The potential for

Miscanthus fuel supply in New Zealand

Miscanthus is a highly productive "green" energy crop that produces income from the second year after planting, and has an estimated life of 20-years; offering revenues over that period on a consistent and sustainable basis. It produces a high quality fuel that can displace coal and other fuels, and also has a range of other uses. Miscanthus and other crops are seen as an integral component of the recently developed New Zealand Bioenergy Strategy.

Miscanthus is extensively grown in Europe, and the planted area is rapidly expanding in North America. In New Zealand root stock and plants are now available, trial plantings are underway and commercial scale plantings are under discussion.

Miscanthus as an energy crop offers significant environmental benefits with "a strong energy balance, efficient use of water, and positive effects on bio diversity". US figures indicate that "*as an example 100 tonnes of compacted Miscanthus co-fired displaces 55.9t of coal saving, 148 tonnes of CO2 equivalent emissions".*

1. Miscanthus

Miscanthus giganteus is a sterile hybrid perennial grass that has been grown as a biofuel, and for other uses, in Europe since the early 1980s. It grows to a height of more than 3.5m in one growth season and is harvested annually with a dry weight yield that can reach more than 25t/ha or more. In terms of energy production it is one of the most productive fuel crops available.

Miscanthus crop in late summer

Its rapid growth, high biomass yield and low mineral, moisture and ash content make it an attractive choice as a biofuel. In terms of emissions it is greenhouse gas-neutral (ignoring fossil fuel inputs) and is noted for sequestering carbon in its root structures.

Miscanthus is said to grow almost anywhere including on poor soils and in areas prone to frosts and is drought tolerant. In New Zealand it is intended to grow Miscanthus on marginal or currently underutilised and relatively flat land, on pastoral land, and as a replacement for forests (subject to approval under the ETS as a replacement for forests without triggering carbon charges).

2. Farming Miscanthus

Miscanthus requires little cultivation or fertilizer once established and no irrigation, and is expected to provide landowners with attractive and consistent returns from the second year after planting to the end of the plant's life at around 20-years. While the type of land on which it is grown is not critical the limitations of planting and harvesting equipment mean that it must be grown on flat or rolling country (less than 20^{o}C slope).

Yields depend on the site, soils, climate, and the amount of moisture available. The crop is harvested annually in late winter/early spring using combine harvesters and specialised bundling equipment, after natural nutrient recycling and stem drying has taken place.

3. Use of Miscanthus

As a fuel Miscanthus is harvested in late winter as a relatively dry fuel at nominally less than 17% moisture, though tests of New Zealand produced product have indicated figures between 10 and 12%. It has a calorific value in the range 17 – 19 GJ/tonne, which is somewhere between lignite and sub-bituminous coal, and higher than that for pinus radiata. It can be readily processed to the requirements of existing or new boilers and co-fired with coal without major boiler modifications in proportions up to 50% or more.

Potential fuel customers include dairy factories, pulp and paper producers, meat processors, cement manufacturers, Huntly power station and other heat users. Other uses include pellet manufacture, industrial materials (bio-composites), bedding for animals, bio-oil and second generation liquid biofuel manufacture.

Baled miscanthus, pellets, bio-oil

4. The role of Miscanthus in New Zealand

Miscanthus is one of a range of potential fuel crops identified in the New Zealand Bioenergy Strategy as part of a mixed bioenergy supply sector. This strategy (an extract is attached) was prepared by the Bioenergy Association of New Zealand on behalf of a range of industry stakeholders, including the Forest Owners Association, in September 2010 as a basis for securing Government, landowner and industry support and as a basis for building a rapidly growing biomass-based energy sector. The strategy encompasses the following vision:

> *"Economic growth and employment, built on New Zealand's capability and expertise in growing and processing wood-crops and converting organic by-products to energy, leading to new business activities which by 2040 supply more than 25% of the country's energy needs, including 30% of the country's transport fuels."*

The potential for bioenergy grown in New Zealand is seen as very high based on increased future use for heat generation, exports in pellet form, and in transport-fuel manufacture. Fuel crops are seen as a key component of the expected growth with potential sales (figures at 2010 prices) of transport fuels produced from biomass of $3 billion by 2040, and of biomass produced heat rising to $500m pa.

5. Miscanthus development status

Two parties, Taharoa C and Miscanthus New Zealand, have focussed on Miscanthus growing in New Zealand and have root stock or plants available. Volumes are now at a level where discussions with commercial growers and customers for the fuel can commence.

6. Economics

Typically the crop yields 17 tonnes per Ha and has a calorific value of around 17 GJ/tonne which means that a hectare can produce around 300 GJ pa, or more in favourable growing conditions. The product is expected to be grown close to point of use, reducing delivery costs, with farmers devoting part of their property to this crop. Costs are those associated with the planting, growing, harvesting, storage, delivery and final processing of the fuel. Preliminary financial assessments have indicated that the economics should be favourable for a number of customers considered.

From the farmer's perspective Miscanthus provides income from the second year after planting and requires little management or fertiliser once established. Income from the crop is expected to be based on a back-to back fuel supply contract, and therefore consistent and predictable over the contract period.

Harvesting is expected initially to be by haymaking equipment and contractors, including baling where required. Longer term, as volumes grow, specialist equipment now available overseas may be used. As the product is harvested once a year, in late winter, storage will be required and this is likely to be in bale form with chipping or other processing occurring at point of use.

Crop ready for harvest (US)

From a sales perspective the price for Miscanthus as a fuel will be driven by the cost of the alternative fuel displaced, including carbon charges, and by the other benefits which include CO_2 and other emission reductions. The quality fuel produced is seen as displacing coal initially, or augmenting forest and timber processing residues for heat production. Used as a co-fired fuel any capital costs associated with boiler or fuel handling equipment modifications are expected to be very minor.

Miscanthus giganteus harvested using a modified forage harvester mounted on a combine, and rhizome lifting and splitting plant (US).

7. Scale of potential business

The work carried out to date, which includes preliminary discussions with a range of potential customers, indicates that planting of thousands of hectares are likely be economic for conventional heat supply. This will require investment in the plant propagation, commercial crops, in the supply chain and in the supply business itself. Total potential sales for supply as a fuel to displace coal in New Zealand are seen as well into the $100's of millions: indicatively Fonterra's Canterbury processing plants alone, co-firing 50% Miscanthus, would require around 6000Ha of crops and $20m in investment in crop growing and other supply chain elements.

Rhizome propagation plot (US)

The potential for exports in pellet or other form and liquid biofuel production are seen as subsequent offering very large scale opportunities.

Mike Suggate

East Harbour Energy

March 2011

Miscanthus growing and baling (France)

New Zealand Bioenergy Strategy

(summary of draft)

The New Zealand Bioenergy Strategy is designed to achieve:

> *"Economic growth and employment, built on New Zealand's capability and expertise in growing and processing wood-crops and converting organic by-products to energy, leading to new business activities which by 2040 supply more than 25% of the country's energy needs, including 30% of the country's transport fuels."*

Multiple national economic benefits are realised via the bioenergy strategy:

- The extraction of additional value from existing wood, organic wastes
- Diversified and higher value land use
- Economic growth from new energy crops that will:
    - Provide additional revenue and business resilience for land owners
    - Improved wealth creation from NZ's natural resources and skill base
    - Reduce reliance on imported fuels and help with carbon goals
    - Transition NZ to a lower carbon economy whilst increasing employment
    - Strengthen NZ's international green trading platform
    - Generate value-added export revenue
    - Reduce environmental impacts to air, soil and water,

To succeed the strategy requires:

- Aspirational leadership by Government:
    - Policy (including ETS) and procurement directives
    - Demonstration of commitment (e.g. wood fuel in schools, hospitals, and biofuels in government vehicles)
    - Across-government support and action
- Clear definition as part of an overarching forest industry:
    - Diversified products (logs, chip, pellets, biochemicals and biofuels)
    - Incentivising the optimisation of use of harvest and processing residues
    - Improved and more efficient by-product recovery
- Greater technological capability to assess wood-to-energy conversion technologies
- A refocussing of research activities on commercial objectives
- Links to waste minimisation and biomaterials strategies
- Support for SME players and encouragement to existing corporate players

It builds on the application of proven bioenergy technologies; using existing and new natural feedstocks and organic wastes:

- Heat from forest harvests, fuel crops and wood growing and processing residues
- Biogas from municipal and dairy wastes, food processing residues
- Liquid biofuels:
    - Biodiesel from used cooking oil, animal fats, canola, residues
    - Bioethanol from whey, black liquor, forest and fuel crops and residues

The strategy will lead to;

- Greater value from existing forest harvests

- Extensive planting of new forests and fuel crops on marginal and pastoral land
- Economic growth and employment from higher-value land use, new large-scale industries
- More than 25% of NZ's energy from bioenergy including:
    - 30% of NZ transport fuels from biomass
    - A 60% increase in biomass use to produce heat
- Production of value added bio-materials
- Export of wood pellets, biofuel, and tallow/UCO biofuel production capability

The Strategy aims to provide a commercial focus to the growing bio-economy and realise greater value from New Zealand's current and potential additional forestry resources It lifts growth in bioenergy use to, by 2040, 25% of New Zealand's energy requirements; a level substantially above the current 8.5% of national energy use with attendant economic, social and environmental benefits.

In comparison a "business as usual" approach to bioenergy would achieve only around 9.5% of New Zealand's total energy needs by 2040, including very little transport fuel.

This projected growth is driven by the underlying demand for heat and transport fuels, and the potential to satisfy these demands economically from proven wood fuel and biogas technologies as the economics of the technologies are improved by further development and a cost of carbon is introduced in the economy.

The vision will be achieved via a three-phase strategy:

The **Establishment Phase (2010 to 2015)** will see growth based on existing resources, processes, markets and expertise, creating a basis for broader acceptance and utilisation of existing and developing technologies and products, and increasing understanding of the market drivers for wood-based energy, wood fibre, and other products. Export of biomass-based fuels in the form of pellets will underpin the early growth in planted areas of forests and fuel crops.

The wood fibre market will be developed to provide quality feedstock with forward contracts to the heat market, and as a basis for later expansion to supply for production of transport biofuels and bio-chemicals extraction in later phases.

In this phase the supply-chain infrastructure will be developed and the technical and economic platforms for the Development Phase will be confirmed. Decisions will be made around crops, processes, funding and future fuel production; based on expanded and commercially focussed research into fuel crop growing and processing technologies, and trial plantings. Technology transfer programmes will be established and New Zealand research focussed on being fast followers and adaptors of overseas research initiatives.

The quality requirements for liquid fuels in particular will see extensive development of regulatory frameworks and the development of experience of production within these. Government and investor support will be secured and work will start on the development of suitable standards and controls to ensure that new crops can be shown to be sustainable and are not a threat to New Zealand's bio-security.

The **Development Phase (2015 – 2020)** will see construction of demonstration plants for transport fuel production and accelerated plantings of energy forests and fuel crops in selected regions, based on the platform built in the Establishment Phase. Heat use growth will continue, maximising available opportunities. Growth in fuel-wood demand and the export of wood chip and pellets will drive improvements in infrastructure and provide economies of scale for expansion of planting while harvesting technology developments will develop to allow economic harvesting of wood currently left in the cutover. This, and the growth in energy crops as part of mixed land use, offers significant growth in value to landowners.

This phase sees the commencement of an investment programme estimated to be in excess of six billion dollars in crop planting and construction of production plants; requiring a mix of supporting Governmental and other measures for these lignocellulose to transport fuel initiatives.

In the **Expansion Phase (2020 – 2040 and beyond)** investment in bio-refineries for the production of transport fuel and other associated bio-materials will be supported by further expansion of fuel crops and energy forests on marginal land, and on-going research and development of new higher-value products.