Revenue from Biogas

Biogas and anaerobic digestion

Biogas is a mixture of mainly methane and carbon dioxide. It is produced by naturally occurring bacteria from organic matter at the absence of oxygen in a process called anaerobic digestion. Biogas is a carbon neutral renewable energy source. When made from an energy crop it provides a higher energy yield per hectare of land than any crop grown to make liquid biofuel. Biogas can be used as an equal substitute for natural gas in industrial, commercial and residential use, or can be converted to electricity, heat or vehicle fuel using established technologies.

Various organic feedstocks can be converted into biogas, such as farm waste, organic municipal and industrial waste or a large variety of purpose- grown energy crop species. These feedstocks are abundant and their current treatment and disposal practices do not utilise their energy potential. By not capturing this resource and using the resulting energy, can lead to the production of greenhouse gas emissions. Along with biogas, anaerobic digestion of organic matter results in the production of a nutrient rich sustainable alternative to commercial mineral fertilisers, called digestate.

The economic feasibility of biogas production from organic waste or energy crops is strongly dependent on the composition of the feedstock in terms of dry matter content and the biodegradable proportion of the organic matter. The end utilisation/sale of the produced biogas has a comparatively large effect on the project viability, where even small changes in heat and power prices can change the net outcome of a project, from being a socio-economic cost to being a significant gain. The ability to utilise digestate can improve the economic viability of biogas activities.

Overall, biogas offers a renewable energy alternative to fossil fuels. Biogas can be produced at a marginal cost from existing waste materials with many associated environmental and socio-economic benefits, such as the reduction of GHG emissions, waste minimisation and odour mitigation.

Biogas in New Zealand

New Zealand currently produces 74% of its electrical energy from renewable sources. However, the country's increasing energy demand and continued reliance on fossil fuels has seen the ratio of renewable to non-renewable energy decrease over the last decades with concurrent increase in GHG emissions and foreign debt.

According to a study from 2007 (Thiele at al., 2007, *SCION & FRST*), New Zealand has the potential to produce 6 PJ of methane bioenergy from waste material per year. Over 40% of this energy can be produced from municipal solid waste and more than 20% from dairy farm waste collected in milking sheds, the remainder being produced from meat and dairy processing, slaughterhouse waste and sewage biosolids. This energy potential assessment excludes 15 PJ of biogas energy potentially harvested from purpose-grown biomass crops.

Biogas is currently being produced and utilised at 10 medium to large-scale wastewater treatment plants, several landfills and some industrial plants. The biogas is mainly processed into heat and electricity for internal use within the plants or in communal buildings (e.g. Christchurch Civic Centre, Nelson hospital). There is significant potential to expand the biogas market via regional or collaborative facilities taking advantage of the economies of scale

What can the Bioenergy Association do to help?

The Bioenergy Association (BANZ) counts a range of biogas experts amongst its membership base. As consultants, equipment providers, technology developers and researchers, these experts are at the forefront of developing biogas resources and understanding in New Zealand. As an Association, BANZ provides a neutral platform for preliminary information resources, discussion and development. The Biogas Strategy 2010 was developed by the Biogas Interest Group and sets out a plan of activities for the next 20 years that could help to turn New Zealand's biogas potential into reality.

Producing biogas on the farm

Small-scale biogas schemes can generate electricity or heat for use on farm, within communities, in business and in homes, and in some cases can also export electricity back into the local network. Farms and businesses which export may be able to sell the electricity to a power retailer, or to another user.

A prototype biogas system has been operating for several years on a Landcorp-owned farm at Eyrewell, North Canterbury.

Manure from the farm's 900 cows is collected on a concrete pad outside the milking sheds, and pumped into a tank digester. The gas produced is used to power a generator that provides around a third of the farm's energy requirements.

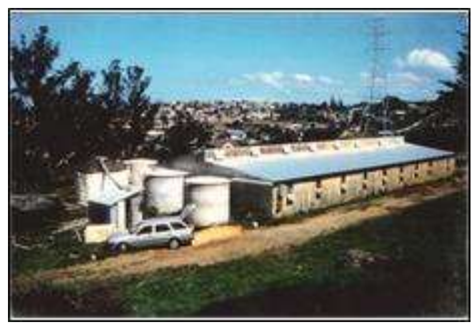
An arrangement with the local retailer, Genesis Energy, means that any excess electricity that is exported gets subtracted from the farm's overall cost of electricity.

How can the Bioenergy Association help?

BANZ is aware of a range of generation opportunities. BANZ can assist rural land owners and others as they consider potential biogas generation options. BANZ can provide independent advice on potential, technologies and can assist with negotiations to ensure that the best contractual arrangement with energy companies is achieved.

Collective digesters

One of the major advantages of anaerobic digestion is its flexibility to operate at varying loads, created for example by the dairy farming seasonality. There are several regions throughout New Zealand with high dairy farming activity. High density of farms may, in some cases, lead to electricity shortages (or a marked quality deterioration) during milking times. On the other hand, the close proximity of farms creates an ideal platform for the development of a collective farm waste treatment facility. This 'co-op' approach is popular in a number of European countries. Milking shed effluent can be either piped or tankered to the digester facility, while using the same route for return of treated digestate back to the farms for irrigation as a fertilizer. The digestate composition depends on the feedstock and the degree of anaerobic degradation, but often shows high concentrations of macro- (N, P, K) and micro-nutrients essential for plant growth. The residual organic matter in the digestate positively contributes to the soil organic matter turnover and the alkaline pH helps to reduce the worldwide problem of soil acidification.



The biogas can be used for generation of electricity to power the digester system (which would use less than 10% of total electricity produced) and for export to the local grid during peak electricity demand. Exhaust heat from the cogeneration unit can be used to maintain the digester contents at optimum temperature. A recent study shows that the payback period of such a collective facility can be substantially reduced via "tipping fees" if a small proportion of industrial waste with high fat content can be sourced from within the catchment area (Thiele et al., 2013).

What can the Bioenergy Association do?

As an Association representing a wide range of members BANZ has a strong overview of what's possible in the biogas generation field. BANZ has connections at each point in the chain that would be required to turn a potential opportunity into reality, or equally is able to establish early on that the situation is not economically viable. BANZ is able to mediate connection between all potential parties.

Regional centres

Examples of regional or community waste treatment facilities from around the world have been demonstrating the benefits of co-digestion of municipal and industrial organic wastes. Combining various types of organic wastes improves the methane yield of the feedstock due to positive synergistic effects and improved digester health. The common drivers behind these projects are minimisation of organic waste disposal in landfills and reduction of GHG emissions, with production of energy and biofertiliser being additional, marketable, benefits. Security of feedstocks, an established market for products and an adequate waste pre-treatment are critical for the success of these projects. The end-use of produced biogas varies depending on a number of issues including:

- The distribution of local energy prices
- Feedstock availability throughout the year
- Specific local needs, e.g. heat, electricity, transport

While profitable utilisation of biogas as transport fuel requires an adequate fleet of suitable vehicles, the ever-increasing petrol prices have seen this biogas application gain popularity throughout the world. The use of biogas as a vehicle fuel can eliminate or reduce dependence on fossil fuel importation and increase national transport fuel security. Similarly, substituting biogas for natural gas using existing transmission and distribution networks throughout the North Island would extend the useful life of existing gas network and reduce New Zealand's reliance on imported gas once Maui gas stores are depleted. BANZ is committed to support development of bioenergy projects via its collaboration with local, regional and central government, as well as regulatory bodies

Co-digestion waste in municipal digesters

Anaerobic digesters are commonly used at municipal wastewater treatment plants for stabilisation of solid residue from the treatment process, the so called sludge. While the primary purpose of sludge stabilisation is to reduce the sludge mass, reduce pathogens, eliminate offensive odours and inhibit, reduce or eliminate the potential for putrefaction, biogas can also be produced if anaerobic stabilisation is employed. The majority of New Zealand municipal digesters are designed to be operated at relatively low organic loading rates with long hydraulic residence times and low biogas productivities. A recent study by Thiele (2013, BANZ OP11) shows that the biogas production of these municipal digesters can be increased 2-4 fold via co-digestion of wastewater solids with commercial and industrial liquid trade waste, provided the digesters are equipped or retrofitted with efficient mixing technology and a solids recycle system.

Through low cost digester upgrades, municipal wastewater treatment plants are then able to not only produce enough electricity and heat to become self-sufficient, but to also generate revenue from selling surplus electricity to the local grid and in some cases also from collecting gate-fees from the waste producers. Such a plant upgrade has a lower capital cost and a shorter simple payback period than the construction of a new, greenfield, trade waste, co-digestion facility. Consequently, an additional 0.9-1.9 PJ of biogas/annum could be produced in New Zealand using the existing infrastructure of municipal digesters at a minimum investment cost. A successful full-scale validation of this approach can be found at Palmerston North wastewater treatment plant.

Energy crops

Energy crops are those crops specifically cultivated in order to utilise their biomass as fuel for energy production within a short time frame, but excludes biomass extracted from existing (long-rotation) forestry. The ideal purpose-grown crops for anaerobic digestion are non-woody and highly digestible with a high biomass yield per area of land. A recent study (Kerckhoffs *et al.* 2011) suggests that maize, Jerusalem artichokes and sorghum can achieve high biomass yields even when grown on marginal land in New Zealand that is not usually used for producing arable crops. Energy crops can be digested as a sole substrate or co-digested with other feedstock, such as animal manure. The study implemented a closed-loop nitrogen supply approach, proving that energy crops can be grown without a need for mineral fertiliser when digestate is used as a fertiliser substitute. The same group of researchers determined that the total potential biomass from New Zealand summer dry marginal land could produce a net 580 million m^3 of methane per year. This equates to 548 million litres of diesel per year with total energy content of 19.7 PJ.

Conclusion

Biogas offers a renewable energy that can be produced at a marginal cost from existing waste materials. Biogas use has many associated environmental and socio-economic benefits and its wider use would also provide an increase in the country's energy supply security.

There is the opportunity to greatly increase the penetration of biogas production from waste material, which is presently being used only as landfill in New Zealand. This can be achieved, at the simplest end, by extending the digestion process design and feedstocks used for biogas production. At the more complex end, this can be done with, for instance, a number of collective, regional, waste treatment centres, or by using crops grown especially for conversion to biogas.

Apart from the obvious economic advantages of the energy produced by anaerobic digesters, other advantages also accrue. In addition to the valuable digestate, added benefits include a reduction in greenhouse gases emitted, a reduction in landfill deposits (which increases the life span of those landfills is extended, as well as reducing the in odours emanating from such landfills). Finally, there is the reduction in the use of non-renewable, fossil fuels, which over time will increasingly be imported.

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