Supporting bio-energy in New Zealand - Why and how?

By
Stephan Heubeck*
Dipl.-Ing. agrar (FH)
M.Eng. Environmental
Research Engineer with the National Institute of Water and Atmospheric Research Ltd. (NIWA) in Hamilton

Note: this is a discussion document intended to stimulate debate about support mechanisms for bio-energy schemes at the Wellington Bio-energy strategy workshop on the 9th of February 2010. All comments and further suggestions on the topic are warmly welcomed.

Introduction

Since the industrial revolution, fossil fuels (coal, oil and natural gas) have underpinned economic activity and shaped everyday life in all western countries, including New Zealand. However, since fossil fuels are non-renewable and the world's fossil fuel endowment is finite, extraction rates of these fuels will at some stage reach a maximum, which will be followed by a period of continuously dwindling supplies. Many economists expect that during this period of dwindling fossil fuel supplies bio-energy schemes can be developed quickly, primarily driven by the continuously increasing cost of fossil fuels.

However, letting the bio-energy sector develop purely on the relative cost advantages in comparison to fossil fuels, is a risky strategy that will not realise the full potential that the bio-energy sector has to offer, particularly in New Zealand.

Bio-energy benefits

Many benefits that bio-energy schemes have to offer are non-monetary, or benefit stakeholders that are not necessarily directly engaged with bio-energy setups. Some of these benefits relate to environmental performance, others to security aspects, but the most important ones are related national economic performance:

- **Local air pollution**. Many transport bio-fuels such as biodiesel or compressed biogas reduce vehicle air pollutant emissions markedly, and can often provide air quality improvements within short time frames. The same applies to the use of wood pellets for residential heating and biomass co-fueling or switching in industrial boilers, in particularly coal and heavy oil fueled ones.
- **Waste minimization and improved waste management**. Biogas systems using farm wastes or organic municipal wastes can mitigate odour emissions, combat the spread of diseases, divert wastes from land fills and make fertilizer nutrients (in the case of P a finite resource) available for agricultural use. Similarly wood fuel schemes can help to divert waste wood from being land filled.
- **Direct GHG emission reductions**. Every megajoule of coal, oil or natural gas derived energy substituted by solid, liquid or gaseous biomass is a GHG emission abatement.
- **Fugitive GHG emission reductions**. Wood waste recovered from forest and used for bio-energy releases less methane than would be the case if the waste decayed anaerobically e.g. in windrows. Biogas schemes at landfills, wastewater treatment plants and farms actively reduce fugitive methane emissions, while manures treated in biogas systems may also help to reduce N_2O emissions from agricultural soils.
- **Bio-energy crops improve agricultural environmental performance**. Aforestation is a proven tool for reducing erosion and nutrient leaching, soil and surface water degradation in unstable hill country, and bio-energy schemes are a sensible use for these additional trees. Many bio-energy crops e.g. canola, sunflower, sorghum, are good brake crops in traditional agricultural systems, reducing weed and pest pressure and leading to a reduction in pesticide use. In sensitive lake and river catchments, bio-energy crops (trees and crops) can markedly

* Contact: s.heubeck@niwa.co.nz

reduce nutrient leaching and run-off in comparison to traditional livestock farming practices. Many bio-energy crops (trees and crops) can produce acceptable yields and financial returns in areas where livestock farming has to rely on irrigation. Bio-energy cropping systems (trees and crops) produce far less fugitive GHG emissions (methane and N_2O) when compared to traditional livestock farming on the same land.

- **Safety**. Transport bio-fuels (biodiesel, ethanol, compressed biogas etc.) are non-toxic, and spilled fuel does not leave lasting contamination of soil or waterways as it is biodegradable. Wood waste removed from forest and used for bio-energy schemes markedly reduces the risk of forest fires.
- **Security of supply**. Bio-energy resources grown, produced and marketed on-shore are far less impacted by international political stability and turmoil, in particular when compared to the volatile and vulnerable international oil market. Faced with the threat of peak oil, and in particular the problem of globally declining net petroleum exports, it is very important for New Zealand as a net oil importer to gain more national control over a greater proportion of our transport fuel supplies, which preferentially should be derived from renewable resources. The long lead times involved in a switch from petroleum to bio-transport fuels make it however essential to plan ahead and be prepared for a time when oil becomes short in supply and / or very expensive.

  Small scale, embedded and distributed electricity generation based on biomass resources are a safeguard against power cuts for the operator of such schemes (sawmills, farms, rendering plants), and can help to stabilize the national transmission system by by-passing bottlenecks within the grid and possibly balancing intermitted generation (balanced biogas – wind generation is practiced in Denmark and Germany).
- **Business resilience**. Multi-products lead to additional revenue streams and break dependency on one single market / commodity (e.g. forestry - timber plus energy; land owners – meat / produce plus fuels).
- **Ability to plan and forecast**. In comparison to fossil fuel developments there is little resource risk associated with bio-energy schemes. Little exploration is required to get a detailed picture of the bio-energy resource and once established the schemes can run for very long periods of time, because the resource base is renewable and few “unpleasant surprises” generally occur (in comparison to water brake-through, gas cap formation, steep decline curves etc. known to petroleum developments).
- **Employment**. Bio-energy schemes generate several times more employment than similar sized fossil fuel developments. These employment opportunities are usually at a number of skill levels, and occur more or less all over the country. For some sectors bio-energy schemes can be a value-add step, capturing more value from the same resource base within New Zealand, e.g. wood ethanol manufacture in comparison to wood chip exports.
- **Novel exports.** Bio-energy products could be additional export commodities for New Zealand, e.g. massive demand for wood pellets to meet European and Asian renewable energy mandates is creating a new market where international trade is advancing very fast.
- **Future industries**. New Zealand has a world class bio-energy resource base. If developed early and boldly enough this could allow the country to develop a world leading niche industry (from R&D to planning to equipment manufacturing to project management) with enormous export potential in the years to come, specifically within the Asia / Pacific region.
- **Rural development**. If combined, the aspects of Employment, Novel exports and Future industries could provide New Zealand’s often neglected rural areas with a welcome economic stimulus, radiating into the wider rural economy, and improving livelihoods in these areas. (Example: Guessing bio-energy region in Austria).
- **Maori development**. Maori are among the largest landholders in New Zealand and are disproportionately represented in neglected rural areas, and would probably profit more than any other group in this country from a bold development of bio-energy resources.
- **Balance of payments**. Our unsustainably large current account deficit may well be New Zealand’s biggest economic problem. The single biggest merchandise import blocks are crude oil and petroleum products imports (16% of the total), with coal and LPG imports further contributing to the deficit. NZ would not have a current account deficit, if all petroleum imports were eliminated. Although total elimination of petroleum imports could only be achieved over

a time frame of several decades, it should none the less be an aspirational goal, in particular since New Zealand does have the physical resources to achieve it.

A transition based purely on high fossil fuel prices may not work

Considering just some of the advantages listed above, it appears unwise that New Zealand hasn't yet started to develop its indigenous bio-energy resources to the fullest extent. But then it should not be forgotten, that perhaps with the exception of the last 5 years, fossil fuels have been very cheap by any standard for the last 5 to 6 decades. However, the same simple 1 0 1 economics that have prevented the development of bio-energy resources for decades, may not be able to spur the development of solid, liquid and gaseous bio-fuels, once fossil fuels resume their climb to yet unprecedented price levels. There are several possibilities why this may be the case:

- **The interest rate trap**. Starkly increasing fossil fuel prices, in particular petroleum, are a key driver for inflation (as seen in 2007 / 08). High inflation is one driver for high interest rates. Most bio-energy schemes are characterized by a large up-front investment and moderate operational costs (e.g. a sophisticated boiler burning wood waste, a manure based biogas plant etc.) As a consequence, while continuously increasing fossil fuel prices should push for a switch from fossil fuels to bio-energy, high interest rates caused by increasing fossil fuel prices may well make it impossible for investors to source cheap enough capital to carry out the investment necessary for the switch.
- **The cash flow trap**. Analogous to the interest rate trap, the cash flow trap may make a switch from fossil fuels to bio-energy impossible for entities that are unable to pass on higher fossil fuel prices e.g. private consumers. Since this group of people has to spend an increasing amount of their income on petroleum and electricity as the price of fossil fuels increases, they have no money available for the installation of a pellet boiler in their home or a conversion of their car to compressed biogas.
- **The export trap**. New Zealand has a market economy with few restrictions. This allows overseas processors enjoying more government backing or restrictions to source bio-energy raw materials at the bottom end of the value chain and also transfer with the raw materials employment and development opportunities from NZ to their respective countries. A living example for this problem is tallow. Many overseas countries have introduced tax breaks for biodiesel over the last decade, increasing demand and raising prices for vegetable oils and fats, not only specifically for biodiesel manufacture, but also for animal feed and chemical processing. As a result of the tax break, overseas biodiesel manufacturers (and with them chemical (soap) manufacturers and others) were able to order tallow from New Zealand at prices that made local biodiesel manufacture (not enjoying a tax break) uneconomic. As fossil fuel supplies dwindle, and competition for many kinds of raw materials becomes more fierce, we can expect to see such cases that prevent the development of a NZ bio-energy processing industry more frequently.
- **The problem of the receding horizons**. The problems that may prevent the development of a strong NZ bio-energy sector driven purely by increasing fossil fuel prices listed above, get compounded by the fact that many bio-energy schemes rely on fossil fuels for their establishment, and sometimes even for their operation. Examples include coal derived steel for biomass boilers, natural gas derived concrete for biogas digesters, natural gas derived methanol for biodiesel manufacture, diesel fuel to drive wood chippers, and oil derived plastic membranes for landfill covers. This means that while fossil fuel price increases may make bio-energy schemes relatively more competitive, they will also make them more expensive. In some (the worst) cases it will mean that bio-energy schemes remain just out of reach, while fossil fuel prices are increasing. This treadmill problem can be combated, e.g. if the infrastructure to use bio-energy is put in place before fossil fuel prices increase, or if a system is put in place that allows a scheme to initially operate at a loss, redistributing the benefits later.

Overseas experience with support systems

Many overseas countries have started to support the bio-energy and the wider renewable energy sector many years ago, and already enjoy many of the benefits that bio-energy schemes have to offer. New Zealand now has the option to evaluate the overseas track record carefully, and choose the most effective and appropriate support mechanisms, that may be implemented here, so that all of NZ can enjoy the many benefits of bio-energy systems as soon as possible and prepare the country for the period of rapidly increasing fossil fuel prices.

Below we review international experience with a range of bio-energy support mechanisms in the electricity, transport and heat sector. The focus is on support mechanisms that are effective, can easily be applied to other renewable energy sources where appropriate, involve minimal administrative effort and are designed for the long term, giving confidence and a clear set of rules to the investor community, consenting authorities, and the manufacturers and operators of bio-energy schemes.

Biomass in the electricity sector
A number of tools are used overseas to stimulate the uptake of bio-energy systems in the electricity sector, including the co-generation and co-fueling segment. Although biomass derived electricity will play a smaller role in New Zealand than in other countries due to our large and world class non biomass renewable resources (wind, geothermal, hydro etc.) it is important to establish some bio-energy electricity schemes. Since these can be developed quickly and early (with the right support tools) they may help to pioneer the infrastructure (logistics etc.) for biomass, while other, higher value uses of biomass (such as wood to ethanol, gasification liquids etc.) are still under development. Furthermore there are unique electricity niche applications in renewable co-generation and active load management (e.g. wind – biogas synergies) for biomass. Overseas support mechanisms for bio-energy in the electricity sector include:

- Feed in Tariffs (FIT)
- Renewable quotas (includes co-fueling quotas)
- Cash grants and tax credits
- Direct government investment

In the electricity sector it is possible to identify a clear winner among the support systems - the feed-in tariff system. FIT's support by far the largest proportion of biomass derived electricity generation around the world, they are easy to administer, applicable to all other renewable generation technologies, and give investors the confidence to make long term investments. In its simplest form a FIT guarantees grid access to all renewable energy schemes at a price (tariff) fixed for extended periods of time (usually 20 years) but different for various types of generation, that is high enough to give a adequate return for most well managed set ups. The premium cost (or benefit) over and above (or below) the spot market value of the generated electricity is spread equally over all electricity sold in the country (e.g. recouped (redistributed) from the end user). In Germany, where FIT electricity contributes > 17% to the national electricity mix, the FIT system contributes a net 1% to the overall cost of a kWh retail electricity. FIT's have been introduced in most European countries, some East Asian countries, and some States in the US and Canada, most importantly Ontario. The UK has recently announced that it will introduce a FIT system to supplement the (not at all well performing) renewable quota system, with a particular focus on small scale set-ups < 5 MW. With the UK switching to a FIT system California remains the only major area where renewable electricity generation (including biomass generation) is supported by a quota system. Quota systems usually lead to the development of boom and bust cycles (with a boom shortly before the quota needs to be met) and are more open to abuse than other support system. Because of this, the unit cost of a kWh of renewable electricity is usually higher under a quota system than under a FIT.

Cash grants have been used extensively in Scandinavia to support the establishment of bio-energy systems. However today these grants are largely only a supplementary support for schemes managed under a FIT, co-gen or district heating scheme.
Tax credits are widely used in the US to support renewable energy systems, although not particularly bio-energy systems. The US wind industry, basically built on the federal tax credit, is notoriously difficult to operate in, with very pronounced boom and bust cycles, a lot of uncertainty before and after elections and the frequent occurrence of a "valley of death" when the old tax credit period comes to an end and a new one or extension, hasn't been decided on.

Direct government investment in bio-energy electricity schemes is only known from local government. Such activity is again often found in Scandinavian countries, where direct investment is supplemented by other programs.

Biomass in the transport sector
Special attention should be paid to the use of biomass in the transport sector, since bio-energy (apart from the not yet very well developed options of renewable electricity and/or hydrogen fuelled transport) is one of few options which can support renewable transport applications. Since transport is the single biggest primary energy user in NZ, and a major contributor to the current account deficit, consideration of this option is vital.

The most widely used support mechanisms for the development of biomass in the transport sector around the world are:

- Tax breaks
- Blending obligations
- Export subsidies
- Direct government investment
- Special privileges

Brazil has achieved 40% substitution of national petrol demand with ethanol due to a combination of long term tax breaks and blending obligations. Some European countries have established a large biodiesel sector employing tax breaks, some of which have been destroyed again when the tax break was partially removed and supplemented (substituted) with a blending obligation.

The US (soy) biodiesel industry has largely been developed on the back of an export subsidy, which has led to boom and bust developments. Due to budget constraints the US export subsidy is currently removed and the biodiesel manufacturing industry only operating at 15% of capacity.

Some Scandinavian countries have had good experiences with direct local government investment in transport bio-fuel systems, mainly compressed biogas in bus and community service vehicle fleets. However these initiatives are largely restricted to fuels that are difficult to trade on a trans-regional or international basis. Also in Scandinavia, granting of special privileges to bio-fuel powered vehicles (such as the right to use bus lanes, enter clean air zones, free city parking etc.) by local territorial authorities, was the issue that swung the balance in favor of bio-fuels for many fleet managers and commercial transport operators. However, the granting of privileges needs to be aligned with other bio-energy support mechanism (such as tax breaks) to be effective. Unlike the support mechanisms for the electricity sector, no clear winner among support mechanisms for the transport fuel sector can be identified globally – although a tendency in favor of tax breaks can be seen.

An effective support mechanism for bio-energy in the transport sector must be focused on national and/or regional conditions. In New Zealand, the bio-ethanol tax break has been effective in establishing some transport bio-fuel use. The system has been easy to administer and few disputes have arisen so far. Broadening the scope of a tax break to all solid, liquid and gaseous bio-transport fuels in New Zealand may be complicated by New Zealand's current RUC system, however if this issue could be solved, a simple tax break could also be made available to other renewable transport schemes such as vehicles powered by renewable electricity. What is apparent from overseas experience (in particular the Brazilian bio-ethanol success and the European and US biodiesel failures) is that any support mechanism needs to be implemented for the long term - at least 20 years - without further revisions once the support system is up and running.

Biomass in the heat sector

Biomass in the heat sector may represent the lowest hanging fruit for bio-energy in NZ. There are very few support systems for bio-energy in the heat sector known around the world that are applicable to NZ. Some initiatives include

- Renewable heat act for new buildings in Germany
- Swedish district heating initiative
- Gas FIT
- Tax break – carbon tax

Germany has recently introduced a renewable heat obligation (EEWaermeG) for all new residential and commercial buildings. Under this system all newly constructed buildings have to supply a certain percentage of their combined heating and cooling demand from renewable sources such as solar, geothermal or biomass (at least 50% of all heating and cooling demand if biomass is envisaged as the renewable energy source for meeting the requirements of the act). Since the act was only introduced in 2009, too little is yet known about its effectiveness.

Sweden has halved its oil use since the 1970's by substituting individual oil fired home heating with biomass fuelled district heating systems. This initiative relied on a combination of regulation and direct local authority investments (just like roads, heat grids are today seen as a piece of vital public infrastructure in Sweden). In NZ, with a different climate, such initiatives would be restricted to a small number of industrial estates, where

high heating demand would justify investment into heat grid infrastructure. Analogous to an electricity FIT, the merits of a natural gas grid FIT is currently debated in many European countries. Such an initiative could get large volumes of purified biogas and wood derived synthetic natural gas (bio-SNG) into the natural gas grid, and allow all natural gas heating applications to rely on gaseous biomass. Again no gas FIT has been in place long enough to comprehensively judge its merits.

A high carbon or fossil fuel tax on fossil heating fuels, combined with an appropriate tax break for renewable heating fuels, may well be the simplest and most effective way to get more biomass used for heating applications, in particular in the industrial sector. However the success of this approach in East Asian, European and North American countries has been patchy to date. It is therefore doubtful if the fossil fuel price increases resulting from New Zealand's planned ETS will be large enough to lead to a step change in biomass use within the heat sector – most likely the cost increases will be too small.

Given the role that biomass in the heat sector could play in NZ, it would be desirable to have more debate about support mechanisms in this area. Most likely NZ has to develop its own support strategy to reap rewards in this area. Investment tax credits or one-off depreciation options for biomass heating equipment may well be one of the tools that may get biomass in the heat sector going in New Zealand.

Support mechanisms summary
New Zealand has currently few support mechanisms for bio-energy. Feed-in tariffs for biomass derived (and other renewable) electricity have well proven their effectiveness and reliability in getting more renewable electricity generated and used in many overseas countries. Although biomass will never be a major contributor to New Zealand's renewable electricity supply, introduction of a comprehensive FIT system could strengthen our country's electricity supply in an environmentally sensible and cost effective manner, and is a more effective measure in comparison to other bio-energy support mechanisms in the electricity sector.

Support mechanisms for bio-energy in the transport sector need to be designed for the long term. No clearly superior system for supporting bio-energy in this sector can be identified internationally, although tax breaks, which NZ has started to implement, appear as an appropriate tool. A potentially problematic future issue for NZ may be to broaden the scope of the existing bio-ethanol tax break to other transport bio-fuels and renewable energy carriers, while maintaining balance and fairness within the system.

More debate is required to identify effective support mechanisms for bio-energy in the heat sector. Since few support mechanisms implemented overseas are applicable to NZ or do not (yet) have a proven track record of effectiveness and reliability, New Zealand may have to develop its own novel support mechanisms.

Workshop participants input
- What specific support mechanism would lead to more bio-energy use within your business / organization?
- What specific support mechanism would lead your business / organization to diversify / extend into the bio-energy sector and make investments into production capacities for bio-energy products?
- Can you identify / see options for directly monetizing non energy benefits (soil and water protection, improved waste management, macro-economic implications, etc.) of bio-energy schemes?
- What further support mechanisms could increase the use of biomass in the heat sector?