New Zealand Energy Strategy to 2050
Biogas as an Alternative to Natural Gas

Submission

Ministry of Economic Development

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MAUNSELL | AECOM

Biogas as an Alternative to Natural Gas

Prepared for

Ministry of Economic Development

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Executive Summary

Maunsell congratulates the Ministry of Economic Development for its Draft Energy Strategy to 2050 and appreciates the opportunity to contribute to its content.

We are concerned that one of the most promising solutions to a potential energy crisis in New Zealand has not been considered in the Draft New Zealand Energy Strategy to 2050 and submit that significant consideration should be given to **BIOGAS**.

Biogas is a mixture of mainly methane and carbon dioxide produced by bacteria in natural or industrial processes and can be generated from conventional **crops** or **organic waste streams** for the production of energy. European biogas producers have significantly reduced production costs to make this renewable energy product economically viable.

Market

1) Biogas has emerged as the **fastest growing** renewable energy **trend** in Europe after wind power;
2) in New Zealand, natural gas reserves are declining and consumers are concerned about **sustainable gas supply**;
3) reticulated natural gas has been playing an important role in the **energy mix** of New Zealand and in complementing power generation from hydro, geothermal and wind;
4) home grown biogas could significantly reduce the need to earn foreign cash for the finance of imports and could **substitute natural gas** for power generation, industrial, commercial and residential use; it can fuel motor vehicles and embedded power generators;
5) biogas complements the production of liquid biofuels like biodiesel and bio ethanol.

Environment

6) The substitution of 100 PJ of natural gas could reduce the carbon dioxide emissions of New Zealand by 5.5 million tonnes of CO_2-equivalent every year, which, at a value of NZ$20 per tonne CO_2-equivalent, would equate to a value of $110 million per year;
7) biogas is **carbon neutral;** the by-product can be recycled as a nutrient rich compost, which eliminates the need for artificial fertilisers;
8) biogas has the best energy yield per hectare and is likely to be the **most economic form of bio energy** produced in New Zealand.

Production

9) New Zealand is ideally placed to adopt this technology because of its **geography, climate** and well established **farming infrastructure**;
10) **land demand is marginal** and does not need to impact on traditional farming products such as milk, meat or wool; farmers are likely to welcome producing for the domestic market; energy crops grown for biogas can be produced from a large **variety of plants** and could alternatively be used as animal fodder, which would increase **productivity and flexibility**;
11) the **technology is mature** and can readily be adopted in New Zealand;
12) biogas can be purified to New Zealand **pipeline gas quality** with existing technology, can be stored in depleted gas fields and transported in existing pipelines;
13) in locations without gas transmission pipelines, biogas can be converted to electricity by **embedded generators** and support local power grids.

Strategy

14) To substitute the current natural gas supply, the industry will need to develop its full capacity **within less than 10 years**;
15) the New Zealand government must understand the potential of biogas and **support the development of the industry** with appropriate policies.

1.0 Introduction

In this submission, we will explain the potential of biogas and point out how the Draft Energy Strategy could consider this new form of renewable energy. We propose a separate, dedicated **biogas strategy** for New Zealand and are happy to make presentations to the Submissions Committee, the Ministry of Economic Development and other relevant government agencies.

We believe that we are well qualified for this submission and wish to briefly introduce our organisation.

1.1 AECOM

Maunsell is part of the US-based AECOM group of companies – one of the largest infrastructure design groups in the world.

Our vision that is shared amongst 28,000 staff around the world is:

To enhance and sustain the world's built, natural and social environment.

We offer a blend of global reach, local knowledge, innovation and technical expertise.

1.2 Maunsell

Maunsell is a leading provider of planning, advisory, design and management services in the fields of environment, transportation, minerals, power, building and defence. We work throughout Australia, New Zealand and South East Asia and employ nearly 2,400 staff.

In New Zealand, Maunsell draws on a permanent staff of 370 skilled professional and technical personnel operating out of offices in Auckland, Hamilton, Tauranga, Wellington and Christchurch.

We are recognised in the energy sector as a global leader in designing and managing power generation, transmission and distribution systems. Our track record includes a client base of more than 100 power utilities and 80 years' experience in more than 50 countries. Maunsell New Zealand previously traded as Meritec and Worley Consultants.

Our skills in renewable energy and clean fuel technologies put us in a key position to contribute to the increasing worldwide demand for a reduction in greenhouse gas emissions and a 'low carbon' future.

1.3 Background in Biogas

Our background in biogas is derived from more than 20 years of working in the planning and design of energy supply solutions in New Zealand, Australia and Asia. This work has included master plans, business cases, feasibility studies, management advice, detailed design, as well as environmental and expert advice in the fields of natural gas (production, transmission and distribution), CNG, LPG, LNG, biogas from landfills and sewer treatment plants as well as alternative liquid fuels.

Maunsell recently won an award for the design of a highly efficient, dual fuel power generation plant using biogas from the Mangere Sewerage treatment plant in Auckland. This cogeneration facility includes four gas engines, which each generate 1.7 MW of electricity and 2MW of heat.

2.0 Biogas as a Substitute for Natural Gas

2.1 Emerging Trends

Further to the “Oil Shock” of the 1970s, the Chernobyl disaster in the 1980s, the greenhouse gas discussion of the 1990s with the emergence of the Kyoto Protocol, and the reaching of peak oil and gas production during this decade, New Zealand is facing the same challenges as other countries in the world. What is special to New Zealand is its geography, its small population and relatively large agricultural sector.

Europe has been leading the application of renewable energy technologies in recent years and New Zealand has been trailing behind with a five to ten year delay.

Wind energy has been the fastest growing energy technology during the last decade. In some countries, like Denmark and Germany, who have been leading this development, the growth rate has recently been slowing down due to a lack of available sites and increased costs for resource consents.

In Germany, biogas has taken off at a large scale during the last two years and reached the growth rate of wind power in terms of energy production in 2006. The German Biogas Association believes that Germany is likely to have a power generation capacity of 9500 MW fuelled by 500 PJ of biogas in 2020, which is close to the entire energy supply of New Zealand of today.

2.2 Sustainability of Gas Supply

With the running out of Maui gas, New Zealand appears to have passed its peak gas production. The existing reserves could be depleted within 10 years if no other resources are found. Differently to European countries, who have forward supply contracts for 20 to 30 years, New Zealand has become vulnerable in the medium-term and the only alternative to finding new natural gas reservoirs appears

to have been the importing of LNG. Both natural gas from indigenous resources and imported LNG are not sustainable and will cause further greenhouse gas emissions.

The only carbon neutral, sustainable and readily available alternative is biogas.

Biogas is a mix of mainly methane and carbon dioxide and is naturally occurring in anaerobic decomposition of organic material. It has traditionally been found in rice paddies, landfills and sewage treatment plants. In New Zealand, it is mainly occurring in the rumen of cows and sheep and has been recognised as a main contributor to the emissions of greenhouse gases if released without being utilised.

The technology of producing biogas from crops is relatively new. The use of plants like maize and grain for the production of biogas opened new, non-food markets and was quickly picked up by the European farming sector. Biogas is now seen as a potential substitute for natural gas, which is running low in the North Sea and on the European continent. Russia seems to be the main source of natural gas during the next 20 years, but has experienced its first supply shortages already.

This is similar to New Zealand, where the main source of natural gas, the Maui field, is expected to run out within the next few years.

LNG may be a short term, non-sustainable solution to cover possible gaps in energy supply. In order to finance LNG imports, the New Zealand economy would need to increase its exports of milk, meat and wool and pay for the marketing of these products, the production, the fertiliser, the processing and transport as well as the associated carbon emissions.

Biogas would short circuit that inefficient process.

2.3 Energy Mix

With wind not always being available and hydro power being short in dry years, New Zealand has in the past relied on natural gas to provide the missing power generation capacity when it was needed. An alternative to natural gas could be coal or heavy fuel oil at the cost of air pollution and dependency from fuel imports.

During the past 35 years, New Zealand has learnt to appreciate its reticulated, natural gas as a clean, economic and highly effective form of energy, and many industries rely on its availability. If this is to stay, and LNG is not available in the long-term due to international market pressures or environmental concerns, biogas could be the most viable solution.

2.4 Substitution of Natural Gas

New Zealand's current gas demand of approximately 100 PJ per year (for power, industrial, commercial residential use) makes up about 20% of the energy supply of New Zealand. This energy quantity could easily be produced from the growing of energy crops and their conversion into biogas for the reticulated gas market. Additional markets, which could also be supplied by biogas, are embedded power generators, which are the typical application in Europe, and motor vehicles powered by CNG or fuel cells.

2.5 Competing with Liquid Biofuels

For a substitution of the current gas demand of about 100 PJ, only a small fraction of the New Zealand farm land would be required, i.e. approximately 0.5 of the 15 million ha, if productivity would be as high as in Europe. The production of liquid biofuels requires about three times the land for the same amount of energy and often only utilises the seeds of the plants. Biogas can utilise the entire plant and other organic waste streams. Therefore, biogas requires less valuable feed stock and is more economic than liquid biofuels. It can utilise the waste streams of the biofuel production, should this also develop at a large scale.

2.6 Environmental Considerations

Natural gas is the cleanest burning fossil fuel and produces approximately 55,000 tonnes of CO_2 equivalent per PJ of energy in accordance with a report by PA Consulting, commissioned by the Ministry of Economic Development in 2001. Therefore, 100 PJ of natural gas, the current gas demand for the power, industrial, commercial and residential markets, produces 5.5 million tonnes of CO_2 equivalent. At an international trading value of NZ$ 20 per tonne, the economic burden of these emissions is $110 million. The cost of penalties for excess greenhouse gas emissions above the limits set by the Kyoto Protocol will be even higher.

In the biogas fermentation process, most of the organic content of the biomass is converted to gas. The discharge from the process contains the remaining organic compounds and the minerals of the original feedstock and can be returned to the fields as a valuable compost-fertiliser.

2.7 Carbon Neutral Energy Conversion

The energy content of the plants grown for biogas is basically stored in the form of carbon and hydrogen, which are converted in the biogas process to methane and CO_2 in approximately a 60/40 ratio. While methane is used for combustion and energy conversion, the CO_2 is just passed into the air. The total CO_2 that is discharged into the atmosphere will be absorbed by the next generation of biocrops through the process of photosynthesis, which closes the CO_2-cycle. The energy used for transport and biogas production reduces the net output of energy per ha. However, this does not affect the CO_2 neutrality; it only impacts on the overall energy efficiency of the biogas production.

2.8 Land Requirement

Compared with liquid biofuels, biogas has the highest energy yield per ha of farm land. New processes are in development, in which biomass is directly converted into liquid fuels at a similar energy yield, however, they will not be available for some time (our estimate: 10 years). Biogas is therefore currently the best form of bio energy with regard to land utilisation.

2.9 Production Conditions

New Zealand has a mild climate and gets, in most parts of the country, plenty of rain, which should enable the farmers to grow energy crops as productively as in Europe, at least on the flat sections. As biogas crops like maize do not need to fully mature and dry on the field, it is possible that rotational crops such as clover grass can be grown during the rest of the year.

Maize appears to be the most popular energy crop in Europe; however, many other crops can be used, such as barley or wheat. Organic waste streams can be supplemented to dedicated energy crops, such as fruit and vegetable waste, straw, hey, meat processing or communal waste as well as animal manure.

2.10 Effect on Land Demand

Because of the large variety of feedstock for biogas production and the potential use of waste streams, the land demand for 100 PJ of biogas production is likely to be less than 0.5 million ha. Dedicated energy crops like maize will require mechanical farming and relatively flat land, of which New Zealand has about 2.0 million ha. It is therefore likely that the flat sections of the land will be used for crop farming and animals will mainly occupy paddocks on slops. This land use would be quite similar as in older, mountainous countries like Austria and Switzerland, where crops are grown in the valleys, animals graze on slopes and forests are grown on hilltops. On a national scale, part of the crops grown on flat land will be used as fodder, which is likely to increase the overall productivity of milk or meat production per ha.

It is therefore assumed that New Zealand's output of milk, meat and wool would not be affected by the production of 100 PJ of biogas.

2.11 Biogas Technology

The biogas technology is not new and has been applied for many years in the processing of manure, sewerage and on landfills. However, these traditional methods of generating biogas have been less efficient and less economic because of the low organic concentration of the substrates. Using crops as a feedstock and providing the right growth environment for the methane generating bacteria will maximise the conversion rate and reduce the size of the fermenters. The efficiency has significantly improved during the last five years and so have the economics of biogas.

2.12 Biogas Distribution

Biogas as a substitute for natural gas could be collected at central plants (e.g. in Taranaki, Waikato, Bay of Plenty, Hawkes Bay and Northland), CO_2 would be removed by industrial processes similar to that of the Kapuni Treatment Plant (see picture above), and the pipeline quality gas would be compressed for transportation in the existing transmission and distribution networks.

Biogas is produced continuously and the fluctuating gas demand would be balanced with existing natural gas reserves or through the use of underground storage in depleted gas reservoirs.

2.13 Embedded Power Generation

At locations, where the gas transmission network is not available, like in the South Island, biogas will be converted into electricity. Typical plant sizes have electrical ratings of 500 to 1000 kW. These generators are likely to be installed on farms and will feed the generated power into rural distribution networks. They would effectively become embedded generators and reduce demand of transmission capacity by the respective distribution networks.

2.14 Strategy

Farmers and energy companies will need to invest into equipment and learn how to market and to manage the new product effectively. While the technical know-how can be imported, it will take time for its adoption in New Zealand and for the required structural changes of the farming sector. We estimate that even with initial government support, this development will take 10 years, which is about the depletion time of the current gas reserves.

2.15 Government Action

Government support will depend on public demand for renewable energy and the popularity of reticulated natural gas. From our observations of European markets, we believe that public interest in biogas is very high. Governments in Europe have supported the emerging markets for renewable energy and it is possible that a European biogas strategy will be developed soon.

We therefore propose that the New Zealand government takes urgent action in developing policies that:

- **provide security of gas supply beyond a 20 year planning horizon;**
- **support sustainable gas supply;**
- **support a rapid development of a biogas industry;**
- **support technical and market research for optimum biogas economics;**
- **conserve existing natural gas resources for future generations.**

3.0 Submission

Part 1: Sustainable energy system

3.1 Introduction

Maunsell acknowledges the effort that has gone into the Draft Energy Strategy to 2050 and believes that it points into the right direction. We support the vision and believe that the development of a New Zealand biogas industry will be fully in-line with that vision as it will:

- provide security of supply and be a reliable source of energy;
- maximise the use of existing resources and minimise the environmental impact;
- be a fully renewable energy resource;
- reduce the country's greenhouse gas emissions;
- promote sustainable use of our land.

3.2 Security of Supply (3.3)

Insert a section on Gas (3.3.2)

Priority should be given to long-term security of gas supply to existing and future markets as part of a secure and effective energy mix and to continue the environmentally friendly transport of that fuel. Timely investment into alternatives to the declining natural gas reserves is required. Biogas has the potential to substitute natural gas at marginal land use.

3.3 Energy Diversity (3.3.3)

Insert: **Biogas can be produced at marginal cost from existing waste streams and from dedicated energy crops, which have a high energy yield per ha of land.**

3.4 Renewable Energy for Electricity (3.5.1)

Biogas can play a significant role in embedded power generation. It has the potential to reduce base load and to reduce the demand on the transmission network.

3.5 Transport (3.5.2)

Compressed natural gas used to fuel 10% of the New Zealand vehicle fleet in the 1980s. Reticulated biogas has the potential to fuel motor vehicles with conventional combustion engines or with electric motors in combination with fuel cells.

3.6 Page 15 “Measures to promote renewable energy include:

Section b) encouraging the development and use of **biogas** and liquid or solid biofuels …

3.7 Facilitating sustainable technologies (3.7), Vision:

Insert at end: **The government could encourage technology transfer from overseas and support the construction of demonstration plants for sustainable technologies that have been successful.**

3.8 Energy security (4.1)

Insert 4.1.2: **Gas supply security: The government established the Gas Industry Company to co-regulate the gas market. An additional task could be the reporting on, and overseeing of, long-term and sustainable gas supply. This could include the monitoring of emissions by the gas industry and providing advice on market implications of emerging technologies such as biogas.**

3.9 Climate Change (4.2)

After In electricity, ….

The gas industry is facing a real challenge with securing future supply. The industry is currently looking at the importation of LNG, which is non-renewable and may face price increases through growing demand on the world market. Biogas is an alternative that can be produced domestically and the New Zealand farming sector could embrace its production as an alternative to exports.

Part 2: Action Plan

3.10 Introduction (1)

Insert a further bullet point:

- **Security of gas supply**

3.11 Transport (2)

Insert in Summary, second bullet point: Increasing the diversity of transport fuels through introduction of biofuels, **compressed biogas** and electric cars …

3.12 From vision to action:

Insert the following bullet points:

- **Encourage walking and bicycle riding**
- **Support the construction of safe bicycle tracks throughout New Zealand**
- **Promote the use of small and light vehicles for low energy consumption**
- **Support the introduction of compressed biogas as a vehicle fuel.**

3.13 Developing and adopting future fuels (2.3.1)

Insert 2.3.1.2 **Biogas**

New Zealand had a gas powered vehicle industry in the 1980s, when approximately 10% of all cars were converted to compressed natural gas. This environmentally friendly technology died in the 1990s, after withdrawal of government subsidies and a temporary decline of oil prices. As New Zealand has the potential for producing reticulated biogas, a gas vehicle industry could be re-established. Compressed biogas can become attractive for low fuel consuming vehicles and for vehicles with electric drives and fuel cells. This technology has made significant progress in recent years.

3.14 Diversity of transport fuels (2.3.5)

Under Action: The Government recognises the contribution that biofuels, electricity, **biogas** and LPG can make to improve the energy security for the transport sector **and will proactively and appropriately support the use of environmentally friendly fuels**.

Part 3: Security of electricity supply

3.15 From vision to action

Second bullet point:

- **Develop policies to encourage and manage increased contributions of power generation from renewable energy sources such as hydro, geothermal, wind and biogas.**

3.16 Our direction (3.1)

Second bullet point:

- ensuring there is enough fuel (including water, **gas** and wind) to generate sufficient electricity at any instant in time and over time

Regulation of supply security (3.1.4)

Last paragraph:

The gas market is overseen by the Gas Industry Company (GIC), which is charged with ensuring improved gas market arrangements are developed and implemented. **Its role could be extended to the monitoring and reporting of greenhouse gas emissions by the industry and the long-term security of gas supply.**

3.17 Gas market initiatives (3.2.4)

Insert a new paragraph after the third paragraph on new gas exploration:

As both natural gas and fossil fuels will increase greenhouse gas emissions, the government will encourage the production of New Zealand made biogas. It will support the development of this industry with appropriate economic tools.

3.18 Generation sources (3.3.2)

Third paragraph:

New Zealand's renewable energy resources – geothermal, wind, hydro, **biogas** and, potentially, marine – are extensive and …

Fifth paragraph:

Several companies are exploring options for importing gas – CNG or LNG – to cover the risk of insufficient gas discoveries. **The government welcomes these initiatives and will in parallel support initiatives that lead to renewable forms of gas supply, such as biogas.**

3.19 Gas market and availability (3.3.3)

Last paragraph and third Action:

Action: The GIC will take a proactive role in ensuring that long-term gas supply is secured and will report on the greenhouse gas emissions caused by the industry. It will advise on appropriate market mechanisms to reduce emissions.

3.20 Into the future (3.4)

At the end of last paragraph:

International progress made on the production of biogas is most encouraging for New Zealand with its large farming resource, existing gas networks and an urgent need for sustainable gas supply.

Part 4. Low emission power and heat

3.21 From vision to action:

Sixth bullet point:

- Explore the potential for the use of climate-friendly energy technologies in New Zealand, such as **biogas and** carbon capture and storage (CCS). (include in Glossary!).

3.22 Table 4.1

Below Wind:

Biogas, 2005 energy supplied: 160 GWh/yr, Econonmic potentials: 18,000 GWh/yr [3]
Total: update sums.

Under Notes:

3. **based on substitution of natural gas for current power production at 50% efficiency and doubling of this capacity with distributed, biogas fired generators.**

3.23 Distributed generation

Second paragraph, second sentence:

DG includes smaller-scale generation (including wind, **biogas,** biomass ….

(replaces landfill gas, which is a form of biogas)

Part 6: Sustainable technologies and innovation

3.24 From vision to action

First bullet point:

- Establish working groups made up of private and public sector representatives to provide strategic leadership in priority energy innovation areas such as geothermal, **biogas,** marine energy, biofuels and CCS.

Last bullet point:

- Establish contestable funds to support the deployment of **farm- and** marine-based electricity generation.

3.25 Energy research roadmap (6.2.1)

Second bullet point, first sub-bullet point:

- bioenergy, including **biogas**, liquid transport fuels and stationery energy fuels

3.26 Table 6.1, Areas for action

After geothermal:

Biogas (from energy crops and organic waste streams) – feasibility, demonstration, market creation, deployment

3.27 Into the future (6.4)

At first place:

Biogas as an alternative to natural gas and as a fuel for distributed generation has made considerable progress in Europe and has the potential of becoming the next significant, renewable energy trend after wind power. New Zealand has the potential for increasing the productivity of its farming sector and producing large quantities of biogas. This could replace the current natural gas production and provide energy for distributed generation as well as an alternative fuel for motor vehicles. Given the currently small reserves of natural gas, the New Zealand government considers the demonstration of biogas from crops and waste streams a top priority.

Action: The government will support the construction of biogas demonstration plants and the preparation of economic studies to identify appropriate market mechanisms for this fuel.

Glossary

3.28 Biogas

A mixture of mainly methane and carbon dioxide produced by anaerobic decomposition of organic material, which occurs naturally and which can be produced in plants that maximise the energy conversion from crops in an optimised bacterial process.

4.0 Conclusion

4.1 Work to be done

Maunsell believes that biogas made from energy crops can play a significant role in the future energy supply of New Zealand and proposes that the government give this renewable energy source its strongest possible support.

Maunsell proposes:

a) the formation of a working group with members from the farming and energy sectors to formulate a biogas strategy,

b) the preparation of a feasibility study to assess the market and economics and

c) the construction of demonstration plants to test the technology within the New Zealand environment.

4.2 Address for contact

Maunsell is happy to present further detail to the Submission Committee, to the Ministry of Economic Development and to other interested government and non-government organisations.

Inquiries can be directed to the author of this submission:

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