioenergy options.

The knowledge of the cost drivers throughout the bioenergy value chain is poorly researched and generally rarely publicly available. While the information in this report is the best available, some of its quality is such that the results should be considered to be indicative only. Obtaining a better understanding of the economic drivers of bioenergy should be the highest priority. Collective researching this on behalf of the large number of industry participants will provide economies of effort and allow cross-fertilisation of knowledge and experience. Making this information available on an open basis to industry participants will improve decision-making and allow better management of business risk.

The economics of bioenergy are currently driven by the need for heat and the avoided cost of woody biomass process waste. Currently bioenergy is attractive against gas and coal for heat production only with inclusion of the avoided cost of waste disposal. Bioenergy is only marginally more attractive against gas and coal if there is no avoided waste cost. The relative costs will change significantly in favour of bioenergy as gas prices increase over the next few years in response to the decline of Maui gas, and post 2007 if the carbon charge is introduced.

Left to business-as-usual the bioenergy market will continue to grow but at only just above its current rate. To be fully effective as a hedge against increased energy prices the rate of uptake needs to be increased by effective collective action. Particular support is required for the large number of small/medium sized industry participants who will not have the resources to take individual action.

Forest residue as a fuel for energy production has the potential to meet all the wood processing industry's energy needs for heat and electricity. Currently the cost of residue as a fuel source is too expensive but because of its significant potential this is an area where more reliable information is required.

There are four areas where further research effort should be focused;

Fuel Quality

- Improving the homogenous characteristics of fuel
  - Pelletising
  - Reducing boiler design costs
  - Reduced O & M costs
- Improving equipment for processing wastes
  - Improving ability to take all waste
- Improving fuel storage
  - Reducing storage costs
  - Automating fuel handling

Fuel Supply

- Improving long term supply
  - Trade in surplus waste
  - Backup sources of biomass
  - Co-firing with coal and gas
- Forest residue as a contingency supply
- Improving delivered biofuel cost
  - Developed supply infrastructure
  - Economies of scale

  - Sourcing, processing and delivery technologies

Knowledge
- Preparation of;
  - Case studies
  - Handbooks
  - Good practice guides
- Research into economic drivers and risk management strategies
- Dissemination of international advances in technologies and equipment
- Dissemination of international conference papers

Experience
- Reference projects
- Case studies

There are a number of organisations each able to contribute to increasing the uptake of bioenergy. While some such as the Bioenergy Association are only in their infancy others such as MAF and Forest Research are long established. There is a need to co-ordinate their interests and pool scarce resources to focus on priority activities within an agreed Action Plan. The Bioenergy Association has taken a lead and prepared a first draft action plan for discussion but this will go nowhere unless adequately funded.

3 Overview

The bioenergy market from wood is well established with an estimated 40 MW_{th} of new and replacement heat plant being installed over each of the last three years. This is substantially more energy plant than is currently being installed on a regular basis in the electricity sector. This has received little recognition as the energy industry has until now been dominated by a focus on electricity. A paradigm shift in thinking to encompass energy rather than electricity will allow bioenergy to consolidate as a premier fuel for the wood processing industry.

The bioenergy market is focused around:
- obtaining heat for kiln drying of timber, and
- disposal of processing wood waste that is converted to heat for on-site wood processing uses.

The market also includes pulp and paper, veneer drying, MDF and particleboard manufacture.

High costs of disposal of waste to landfills are a principal driver of the economics for new bioenergy plant within the current economic context. As disposal costs increase the value of the waste as a fuel source will increase.

The economics of the energy market are currently such that an estimated 50% of new wood processing heat plant installed over the last few years is based on gas and coal fuel. Bioenergy is on the margin of the economics for heat production however it is expected that increases in wholesale market electricity, gas, coal, and oil prices over the next few years will swing the market in favour of bioenergy for heat and cogeneration of electricity. The degree of increase will depend on the fuel cost, which will be determined by what biomass fuels are used, where the energy is required, and what competition there is for the fuel.

Little bioenergy is used to produce electricity, as with current electricity prices it is generally cheaper for a wood processor to purchase electricity than to make it. The cost of gas will have to increase significantly before it will be economic to produce electricity from biomass. However the economics of on-site cogeneration based on biomass will improve as the cost of gas and other fossil fuels increases over the next few years.

The gas price is anticipated to increase anytime between 2004 – 2008 and prudent wood processors should undertake monitoring and have contingency plans to cope with these anticipated input cost increases.

Fuel supply and cost risk is the most significant aspect that investors in bioenergy heat plant have to consider. Adoption of strategies for managing these future risks such as having access to dual fuelling capability, access to other wood waste streams such as forest residue, treating waste to make it a homogenous fuel, developing a biomass fuel market (e.g. pellets), and ensuring plant flexibility will minimise likely wood processor costs.

Because bioenergy plant have a high up-front capital cost the ability to raise finance, and meet the required financial payback period, can disadvantage investment in bioenergy plant compared to lower capital cost gas plant.

Biomass is already in demand for uses other than bioenergy e.g. bark for garden mulch, and the competition for biomass will increase as new uses are identified and/ or existing sources such as for MDF plant increase in cost.

The wood processing industry is characterised by having a few large players, a few medium players and a large number of small players. In most cases the players do not have the financial resources to undertake by themselves significant research and development of opportunities that would improve their international cost effectiveness. Amongst the small/medium players there is a high degree of ad hoc decision making based on little well founded information and sound data. It is acknowledged however that a number of small wood processors have made very successful and innovative investments in bioenergy plant based on the little technical and experiential information available. Wood processors of all sizes are generally dependent on the quality of advice and engineering of equipment suppliers. While the quality of advice and engineering is generally high there are well known examples where inappropriate suppliers have provided inappropriate equipment probably due to a lack of experience on the part of the investor.

The forest processing industry has moved from being lead by Government initiatives through the period of the 1950s – 1990s when the NZ Forest Service in particular had extensive research programmes and information was freely available. The industry then moved into a laissez-faire period when market participants looked after themselves. Since then it has been widely recognised that significant gains can be made by pooling scarce resources. Shared monitoring and information will assist the large number of small wood processors to continue innovation and respond to anticipated changes in the cost and risks of energy supply.

The bioenergy market is constrained by the price of biofuel. As the price improves relative to other fuel types the bioenergy market will expand further from its current sound base.

4 Industry Players

4.1 Wood Processors

Many wood processors have bioenergy facilities. These have been installed over the years and are totally based on combustion technologies. Small sawmills tend to have old, second-hand, or simple pile burner combustors producing heat for timber drying. Larger sawmills have more sophisticated combustors for kiln drying, and large wood processors such as LVL, MDF, pulp and paper mills and others have a range of plant to produce heat which is used in their production processes. Except at large integrated sites, such as Kawerau, there is very little sharing of heat plant to gain economies of scale, mainly because of their generally scattered location.

Wood processors also use significant amounts of electricity which is generally imported to the site. There is very little on-site electricity generation other than at large processing sites.

Except for the Kawerau industrial area where geothermal is utilised, wood processing sites have generally been developed over the years with little reference to energy requirements. This has resulted in plant generally being installed without reference to optimising on-site energy use. The focus has been on the wood processing and energy has been seen simply as a commodity input.

Except for large companies there are rarely experienced energy staff on-site and management generally rely on suppliers for their energy advice.

Many medium/small sites also still have significant biomass waste streams which are dumped, traded or sold for other purposes, more as waste than as a potential fuel. Because of the cost of waste processing plant, and the need to spend scarce funds on core production facilities, little attention is often taken on maximising value from the waste for bioenergy production. In recent years however some wood processors have begun to coordinate their waste streams in order to keep costs to a minimum or maximise value.

4.2 Biofuel Managers / Handling

There are players now entering the market who are collecting forest residue and chipping it but generally it is left in the forest or on landings etc. As the value for forest residue derived chip increases, more companies undertaking chipping will enter the market. None at present are processing forest residue as a fuel for bioenergy plant, but as more companies undertaking chipping and hogging enter the market their fuel preparation and processing costs should reduce and this should flow on to the cost of processing forest residue for fuel.

Most fuel for bioenergy plant is obtained from on-site sources. Only Biogrid and Energyco at Kawerau actively manage the waste streams from and between multiple sites. For other companies biowaste is rarely brought in from other sources as generally plant has been sized to handle on-site waste only.

Fuel handling and storage equipment can be up to 50% of a bioenergy facilities capital cost. This is an area of activity that often encounters problems because of the difficulty of the material being handled. Equipment suppliers in this area are developing experience but it is often an area of frustration with significant breakdowns.

4.3 Boiler Suppliers

Suppliers of boilers and other heat plant generally have sound products that work well and are well proven and engineered for long life. There are several suppliers of larger plant and small cost effective plants. The largest units being installed tend to be up to around 20 MW_{th} although some large sites are now reaching 100MW_{th} with the installation of a number of heat plant units generally being put in over a period of time.

The suppliers of larger heat plant are supported by large overseas companies who provide product backup. Suppliers of smaller heat plant tend to be local manufacturers and have less strong backup of their equipment.

4.4 Energy Supply Companies

Energy companies are entering the market to supply heat plant facilities. Companies such as Meridian Solutions will contract to install and operate heat plant and provide heat to contractual specifications. Fuel, particularly gas, suppliers may also fund capital plant to support purchase of their fuel.

4.5 Industry and Other Organisations

4.5.1 New Zealand Forest Industries Council

The New Zealand Forest Industries Council represents and promotes the interests of all sectors involved in the New Zealand forest industry. Its mission statement reads: "To facilitate the establishment of New Zealand as the leading international source of innovative and environmentally excellent forest products".

The Council's goal is to enhance the international competitiveness of New Zealand's pulp and paper, remanufacturing, sawmilling, wood panels and resource sectors.
The Council represents an industry based on a sustainable, managed, planted production forest resource of 1.7 million hectares.

It is partnering with Government with the Wood Processing Strategy (WPS).

4.5.2 Bioenergy Association of New Zealand

The Bioenergy Association of New Zealand (BANZ) represents the commercial bioenergy sector and aims to provide a single point of contact for all participants in the bioenergy market.

The Association provides members:

- opportunities for networking,
- latest technical and market information,
- opportunities for brand exposure, and
- an avenue to influence market policies and issues.

The Association is in its formative stages and has yet to build its membership and programme of activities. It also has yet to develop a track record and reputation in its area of advocacy. It has recently appointed a part time Executive Officer which is necessary in order to fulfil its objectives.

The critical issue for the Association is funding as the need for research and information is far greater than the current funds available will allow. As the Association develops it is expected that the beneficiaries of its work will assist in its funding.

4.5.3 Energy Efficiency and Conservation Authority

The Energy Efficiency and Conservation Authority (EECA) is the Government agency with prime responsibility for the promotion of renewable energy including bioenergy, working closely with the Ministry for the Environment on policy. EECA is a sustaining member of the Bioenergy Association and it also funds activities that assist with increasing the uptake of bioenergy.

Development of the Government Renewable Energy Policy is a prime responsibility of EECA and Ministry for the Environment. This is being carried out within the National Energy Efficiency and Conservation Strategy and a renewable energy target and mechanism is being developed alongside the Government's climate change policy.

4.5.4 Ministry of Agriculture and Forestry

The Ministry of Agriculture and Forestry advises the Government, as it develops policies, legislation or regulations affecting forestry. It addresses a wide range of issues affecting the forestry and wood processing sectors. They include issues relating to international trade, the performance of the sector, matters affecting health and safety and the sustainable use of resources. This involves gathering information, consultation, research and advising the Government on policy formulation.

MAF collects and publishes data on the forest resources, processed forest products and national and regional wood supply forecasts. MAF is also responsible for administering the Forests Act, the East Coast Forest Project and Crown Lease Forests.

4.5.5 Ministry for the Environment

The Ministry for the Environment is the lead Government department on energy efficiency and renewable energy policies, working with EECA on promotion programmes and reporting to the Minister of Energy.

4.5.6 Industry New Zealand

Industry New Zealand has responsibility for managing the Wood Processing Strategy on behalf of Government. The Wood Processing Strategy is a partnership between the forest industry, central government and local government to significantly accelerate the development of wood processing and associated industries and get the best value from the regional expansion of wood available for harvest. The strategy, begun in early 2001, was the first industry development partnership for the Government.

Stage one of the strategy had been completed by July 2002 with Government issues such as; transport, the Resource Management Act, climate change and skills and training, having been addressed although some ongoing work is still needed.

There are 10 working groups charged with implementing programmes, involving infrastructure, labour and skills, research, science and technology, the Resource Management Act 1991, trade access, investment, national certification, biosecurity, climate change and energy and safety.

4.5.7 Foundation for Research Science and Technology

The Foundation for Research Science and Technology (FRST) has a funding programme for New and Emerging Energy Technologies that has recently been set for the next two years after receiving applications from interested parties. It includes research on renewable and clean energy (non-polluting) technologies as well as on underpinning science platforms that are not currently mainstream in New Zealand. The aim of technology developments in this area is to improve the economic competitiveness of sustainable and renewable energy sources; assist in mitigating greenhouse gas emissions; and provide export opportunities in distributed generation and credits for carbon trading. This portfolio is linked to a number of other portfolios.

4.5.8 New Zealand Timber Industry Federation Inc

The New Zealand Timber Industry Federation Inc is an organisation of mainly independent small to medium sized sawmilling companies with productions ranging from about 10,000 m^3 pa to in excess of 150,000 m^3 pa. The Federation's membership probably accounts for about 90% of the sawmilling companies in New Zealand.

Federation activities include collection and dissemination of data and information to members, convening meetings of members, providing advice to members on a range of issues, assisting with market development and promotion and managing quality programmes such as Woodmark and New Zealand Dri.

Through its networks the Federation is able to facilitate the exchange of views and information on matters of interest to members.

4.5.9 Forest Industry Engineering Association

The Forest Industry Engineering Association runs training seminars for the wood processing industry and in recent years have run two very successful seminars on bioenergy. The FIEA is well suited to provide seminars on other aspects of energy and in particular bioenergy if the industry recognised the need.

4.5.10 Regional and District Councils

The Regional and District Councils often have economic development staff who use databases such as the MAF forest resource data and forecasts in the development of regional economic development strategies. Council's will also be contacted early in the planning process for new wood processing developments as they provide guidance on consent requirements. They rarely however take an interest in the opportunities or barriers to bioenergy with the result that general policies implemented by their own council planning departments, such as planning and consenting processes under the Resource Management Act, can often be a barrier to bioenergy uptake. Through proactive action they may be in the situation whereby they can assist with the creation of clusters of energy users to gain energy management advantages.

5 Summary of Research and Development

Bioenergy research based on woody biomass is undertaken by Forest Research, the Centre for Energy Research at Massey University, CRL Energy and a few consultants.

There are adequate researchers available to work on bioenergy but there is a general lack of appreciation from the industry and funders of what needs to be done and what the priorities are.

Research tends to be researcher driven rather than industry driven because of lack of interest from industry, the self-sufficiency of the large wood processors and the lack of capability of the medium and small wood processors.

To achieve a more effective uptake and implementation of research requires closer interaction between providers and users, and users need to have a strategic interest in the research being undertaken. In addition, there needs to be a strategic mix of commercial, applied and fundamental research, which supports short, medium and long-term industry objectives. Such a mix needs to be supported with a blend of public and private funding with the private funding having a more short to medium term focus, and the public funding supporting longer term fundamental research with higher risk. However the large numbers of medium / small companies individually do not have the cash flow to assist funding such research.

Research funding is available through the FRST for fundamental research which are typically for programmes that are over $100k per year for 2 to 4 years. However it is difficult to get public funding to support small targeted research projects for specific components of the commercial sector. For example there are no funds available for say a boiler manufacturer to get $20,000 to undertake some tests on clinker build up on boiler grates when co-firing with coal, or for a fuel handler to obtain $15,000 to test the abrasion of wet sawdust on pneumatic ducting. Funding is available through Technology New Zealand, but once again these are often for larger programmes.

There are also no funds available to get handbooks, good practice guides or case studies prepared and promulgated to wood processors who need this type of information for decision making. There is a need for a contestable fund for this applied research, but not in the same sense as a FRST bid which has huge overheads.

There probably are some funding sources (e.g. Sustainable Management Fund, Tech NZ, Enterprise Scholarships, Graduate Industry Fellowships etc) which may enable a small company to tackle some projects and may be available, but as a general rule it is not easy and a lot of effort goes into winning such money. In addition the bulk of the industry is probably not aware of their availability.

Government argues that NZ businesses invest too little into Research and Development compared with other OECD countries and should fund this sort of project itself. However, with the small/medium size of most wood processors who are struggling to remain cost competitive, the reality is that there are rarely adequate funds to undertake even basic investigations let alone R & D.

In general there is insufficient priority on driving the relative costs of delivered bio-fuel down. In the absence of a cost advantage (i.e. the short term) investors will not get interested when the cost is high. Driving the cost down is obviously important in the long term in order to provide competitive advantage for exports.

An issue regarding short rotation crops is that foresters have been reluctant to adopt a pulp wood regime because of the low returns. Similarly bio-fuel is likely to offer even lower returns so the key to bioenergy in the short term has to be through a focus on process wastes followed by forest residues.

5.1 Bioenergy Association

The BANZ has recognised the need to provide a focus for bioenergy research and information and is in the process of developing a Research and Information Programme. BANZ proactively promotes its research programme to both researchers with proposals, and members who have common issues to be addressed. It aims to have a programme that can demonstrate to funding bodies such as FRST the needs of the sector and that there is a body of research not being addressed. It also will provide an avenue for showing priorities for research across longer-term fundamental, medium term applied and short-term commercial applications.

The Association research and information programme objectives are:
1. To have a Research and Information Programme that supports the value proposition to potential members and encourages them to join.
2. To undertake research that provides common value and spreads the cost over a number of parties.
3. To provide shared funding, mechanisms and a programme of obtaining, storing and disseminating bioenergy information to members.
4. To become proactive in establishing priorities for research and development which supports the implementation of bioenergy and the lobby, training and promotion activities of the Association.

[Note: Individual members are responsible for managing or undertaking specific projects.]

At any one time the Research Programme is split into topics with funding, and those for which funding is still being sought. Inclusion of the topics seeking funding will assist BANZ to demonstrate to funding agencies that there is a body of research not being addressed. This may also encourage potential researchers and industry to put funded projects together.

The BANZ research programme should be a key input into the FRST process for establishing priorities for bioenergy research. However to date there has been little interest from industry and the programme as a result tends to be researcher driven.

The current draft of the BANZ identified list of research needs is attached in Annex A. This is purely a list of identified research needs and does not indicate priority or ability to be funded.

5.2 Forest Research

Forest Research has been the pre-eminent research organisation on bioenergy for over 20 years. It works in collaboration with CRL Energy and Massey University.

Forest Research is the contracting agency for NZ's involvement in the IEA Bioenergy research programme.

Forest Research has a research programme funded by FRST covering the full bioenergy value chain from tree planting, fuel collection and energy conversion.

The specific objectives of the current FRST funded research programme relevant to the Wood Processing industry are:

1. Develop information on and costs of delivering wood process residues and wood waste from landfills for use as a fuel source for energy production for the wood processing and other energy use sectors. Identify technology options for fuel up-grading to optimise the value of wood wastes as a fuel.
2. Undertake energy demand analysis for institutions, schools and community buildings and identify opportunities for using bioenergy to meet new energy demands.

Forest Research's interest in bioenergy links to improved utilisation of forest resources, reducing the environmental impact of wood processing operations, enhancing of the overall environmental benefits of wood products, enhancing the role forests have in greenhouse gas mitigation, and identifying opportunities for integrated land use and renewable energy in a sustainable economy.

5.3 Centre for Energy Research, Massey University

Research lead by Massey University's Centre for Energy Research is well respected domestically and internationally following over 25 years of activity in the biomass area. Funding has been obtained for a range of applied studies in parallel with accelerating international research and development. Current and recent projects have included gasification of comparative wood species; field trials on the production of short rotation energy crops to maximise GJ/ha/year; year round harvest to reduce storage costs and losses; transport and operational logistics of forest arisings and energy crops; land treatment of effluent on to energy crops; carbon sequestration; methanol production; and small scale biomass plants.

Dr Peter Read, (in association with CRL Energy and Victoria University) is pursuing the investigation of long range scenarios for joint bioenergy and forest product outputs from long and short rotation plantations, with consequential impacts on prices and carbon in the atmosphere.

A series of studies of distributed generation for rural communities using renewable energy, both in New Zealand and in developing countries, has also included the potential for bioenergy.

5.4 CRL Energy

CRL Energy focuses its research on the combustion characteristics of bioenergy.

CRL Energy works in collaboration with Massey University and Forest Research on FRST funded research.

Current research is to identify the causes of increased slagging and environmental impacts that may arise when biomass residues are co-fired with coal.

5.5 IEA Bioenergy

Forest Research is the contracting agency for NZ involvement in the IEA Bioenergy programme and is interested in identifying co-operative funding mechanisms to sustain NZ's continued involvement in this international research collaborative. Discussions are underway between Forest Research and BANZ to develop a protocol whereby BANZ progressively increases its responsibility for NZ participation in specific tasks. BANZ would through its research and information programme contract Forest Research to undertake specific activities.

- 19 countries belong to IEA Bioenergy.
- The work within IEA Bioenergy is structured around tasks, which have well defined objectives, budgets and timeframes.
- The collaboration of IEA Bioenergy was initially focused on research, development and demonstration. It now has an increasing focus on deployment.

IEA Bioenergy provides opportunities for:

- *Researchers* - to exchange information on recent developments in R&D through networking, meetings and/or workshops; to provide opportunities for collaborative R&D.
- *Industry* - to be informed of new projects; to work together to develop handbooks or models; to offer early participation of industrial partners in RD&D work.
- *Policy-makers and decision-makers* - to gain an international perspective on progress in bioenergy; to compile guidelines and standards; to gain new perspectives on deployment opportunities and issues.

New Zealand is currently a member of four IEA Bioenergy Tasks:

- Short rotation crops for bioenergy
- Conventional forestry systems for bioenergy
- Biomass combustion and co firing
- Greenhouse gas balances of bioenergy systems

Current tasks that may also be of interest to NZ are:

Task 29	Socio-economic activities
Task 33	Thermal gasification of biomass
Task 34	Pyrolysis of biomass
Task 35	Techno-economic assessments for bioenergy applications
Task 36	Energy from integrated solid waste management systems
Task 39	Liquid biofuels

Currently the wealth of information produced from the IEA Bioenergy programme lacks promulgation to the NZ industry. The BANZ / Forest Research arrangements have the objective of gaining greater value for NZ industry from the programme. Discussions are also being held with the Ministry of Economic Development who funds other IEA programmes.

Adaptation of the international knowledge and experience along with the experience of NZ suppliers and their advisers is a necessary priority for increasing the uptake of bioenergy technology.

5.6 Foundation for Research Science and Technology

While FRST has a research fund and criteria for funding, this occurs currently in the absence of a bioenergy research strategy. Bioenergy has been slow to gain market traction in New Zealand's energy market, consequently it has been difficult to gain significant market stakeholder input into the development of a comprehensive bioenergy research strategy and in establishing the nature and scope of strategic research programmes. In the absence of this input the main drive has come from research providers who have been looking 5 to 10 years ahead. As the bioenergy market begins to mature, due to more market acceptance arising from new Government and environmental drivers, then it is anticipated that this process will change and FRST can expect more strategic input through BANZ and the Wood Processing Strategy. However there is no apparent vehicle for generating direction from the wood processing industry on priorities in this area and urgency is required.

Massey University and Forest Research have over the years had a strategic view and have attempted to engage a diverse range of players with mixed success. Forest Research has held at least one bioenergy seminar/conference per year each targeted at a "semi - interested" industry but engagement with the industry has been spasmodic. A change of approach appears to be required in order to achieve integration.

Although FRST has established criteria and processes to allocate funding across a diverse energy portfolio, final funding allocations have not always appeared to be entirely consistent with what have been identified as critically important Government initiatives. For example, the role that forestry has for New Zealand's economic development. Such a decision making process however is always going to be difficult in an environment of rapidly increasing demand for research funding and the availability of such funding from Government.

Despite FRST objectives, FRST research results are not generally available to the industry. The researcher captures the knowledge. Despite being publicly funded the information does not become publicly available, or if it does, there is little evidence to suggest any focus on communicating the benefits of the research to the sector standing to benefit from the research.

For FRST funded research to be effective, technology transfer is imperative.

- Technology transfer needs to be developed as part of the strategic development of New Zealand's bioenergy industry.
- Technology transfer on bioenergy needs to be woven into a broader framework, which will ultimately involve a much larger group of stakeholders. For example, research on slagging and fouling in boilers using coal needs to be linked to the economic analysis of capital and operating costs for producing energy.

6 Cost Drivers

An analysis of the current heating cost of alternative fuels compared to that of bioenergy using new plant and with no allowance for avoided waste disposal costs, is shown in figure 1.

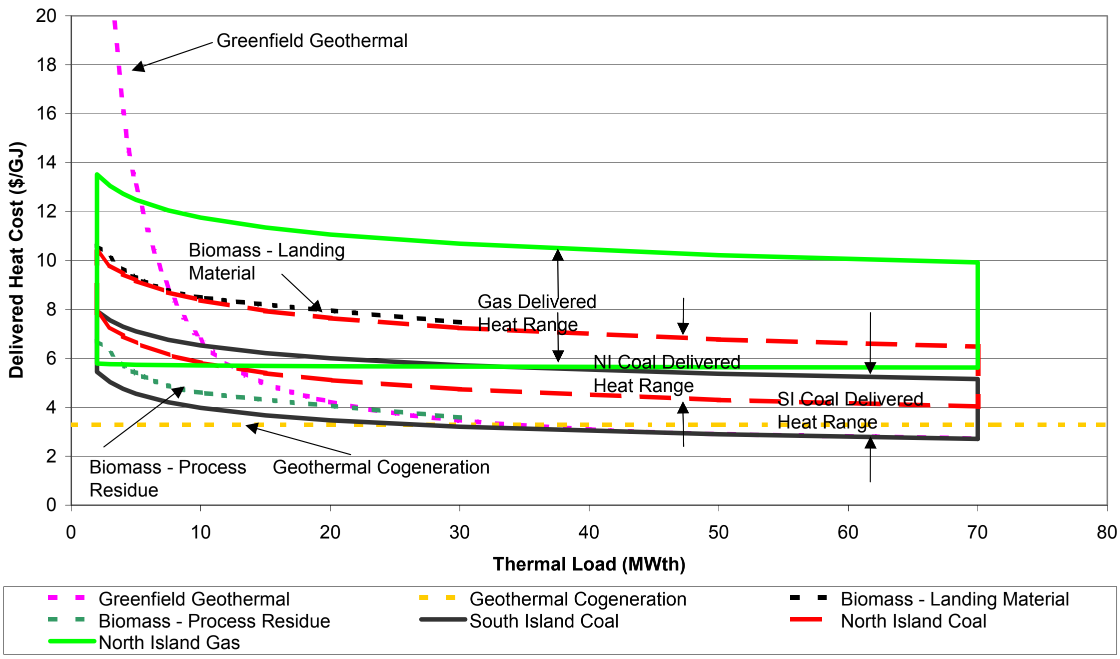


Figure 1 Heat Plant Delivered Energy Costs (includes capital, O & M and fuel costs at 10% WACC and 20 year life)

Figure 1 shows that bioenergy is currently competitive with coal for process heat. In a number of locations coal or gas would be the fuel of choice, while in other locations bioenergy will be more attractive. The choice will come down to risk management considerations and the future value that will be placed on carbon emissions to the atmosphere.

A discussion on the cost relativities between fuel types with anticipated increases in the price of gas is covered in the companion report prepared for the Wood Processing Strategy on future energy supply. The companion report discusses the anticipated increase in the cost of future gas supplies and this is summarised in tables 1 and 2. The increase in the gas price will make gas less attractive as a fuel for heat plant. Similar but smaller effects will occur with the consequential increase in the cost of coal.

Bioenergy is currently marginally economic for heat production, but as the cost of gas and coal increases, wood processors will be more attracted to bioenergy for heat production. This will increase the industry experience with modern heat plant and, along with the future climate change policy implementation, will be the most significant driver for a greater use of bioenergy. On the other hand the cost of biomass for fuel will increase as it becomes recognised as a valuable feedstock for processing such as MDF.

The discussion on the effect of proposed climate change policies is covered in the companion report and summarised in tables 1 and 2. With the current proposed carbon charge of up to 25$/tonne of CO_2, bioenergy for electricity production will gain a 1-2.4 c/kWh advantage at the upper range compared to gas and coal production of electricity. The effect on the price on coal or gas derived delivered heat could be around an increase of $1.8 – 2.7/GJ respectively

With increased gas and coal prices forest residue will be getting close to being economic.

Table 1 Additional Heating Costs due to Gas Price Increases and a Carbon Charge

	Additional Heating Costs $/GJ [1]			
Individual Cost Increases	**South Island Coal**	**North Island Coal**	**North Island Gas**	**Geothermal**
Increased gas and coal cost only	1.3	1.9	2.7	0.0
$25/t CO_2 charge only	2.6	2.7	1.8	0.4
$10/t CO_2 charge only	1.1	1.1	0.7	0.2
Combined Increased costs $/GJ				
Gas $2/GJ plus $25/t CO_2	3.9	4.6	4.5	0.4
Gas $2/GJ plus $10/t CO_2	2.3	3.0	3.4	0.2

These combined increased costs represent significant increases in current heating costs of around 50% to 80%.

The bioenergy cost ($/GJ of useful energy output) is particularly sensitive to:
- fuel feedstock production costs
- fuel collection and harvesting costs
- transport/delivery costs
- competition for biomass for processing and fuel
- future climate change policy imposts
- moisture content
- fuel quality (including contamination issues)
- transport distance
- capital cost of equipment (especially fuel handling equipment)
- labour requirements
- conversion efficiencies
- load characteristics

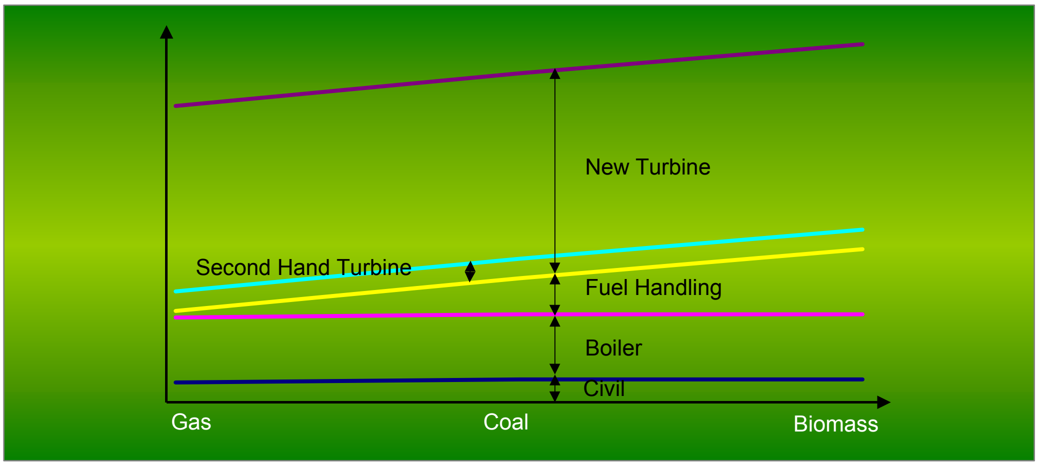
6.1 Capital Costs

Analysis of typical heat plant indicates that approximately 50% of the capital cost is associated with the boiler cost, and 50% with the fuel storage and handling. If electricity generation is required this can double the capital cost because of the higher pressure of the boiler, costs of a turbine, generator and sometimes a cooling tower.

[1] Conversion factor: 1 $/GJ =0.36 c/kWh

Figure 2

Approximate Split of Capital Costs

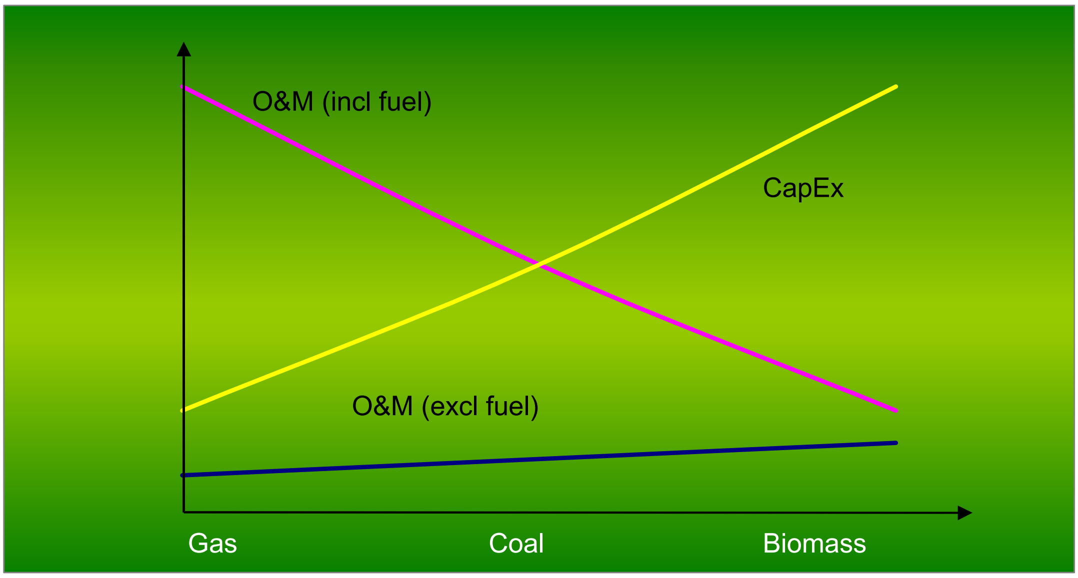


A bioenergy facility has a higher capital cost than a gas or coal facility but as can be seen from figure 3 the fuel for the gas and coal facility can be substantially more. This applies to both heat and electricity generation plant.

Many coal facilities have been installed even when there are adequate quantities of biofuel available because second hand coal boilers are available at a fraction of the cost of new bioenergy plant.

Figure 3

Relationship Between Costs and Fuel Type



6.2 Wood Waste Fuel

Table 2 shows the current and projected contributions of the different residue streams.

Table 2 Assessed Biomass Resources[3]

	Plantation Forest Harvest		Resource Available				Energy Value		
Year	Harvested Volume [2] (Mm³)	Processed Volume[4] (Mm³)	Forest Residues Including Cutover (Mm³)	Forest Residues Excluding Cutover (Mm³)	Wood Processing Residues (Mm³)	Residue After Forestry Industry Use[1] (Mm³)	Forest Residues Including Cutover (PJ)	Forest Residues Excluding Cutover (PJ)	Process Residues (PJ)
1984	8.5	8.1	1.6	0.2	2.0	1.3	13.7	1.5	16.0
1988	9.0	8.5	1.7	0.2	2.1	1.4	14.4	1.6	16.8
1994	14.8	10.3	2.8	0.3	3.4	2.3	23.5	2.6	27.6
1995	16.0	11.2	3.0	0.3	3.7	2.4	25.2	2.8	29.8
1996	16.6	10.8	3.1	0.3	3.8	2.5	26.1	3.0	31.0
1997	15.9	10.4	2.9	0.3	3.7	2.4	24.9	2.8	29.7
1998	16.6	10.8	3.1	0.4	3.8	2.6	25.9	3.0	31.2
1999	15.7	10.8	2.7	0.3	3.6	2.3	23.0	2.8	28.4
2000	18.0	12.5	2.9	0.4	4.1	2.6	24.8	3.2	31.5
2003	26.3	18.4	4.0	0.6	6.0	3.6	33.8	4.7	44.2
2008	30.8	21.6	4.4	1.1	7.1	4.0	36.8	9.1	48.3
2013	31.3	21.9	4.4	1.2	7.2	4.0	37.1	10.0	48.8
2018	33.6	23.6	4.6	1.2	7.7	4.2	38.8	10.5	51.4
2023	38.9	27.2	5.3	1.4	8.9	4.9	44.9	12.2	59.4

1. This residue is Wood Processing Residue after Forestry Industry Use, and does not include Forest Residues.
2. Projections include estimates from Forest Industry Engineering Association.
3. Source for assumptions: Forest Research, East Harbour, Massey University, *Bioenergy From Woody Biomass In NZ*, EECA, 2001.
4. The percentage of the harvested volume that will be processed is difficult to predict. More recent work indicates that the percentage has been dropping steadily over the last couple of decades and is currently about 65% rather than the 70% assumed in this table.

Input feedstock costs range from a negative cost for disposal of wastes, through $20-30/tonne for residues used on site, to $40/tonne for processed biomass transported some distance to the point of use. This cost is getting close to that of wood chips, which is often, just above the $40/tonne level. This price represents a ceiling for the price of biofuel.

Green biomass has a relatively low energy content (7-10 MJ/kg), which loads additional costs of transport, storage and handling and hence increased costs/GJ. Often biomass is difficult to recover, is poorly distributed, and is produced some distance from the potential users. The exceptions are wood processing residues generated on site and energy plantations grown near to areas of demand.

Techniques for drying, handling and storage of the wood waste fuel have been developed for a number of local applications. Wider development will occur once the relative economics improve. This is an area where further work however is required and where adaptation of international experience would be of value.

There is already a critical and fundamental supply/demand dynamic that exists around existing wood waste biomass supplies and the growth in the use of biomass for energy. It cannot be assumed that the value of the waste remains at zero, or less, at source as competition between consumers of this new 'resource' develops. The value of the waste will rise at a differential rate by region depending on the supply demand/balance within each economic catchment area. Theoretically the value will rise to the net calorific equivalent of alternative fuels, adjusted for relative conversion efficiency, once the wood waste supply becomes a constraint. Moreover the current users of wood waste, as raw material inputs for wood products will drive the price of this material up to just below the cost of virgin wood chip. This situation will occur in, say, the Central North Island where Fletcher Wood Panel already consumes 28-32% of the available biomass wood waste from processing operations. Current users such as Fletcher Wood Panel will have no alternative but to bid higher for the waste to the point of closure.

As the value of wood waste increases then other currently unused waste streams will start to be used.

6.2.1 Forest Arisings

Forest arisings can provide a fuel supply risk mitigator. As a contingency fuel supply the resource can be harvested from landings as required without problems associated with storage. In-forest processing and transport will determine the cost.

As a contingency fuel supply it will be of little value while forest residue harvesting is not developed to augment normal operations.

The cost curve shown in Figure1 shows a declining curve with increased volume, however this may not occur if the increased volume requires transport with greater haul distances.

There is debate over whether cutover (the material left in the forest away from the landings) should be included in the forest arisings resource, as it is more expensive to harvest and currently unused as a fuel for bioenergy production. There is also a nutrient depletion issue associated with collecting this dispersed material and taking it out of the forest. (Finland is satisfied that leaving one-third in the forest is sustainable). Assessments on a cutover inclusive and exclusive basis by region have been made in Table 2.

On a percentage basis, residues including cutover are forecast to decrease from around 16% by weight currently to less than 14% of the harvested volume by 2025 due to a trend toward whole tree processing. This assessment still excludes cutover on land that is too steep to harvest. However other observers of whole tree processing which has been going on for some time believe that the same quantities of arisings are occurring – sometimes at the landing, sometimes on the cutover on undulating land.

Excluding cutover and only considering material collected at landings and centralised extraction points, published assessments indicate a rapid increase in the quantity of residues from around 2% by weight now, to 3.7% of the harvested volume by 2012 and beyond, largely due to whole tree processing using log haulers. Estimates are summarised in Table 2.

The waste proportion will change over time as different growing and pruning regimes occur.

Note that while some trials have been undertaken on use of forest arisings at Kinleith, and some scavenging from landings may occur, this resource is essentially unused as a fuel. There will be competing demand for this resource for chipping if prices for particle and fibreboard products grow or sources of chip become scarce.

While these prices have always fluctuated and will continue to do so - the long run prices are declining in real terms so there will be a push for lower wood fibre prices.

An issue associated with the supply of forest arisings is the split between forest owner and wood processor. This split means that in these situations there is no security of fuel supply and the bioenergy operator is dependant on the market cost of fuel from the arisings. While the security of supply is no different from making products from logs, ownership of the forest would ensure fuel supply contingency. The goal with biofuel extraction will be the achievement of a win/win contractual situation for the forest owners and processors.

There may in future be a small energy market associated with forest residues from Eucalypts grown for pulp forests.

Bark is a potential energy fuel but is highly sought after for processing into garden products. Quantities are also reducing in some areas where mechanised de-limbers also remove substantial quantities of bark which ends up as waste on the forest floor.

6.2.2 Wood Processing Residues

Wood processing residues potentially arise from all wood processing. Typical residue streams consist of sawdust, shavings, off-cuts, chip fines, bark, chip rejects and log-ends. The bulk of this material is untreated.

In recent years as forest harvest volumes have increased, the percentage of wood locally processed has dropped from 95% to 65%. The projection for wood processing residues given in the EECA Woody Biomass Report (2001) suggests that processing residues will stay fixed at 23% of total log volume harvested despite trends of decreasing wastage, implying an increasing percentage of local processing.

Of this residue, slabwood and chips from sawmilling will be reused in other processing activities. About half is available for energy production, with half of this currently consumed by the forestry industry, (what particular part of the industry is unclear). Projections are given in the Table 2. This is assuming that the Wood Processing Strategy is successful in its objectives of processing in New Zealand by 2015 at least 50% of the additional wood harvest. The actual volume of wood processed in New Zealand will, however, increase with the almost 50% rise in wood harvest volumes over the next 10 years.

Note that there are competing non-energy uses for this residue, and that some residue may have unfavourable combustion characteristics, e.g. propensity for slagging or equipment erosion in pumice prone areas.

Significant volumes (200,000 tonnes) of sawdust are sold to one MDF producer and may be sold to farmers for cattle pads and other uses. Bark is often sold for processing as a garden product.

As the need for process heat increases more situations will arise where the on-site waste flow will be inadequate to provide the required heat and waste will be sourced from off-site. A significant issue for imported waste is that of quality control. Wood waste is often perceived as just that, waste, and often users of it as a fuel encounter waste steel, rubber and other tramp material having been dumped in the wood waste pile.

The composition and mix of process residues will change significantly over time as waste is recognised as feedstock for further processing. The variability of biomass as fuel supply can have significant problems for the design of energy handling and conversion plant.

Disposal of wood processing residues to landfill can in some areas incur a cost of 70 –120 $/tonne. In these situations by using the waste for bioenergy the avoided expenditure can be a substantial benefit, for enhancing the investment case.

6.2.3 Plantation Fuelwood

Current estimates of short rotation forestry (SRF) in New Zealand are around 1000-2000 ha grown mostly for domestic firewood.

Short rotation forests are often based on nutrient removal from wastewater near population areas. These forests may have a 3 to 7 year rotation. Others have rotations of 7 to 12 years to yield a greater proportion of stemwood.

Harvesting systems, particularly for short rotation plantations have been developed overseas but no plant is in operation within New Zealand.

Generally there is an expected yield of around 15 oven dry tonnes per hectare per year.

The forecast cost for plantation firewood is not expected to be attractive for either commercial heat supply or electricity generation. This resource, if developed is most likely to displace other domestic firewood sources. Plantation fuel wood can be a very attractive contingency fuel reserve within a portfolio of fuel supply risk management options, however landowners will probably get better returns from other land use.

There can be considerable competition for residues and for land for short rotation forest crops. This can lead to problems with variability in both quality and quantity of supply. In the case of biofuels, quality can have considerable impact on success of fuel handling as well as on energy derived.

6.2.4 Woody Biomass Refuse Waste

Woody biomass can be made available from municipal waste. However it is likely to remain the least economic fuel source because of low net calorific value and quality control problems.

6.2.5 Dual fuelling

To ensure security of fuel supply heat plant can be built for dual fuelled operation i.e. with the addition of coal or gas burning equipment to supplement the biomass fuel. Not only can the gas and coal provide supply security but also it can allow fine-tuning of heat supply such as occurs with the Kinleith bioenergy plant. Biomass is not a fast response fuel whereas gas can respond quickly to meet changing energy demand for kilns or processing plant.

Both coal and gas can be fired in a boiler at the same time as biomass with the proportion of the mix being limited by plant design and resource consent conditions. This dual fuelling can provide flexibility of plant operation.

Dual fuelling can have hidden costs such as the fixed portion of the gas connection cost which is based on expected maximum gas demand.

6.2.6 Agricultural waste

Although outside the scope of this report it can be expected that an increase in the use of woody biomass for energy would have a consequential flow-on to use in the Canterbury area of agricultural wastes such as straw as an energy source.

6.3 Fuel Handling (including Storage and Transport)

Fuel handling including storage and facility handling equipment can be 50% of a heat plant facility total capital costs.

Materials handling is now a greater proportion of costs than previously as the technology for fuel storage and handling is now more comprehensive.

While overseas developments in fuel handling plant have had extensive research, within New Zealand fuel-handling equipment is the least developed equipment component of a bioenergy facility. The equipment has not had the extent of research and development that has occurred with boiler plant. This is probably because it is not high pressure and perceived as a safety issue. (The need is not for pure research but practical development by adaptation of what has worked elsewhere.)

Modern large wood waste boilers use high volumes of fuel and the degree of treatment prior to feeding into the boilers can determine the performance of handling plant.

Wood waste on many sites is not homogenous and equipment may be expected to handle different sizes and shapes, sawdust and shavings all of which have different handling characteristics. The more raw fuel can be processed to make it homogenous the easier it will be to handle and the more reliable will be the equipment. This treatment of hogging or chipping comes at a cost. However the reductions in equipment breakage and the ability to take a wide range of raw waste material for fuel provide economies that offset the additional capital cost. In addition boiler costs can be reduced if the boiler can be designed for a narrower fuel specification.

Treatment of fuel may be by way of a simple hogger shredding or chipping the blocks and off-cut waste into a uniform size, or it can involve more complex processing of all waste including slithers and lillypads. Where shavings are used as fuel, costs of storage can be significantly reduced if the shavings are broken up by passing through a hammer mill, though any such processing required will reduce the net amount of energy out of the system.

Fuel handling also requires operator monitoring and intervention. A boiler can operate unattended for significant periods but it is usually the fuel handling that dictates that an operator be present. The more homogenous the fuel the less need for an operator to be continuously present.

For some industrial situations where there is a need for high reliability the fuel can be processed to pellets. Pelletising technology has recently been introduced to NZ for use mainly at the small burner scale and is likely to become more attractive as the cost of pelletising reduces with wider experience.

The cost of fuel drying and storage is probably the area where, with greater research and development, significant bioenergy costs can be reduced. Fully enclosed fuel storage facilities are very expensive but essential to ensure reliable plant operation. There are a number of designs available with different characteristics and costs. The cheapest being open-air storage with free drying if rain can be kept out.

6.4 Fuel Cost

6.4.1 Forest Arisings

The EECA/CAE 1996 report gave fuel estimates in the range $3/GJ to $8.70/GJ and allowed for collection from cutover as well as landings with haul distances up to 80 km. The EECA 2001 report emphasised site-specific aspects including transport and in-forest processes. An example given for Nelson shows landing only residues in the $2.30/GJ to $3.00/GJ range. Residues including cutover would normally be in the range $2.70/GJ to $4.00/GJ delivered to the energy plant.

6.4.2 Wood Processing Residue

The EECA 2001 report pointed out the potentially high cost of waste disposal which would result in the residue having a positive value to recognise the avoided cost of disposal if used as a fuel. The EECA 2001 report provided a value of $0.25/GJ assuming most residues would otherwise be disposed of on-site or nearby. This assumes that current landfill costs prevail. An increase in landfill cost will increase the value of the process residue if used as a fuel.

6.4.3 Plantation Fuelwood

The EECA 2001 report gave the value of short rotation forest fuelwood as $34-$54/tonne (fresh weight) at the farm gate. With a heat value of 8 MJ/kg this equates to a price of $4.3/GJ to $6.8/GJ. Allowing for transport, this could be $5.3/GJ to $7.8/GJ.

A recent paper by Massey University which looked at all year round harvesting versus four standard seasonal harvesting systems indicated a delivered cost of biomass of $1.9 – 3.6/GJ assuming around 35% moisture content and paying $10/t for the material at the landing.

6.5 Energy Conversion

A diverse range of technologies exists to convert woody biomass to useful energy, including combustion, gasification, pyrolysis and hydrolysis/fermentation systems.

For New Zealand wood processing operations, most boilers are in the 2 to 20 MW_{th} size range. Capital costs for 2 to 20 MW boiler and systems are expected to lie in the range $1.6m to $9.2m installed, with a midsize 10 MW unit at around $5.4M. The current specific cost is given by the following equation:

$$\text{Cost (\$/kW)} = 969 \times MW^{-0.25}$$

Operations and maintenance costs are also thought to be higher than previous estimates. These are now thought to be close to 5% of capital cost.

Fuel preparation by wood fuel companies such as CHH Biogrid could allow savings in fuel handling costs at the plant, but would come at a cost while giving increased confidence for uptake.

6.6 Regional Aspects

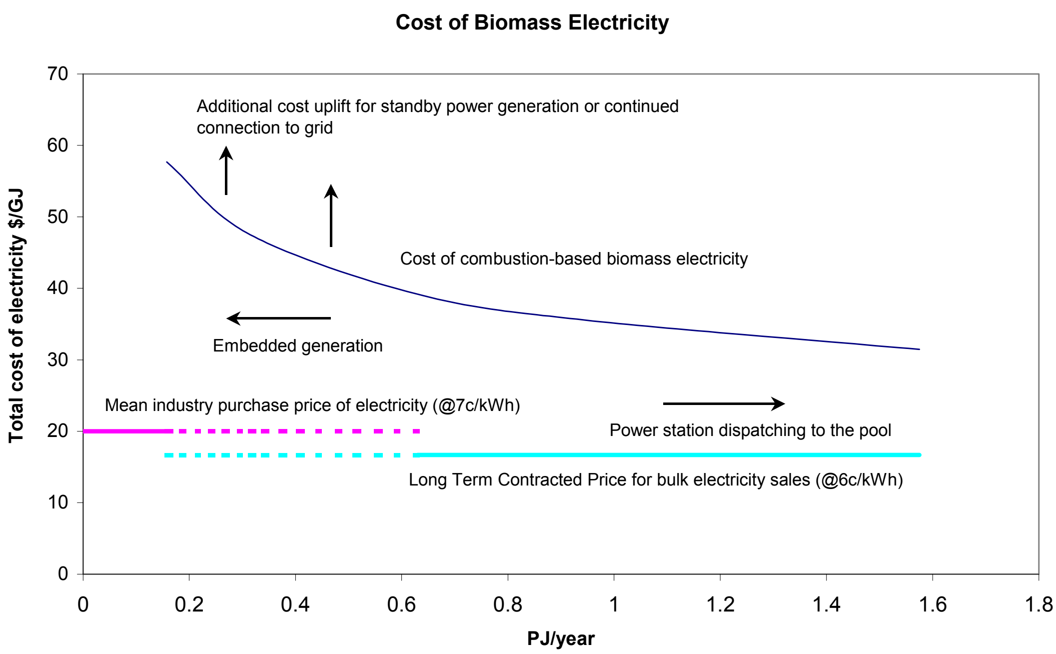
Regional drivers for bioenergy relate to the cost of biomass derived energy relative to alternative sources of energy and also alternative uses for biomass. The proximity to gas pipelines is a particular incentive for gas. However the continuity of biomass fuel supply is a more determining driver as even in the middle of forest areas the security and reliability of coal supplies may outweigh the biomass fuels cheapness.

6.7 Electricity Prices

Long-term wholesale electricity prices are indicated by fixed term contracts. Current contracts are of 1-3 year duration and are generally around 6 c/kWh, although these are now rising again. Simultaneously, the average retail price for electricity has held at around 11-12.5 c/kWh, made possible because rising domestic prices have been offset by falling commercial prices.

Currently, the electricity network charge-pricing regime discourages embedment of generation including renewable energy plants, unless full isolation or 100% internal backup can be provided. The electricity network charge includes a capital component based on the asset value of the network company which means that a retail customer will pay a significant amount for the connection. This in turn discourages investment in embedded generation and also in energy efficiency measures.

Figure 4 Cost of biomass derived electricity



Currently, electricity can usually be purchased by large industrial users cheaper than generating it from a heat plant as shown in Figure 4. While cogeneration opportunities will improve the economics of electricity generation there are still few likely to be built unless waste disposal avoided cost improves the economics even further. The only steam turbine generator installed in recent years in New Zealand and associated with a wood fuelled boiler is at Blue Mountain Lumber. This was installed as a cheap heat dump because the site had excess wood waste that required disposal. Even then the decision was only marginally economic despite the use of a second hand steam turbine. Similarly at Kinleith the cogeneration plant was installed because of a wood waste disposal problem, coupled with inefficient existing wood waste boilers.

Electricity generating stations can be built to supply the grid or to supply electricity to a specific industry. In the case of supplying the grid, the selling price must be competitive with other stations or the electricity will not be dispatched. In the case of biomass-based generation, Figure 4 shows there is a significant difference between generation costs and current wholesale electricity market prices. Increased demand will raise the pool price and encourage new generation, but there are many other generation options (including wind, hydro and geothermal options) which can undercut woody biomass fuelled electricity generation. In this light, there appears to be little likelihood of large-scale woody biomass electricity generating stations being built in New Zealand.

Figure 4 also shows a mean industry purchase price of 7c/kWh. This higher price than the wholesale market could provide an incentive for a business to consider generating its own electricity. There may also be circumstances where the cost could be even higher than average, particularly for businesses located where there are transmission restrictions such as north of Auckland or in the Gisborne area. However the electricity demand for most factories will be relatively small so they would not be able to take advantage of economies of scale. If reliability of supply is important, then additional costs will be incurred by a factory choosing to use biomass-fired power plant in terms of installing standby generation, or in terms of line connection charges if they remain connected to the grid. Thus overall it will take exceptional circumstances for an embedded woody biomass power station to be built in New Zealand under present conditions.

Other than in a cogeneration setup there is no electricity generation using exclusively wood or wood waste in New Zealand, and no immediate prospect of this for the economic reasons described above.

New wood processing plant investors will however probably install cogeneration when the effect of gas price increases, carbon charges and waste disposal costs are taken into account.

6.8 Heat

At the larger industrial scale there are currently around 25 large biomass fuelled heat plants installed within New Zealand with an installed heat capacity of $650MW_{th}$. There are a number of other smaller plants but until a survey is undertaken their significance remains unknown.

Tables 3 and 4 compare the volume of timber dried by fuel type in 1990 and 1998 and by region in 1998. A significant three-fold increase in total dried timber volume occurred during the 8 years, with all fuel types other than electricity increasing in frequency of use. Wood and bark firing doubled over the period but lost out on market share mainly to gas and coal. Wood and wood bark is however still the major energy source for timber drying, providing the energy for drying 45% of total production in 1998.

There is some opportunity for co-firing of coal and woody biomass particularly where the coal can provide fuel security or improve the heat rate.

If gas and electricity prices remain at current levels the percentage contribution from renewable energy, especially bioenergy, for process heat is expected to continue to decrease as the timber drying industry expands. At present there are more fossil-fuelled heat plants being installed than plants fuelled on wood process residues since fossil-fuelled plant can usually produce heat at a lower cost even where the wood residue is virtually free on site. None of the known heat plants currently under construction or out to tender involves cogeneration of electricity and the maximum size is $20\text{-}35MW_{th}$.

However it is not expected that gas and electricity prices will remain at their current levels but will increase significantly over the next few years. Discussion on this is addressed in the companion report on energy supply and demand.

Table 3 Comparison of volumes of timber dried by fuel type in 1990 and 1998

Fuel Type	Timber dried by fuel type			
	1990		1998	
	Volume (m^3)	Percentage of total dried (%)	Volume (m^3)	Percentage of total dried (%)
Wood/bark	537,115	62	1,087,106	45
Gas	62,430	7	584,460	23
Coal	62,666	7	371,840	15
Electricity	127,669	15	106,160	4
Geothermal	21,300	2	160,000	6
Oil and diesel	46,700	5	180,175	7
Total	857,880	100	2,489,741	100

For an approximate estimate of the energy consumption 2GJ/ m^3 of timber dried can be used.

During 1999, 180 MW_{th} of heat plant was under construction within the New Zealand wood processing industry. Of this 8% was fuelled by biomass and 17% was being built for the wood processing industry. In 2000, approximately 120 MW_{th} was under construction of which 70% was biomass fuelled.

Table 4 Annual volumes of timber dried (m^3) by fuel type and region as at 1998

Region	Fuel Type						
	Wood/ bark	Gas	Coal	Electricity	Geothermal	Oil and diesel	Other (solar)
Northland	6,720	1,800	480	9,500	0	6,950	0
Auckland	12,825	19,700	675	12,800	0	3,000	0
Waikato	178,690	386,400	72,000	9,150	0	77,000	0
Bay of Plenty	307,270	106,350	34,850	10,330	160,000	0	0
Hawkes Bay	45,528	0	0	1,125	0	7,300	0
Gisborne	21,600	5,400	0	0	0	0	0
Taranaki	17,200	7,000	8,775	24,740	0	0	0
Manawatu	35,000	24,100	15,240	7,560	0	0	0
Wellington	29,700	28,710	0	540	0	3,000	0
Nelson	295,069	0	6,700	303	0	6,675	0
West Coast	18,750	0	22,900	1,690	0	0	2
Canterbury	49,804	5,000	66,830	24,662	0	76,250	126
Otago	100	0	21,340	60	0	0	0
Southland	68,850	0	122,050	2,700	0	0	0
Total	1,087,106	584,460	371,840	106,160	160,000	180,175	128
Percentage	45	23	15	4	6	7	0

There is a need for a reliable database to be established so that research on trends can be undertaken.

A very strong export market for timber and milk products drives all heat plant currently being considered or installed in the wood processing and dairy industries. New plant installed is a mixture of high quality plant and renovated second hand plant. The decision on second hand or new plant tends to be a philosophical/cash flow decision with new plant selection based on a full life cycle analysis while second hand plant selection is based on the attractive lower capital investment cost and shorter planning horizons.

6.9 Cogeneration

Traditionally analysis of cogeneration opportunities have been undertaken by engineers with an electricity generation bias. This has resulted in plant being sized and designed for electricity generation with the industrial heat requirements being supplied with heat from the electricity generation plant. As a result, few projects have been able to be commercially justified.

Traditionally it has been recognised that heat production is the primary reason for investment in boiler plant and that further cogeneration plant is unlikely to be economic. However to allow for possible future cogeneration, capability provision, including operation at high steam pressure, is sometimes made for the addition of generation plant at a later date.

Currently there is 330 MW_e of large cogeneration plant within NZ. One third of this is from biomass-fuelled plants mainly associated with pulp and paper mills.

The Kawerau pulp and paper mills "Tasman" have been using wood process residues and black liquor for boiler fuel for more than 45 years at Kawerau. Other fossil fuels are also used in the boilers as needed. Some steam is then passed through two steam turbines on site to generate electricity and the residual heat is used for processing. One turbine generates electricity from geothermal steam. Most of the electricity to meet site demand is purchased from the grid.

The Carter Holt Harvey cogeneration plant at the Kinleith pulp and paper mill was fully commissioned by 1998 and generates 40 MW_e. The plant was built on the basis that there was a requirement to dispose of 200-300,000 tonnes of bark and wood residues annually from the site. In addition, there was an inefficient pressure-reducing step within the existing steam system on site. A decision was made to install a wood-fired boiler (supplemented with natural gas) to generate steam into the high pressure steam system associated with the two black liquor recovery boilers. A 40 MW_e passout steam turbine was used to replace the function of pressure reducing valves in reducing steam down to medium and low pressure process steam systems. As such, the turbine is simply a means of improving overall system efficiency, and electricity generation provides a substantial benefit but was not a primary driver for the project.

It is considered that unless new pulp and paper plant or other large processing operations are established, there is little opportunity for this type of development in future. Cogeneration equipment requires a steady steam supply to operate efficiently. This is difficult to achieve on a small site if steam supply is fluctuating because of draw off to kilns etc.

6.10 Cost of Capital

The cost of capital is a significant issue for all wood processors. Wood processors typically seek to recover their capital in 12 –36 months. This can mean that it may be a financially sound decision to keep current inefficient or fossil fuelled heat plant in use, as it is an operating expense, rather than incur capital expenditure.

Disposal of wood waste to a landfill also is an operating expense that may be preferable than committing capital funds that can be profitably used in investment in processing plant.

Gas and coal plant can be a serious competitor to bioenergy as the plant usually has a lower capital cost, again allowing capital to be used for other purposes.

7 Priority Drivers

7.1 Gas Price Increases

If the Maui gas field declines around the year 2005 as is anticipated then the price of gas will increase significantly from that time. There will also be a consequential increase in the price of coal. With these fuel increases the opportunity for heat production from bioenergy will increase, as it would be expected that the economics will drive investment towards bioenergy. Heat from bioenergy could be as much as half the cost as from gas or coal. Depending on the extent of the fossil fuel increases; the economics of electricity production from bioenergy will also improve. Increase in the gas price is likely to be the single most significant driver for bioenergy.

7.2 Electricity Prices

The current cost of electricity is such that production of electricity from bioenergy either on a stand-alone basis or as cogeneration is not cost effective. It is assessed that even with the increase in gas price that it will still not be cost effective although cogeneration may in some situations start to become so.

7.3 Climate Change Policy

If the Government Climate Change policy is implemented with a carbon charge then the cost of fossil fuels for heat production will increase with a subsequent drive towards bioenergy for heat and electricity production. While a carbon tax may eventually be a driver for bioenergy it is not proposed to be implemented until after 2007 and its significance will depend on the level of tax implemented, and the extent of sheltering under NGA's in the transition period.

Other climate change policies which may be introduced prior to 2008 such as the funding of Projects and Negotiated Greenhouse Agreements may assist with encouraging the uptake of bioenergy but there will be substantial competition for the small amount of project funding that is likely to be available.

For these policies to be a real driver for bioenergy the industry will have to ensure that it is active in working with Government to establish the policy procedures and criteria.

7.4 Quality of Biofuel Cost Information

In order for bioenergy to become more cost effective for production of heat and then electricity it will be important that the cost of biofuels from the various sources be well understood. It will be inefficient if each person considering a bioenergy plant is left to establish their own basic information of the cost of fuel sources such as forest residue and appropriate guidance will help them. Research into the cost of delivered biofuel will provide information that will assist potential investors into efficiently evaluate investment options and to establish fuel supply risk management strategies.

The general information on biofuels is based on studies that are often contradictory or at least inadequate. This makes it very difficult to establish bioenergy cost curves and to develop industry strategies.

7.5 Fuel Quality

A difficulty with woody biomass has been the inconsistency of fuel quality. As a waste stream it can have a range of particle size, entrained trash, moisture content and other characteristics. This variability adds significantly to the costs of handling.

The development of a business focussed on supply of a woody biomass fuel (CHH Biogrid) has led to standard fuel products being offered on the market for use outside the forestry industry. It remains to be seen if bioenergy will be taken up by consumers of heat in other sectors. For it to be successful the biomass fuel will need to be processed so that it approaches the qualities of coal and gas with regard to consistency.

Pelletising fuel, or other options, to provide a consistent homogenous consistency will allow a narrower specification of the boiler plant with resulting lowered capital costs.

7.6 Fuel Competition

One issue that will continue to become more important in the future and affect the drive for bioenergy is the potential use of forest arisings and other wood wastes as material input to further manufacture such as MDF. Competition for the resource between production and energy end uses could become one of the many potential factors limiting the use of wood waste as an energy source. Already bark is being used as a raw material for garden products. Highly homogenous residues such as sawdust already face competition from manufacturers of products such as fibreboard. Wood waste remaining for use as an energy fuel is likely to be limited to the scrap from harvesting and processing. This dictates that fuel handling equipment or treatment of waste to turn it into a homogenous quality will become very important. Further development work needs to be done in this area.

7.7 Fuel Security

Installation of bioenergy plant needs to be sized to the quantities of fuel available. Even then it is common experience that on-site waste streams change nearly as soon as a boiler is specified, and certainly before it is commissioned. The result can be that a current waste stream disappears and there may be a resulting shortage of fuel. Counter to this is that the success of the increasing harvest and the Wood Processing Strategy will result in a greater overall volume of residue generated.

Fuel supply risk management strategies need to be identified and implemented before new plant is specified. If the opportunity to supplement biofuel with coal or gas is considered then this should be considered at the time of design. It may not be necessary to install dual fuelling from the start, but making provision in the plant design may be prudent.

Fuel security can most easily be provided from forest arisings. Short rotation forest crops can also be a good standby to cover the event of a shortfall in biofuel however unless costs are reduced this is less likely in the short term.

To reduce the costs of short rotation forest biomass fuelwood crops would have to be grown close to heat and electricity demand centres, reducing transport cost and transmission losses. Where wood drying at source is viable this may reduce transport costs or increase the fuel catchment area. Generally crops could be harvested all year round to save dry matter losses and storage costs, although wet ground conditions may be a restriction at some times and at some locations. In any event the wood can be stored as a growing tree until needed.

Biofuel availability in wet weather can be a significant problem if forest residue is relied upon. With strategic planning however, bioenergy could be obtained from dry fuel biomass in most regions all year round.

7.8 Information and knowledge

One of the greatest needs to encourage bioenergy is for dissemination of information. The research being lead by *Forest Research* and by Massey University needs to be put in the hands of potential developers. These parties will continue to monitor and promote developments in the industry but it will be of little value if it is not promulgated. In particular, there will have to be a watching brief kept on the commercialisation of gasification on a large scale. A key vehicle for these actions is through the newly established Bioenergy Association of New Zealand.

There is a need for transfer of international experience, case studies, good practice guides and handbooks to be available to wood processors interested in bioenergy applications. While the large companies have staff able to undertake appropriate studies medium/small companies do not have the staff or resources to undertake such investigations. They must rely on information flowing from the experience and knowledge of the industry, including suppliers, at large. They can learn from the good and bad experiences of others. It is hoped that the current moves by the Wood Processing Strategy and the Bioenergy Association to focus industry attention on energy, and in particular bioenergy will provide a platform for communication and learning within the industry.

There needs to be recognition of the need for a prioritised research and information programme that makes progress driven by the industry. The listing in Annex A is a start to such a programme.

7.9 Clusters

The economies of scale for heat plant indicate that there will be significant commercial advantages for clustering activities around common heat plant. This also provides a good fuel supply risk management mechanism as individual company fluctuations in waste wood supply can often complement each other. Energy demand peaks can also often be staggered to best advantage of all parties.

While clusters of energy activities are commercially attractive it can be very difficult in practice as the commercial and operational objectives of the various players may not align.

7.10 Government Policies

The policies currently being developed by Government on the National Energy Efficiency and Conservation Strategy, Climate Change and Renewable Energy will each have significant bearing on the cost of future bioenergy activities. As these policies are being determined it will be important that representatives of the Wood Processing Strategy assist with the identification of eligibility criteria, administration and funding.

7.11 Show-casing Experience

While the wood processing industry is changing and there is a growing appreciation about bioenergy, (what it is, what are its benefits, how much impact it can have on business competitiveness, etc). Some of the plants installed have run into significant operational issues - though fortunately these have been resolved through perseverance. Although technology transfer and communication through the development of guidelines, manuals and other publicity material will be critical to addressing this, it is becoming increasingly important to have some showcase examples of what can be achieved through the development of well designed and constructed plant, and to have a clear vision of the commercial benefits of bioenergy so that this form of energy becomes a 'given'.

7.12 Funding Applied Research

A major impediment to the increased uptake of bioenergy is the lack of funds available to undertake small/medium sized applied research projects. Many companies involved with bioenergy continually encounter problems or aspects of bioenergy use that require basic engineering or development, but they are unable to fund the necessary work because of cash flow constraints. Many of the projects would also provide flow-on benefits to other industry participants. The establishment of a contestable fund for such projects would provide a significant boost to the bioenergy industry.

7.13 Future Energy

With New Zealand entering an era of energy availability uncertainty and price increases there will be opportunities for development of synergy between forestry, bioenergy, and the benefits that can accrue to NZ's energy supply options by developing an integrated strategy. There is an opportunity for forestry to increase what it can offer NZ across economic, environmental and social domains. The link between bioenergy and forestry provides many benefits that align to the Government's central policies (i.e. economic development, regional development, energy supply and conversion, new business opportunities, sustainability, value adding, climate change, use of sustainable products, etc). Forestry is a long-term investment which can be developed for future energy supplies.

While not an immediate priority, research and development programmes need to also look to the future. This has been achieved in parts of Europe where bioenergy has become mainstream. To achieve this it is important to develop an 'industry' with its necessary and underpinning infrastructure. Where this has been successful in other countries key components have been development of education and training, systematic development of networks by a range of service providers, development of service contracts and ongoing technology development, (which continually improves service delivery) and development of induced investment (in some cases this has been kick started by government).

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Annex A

LIST OF IDENTIFIED WOODY BIOENERGY RESEARCH AND INFORMATION NEEDS

List being compiled by the Bioenergy Association

Topic	Scope
Research programme	
Update on NZ Bioenergy Research Activities	Review and report on current research activities being undertaken by all NZ based bioenergy research establishments.
Update on International Research Activities	Review international bioenergy research activities and advise on trends and those of relevance to NZ.
Combustion Technology	
Update of international heat plant trends	Review international state-of-the-art bioenergy heat plant of relevance to NZ. (include different scales and feed systems). Compile from the review a short version guide for members.
Summary of Heat Plant technologies for NZ	Compile information sheets on heat plant technologies suitable for NZ decision makers
Heat Cost Supply Curve	Prepare a supply curve for the cost of heat derived from bioenergy.
Combustion Technologies Seminar	Hold a biomass combustion seminar/conference around the IEA Task 32 Biomass Combustion visit to NZ. Opportunity for NZ manufacturers to demonstrate their products
IEA Bioenergy Task 32 participation	Participation in IEA Bioenergy Task 32 – Biomass combustion and cofiring
Fuel (fuel processing, handling and characterisation)	
Air emission issues with cofiring	Identify air emission issues arising from combustion of coal with bioenergy
Clinker issues with cofiring	Identify clinkering issues arising from combustion of coal with bioenergy
IEA Bioenergy Task 30 Participation	Participation in IEA Bioenergy Task 30 – Short rotation crops for bioenergy
IEA Bioenergy Task 31 Participation	Participation in IEA Bioenergy Task 31 – Conventional forest systems for bioenergy
Cost of harvesting forest waste and Prediction of area/catchment yields	
Information (handbooks, case studies, good practice guides)	
Publication of monthly E-Newsletter	Publication of monthly E-Newsletter
Bioenergy Periodicals subscription	Subscriptions for purchase of bioenergy periodicals
Seminar on Forest Research research activities	Support an update seminar on the Forest Research research work being undertaken for FoRST.

Handbook for Bioenergy investments	Prepare a Handbook on Bioenergy Investments for wood processors, potential energy plant owners and biofuel suppliers
Good Practice Guides	Obtain 10 good practice guides from Europe and modify for NZ conditions.
Overseas information material collection	Compile a collection of handbooks, case studies and good practice guides from overseas sources.
Forest Residue cost handbook	Prepare an information / analysis package on the economics of collection and preparation of forest residue as a biofuel.
International bioenergy conference papers	Purchase and promotion of international bioenergy conference papers
Model Wood processing Energy Facility	Part 1 - Develop model facility fuel / energy flows and base case parameters. Part 2 - Residue and alternative fuel case studies Part 3 - Workshop Part 4 - 3 alternative scenario case studies Part 5 - Prepare handbook and software
Wood Pellets Seminar	Seminar covering preparation of pellets, processing technologies, fuel characteristics, storage and handling, combustion technologies, residues and emissions.
Bioenergy Market	
Initiative for increasing the uptake of bioenergy	Undertake a review of overseas initiatives for increasing the uptake of bioenergy.
Low temperature energy market opportunities	Identify and evaluate opportunities to promote the use of bioenergy as a low temperature energy source.
Bioenergy cogeneration opportunities	Identify and evaluate opportunities to promote the use of bioenergy for cogeneration applications
Bioenergy District Heating Opportunities	Identify and evaluate opportunities to promote the use of bioenergy for district heating in NZ.
Bioenergy Hydrogen opportunities	Identify and evaluate opportunities to promote the use of bioenergy as a renewable source of hydrogen.
Biofuels research programme	Identify and evaluate opportunities for a workstream of research on biofuels (tallow, ethanol, biodiesel) for transport.
IEA Bioenergy Task 38 participation	Participation in IEA Bioenergy Task 38 - Greenhouse gas balances of bioenergy systems
Position Paper on Renewable Energy Certificates	Paper providing detail on RECs and T-RECs for bioenergy for assistance with promotion to Government policy development