Greenhouse gas emissions reduction from use of bioenergy and biofuels by 2050

Currently 11% of consumer energy is supplied from biomass. Including only process heat and use of waste this could increase to 15% by 2050 and reduce net greenhouse gas emissions by 3-6%.[1] , but with biofuels use by heavy transport this could increase to 27% energy with 15% reduced greenhouse gas emissions.

The use of biomass to produce process heat instead of fossil fuels is based on technology that is well proven and readily available.

There is adequate biomass throughout New Zealand that can be combusted to produce process heat to allow a theoretical 100% replacement of coal and some gas fuel. 60% of the biomass fuel to replace coal can be sourced from current plantation forestry operations and the remainder from new forest planting, farm forestry, energy crops such as miscanthus, organic municipal and industrial waste, and use of currently unused agricultural biomass such as stover and straw. Treatment of biomass so that it can be cofired in existing coal plant requires some research but internationally is already proven. This assumes that some existing low temperature process heat will also be sourced from electricity-based equipment such as heat pumps.

Municipal Waste Treatment Facilities, which use anaerobic digester technology, process sewage and liquid trade waste into biogas and biosolids both of which can be used as a fuel. Food waste from communities can also be treated in an aerobic digester but in this case the resulting digestate can be used directly as a high-quality pathogen free fertiliser onto land. In both applications the treatment of organic waste reduces disposal to landfill and subsequent discharge of methane, a greenhouse gas, which would otherwise occur. The biogas can be used to generate electricity, produce heat, used as biomethane as a vehicle fuel and a feedstock for manufacture of bio-based.

[1] This includes only the immediately realizable reductions and excludes the emissions reduction potentially available from farming as offsets to biological emissions from livestock eg production and sale of biomass fuel from shelterbelts, woodlots etc; the full potential from diversion of all organic waste from landfill; and the treatment of farm animal and crop wastes to reduce methane emissions. The technical potential is estimated to be double this level of energy production and emissions reduction.

Organic matter can be processed into liquid and gaseous biofuels which can be used as a transport fuel in marine, aviation, rail and road transport vehicles. Transitioning from use of fossil fuels for transport can reduce greenhouse gas emissions.

The opportunities

The opportunities for use of bioenergy and biofuels produced from woody biomass and organic waste to reduce greenhouse gas emissions are generally dependent on infrequent capital investment decisions eg replacement of an aged inefficient heat boiler, or upgrading of a sewage treatment facility etc. In those situations the investment decision maker has to consider a number of options and the consequential business case risk associated with each option.

There is minimal technology risk with biomass heat energy process equipment as it is proven and readily available. Similarly waste-to-energy and anaerobic digestion equipment is well proven and commonly used internationally. There is an adequate level of technical advice available for design, construction and operation.

Biomethane from biogas is able to be used as a vehicle fuel using existing technology. The first generation technologies for production of liquid transport fuel from tallow, used cooking oil and whey are proven but there are limits to the quantities available. First generation liquid biofuels can also be produced from energy crops such as canola but is not often the best use of land unless as a break crop.

The biomass feedstock, whether woody biomass or organic waste, used for biomass energy generally comes from a number of sources with limited economies of scale, and often will require pre-treatment before it can be used as a fuel as it is often not homogenous. There is also often a long supply chain with a number of parties involved. The biomass fuel supply chain is complex and requires specialist suppliers. This means that it needs to be well managed to ensure specification compliant fuel at the lowest cost.

The business risk to the investor is in the biomass supply chain, but it is manageable by sourcing fuel from experienced accredited biomass fuel suppliers.

How much greenhouse gas emission reduction can be achieved.

In 2017 biomass energy supplied 11.1% of New Zealand's consumer energy. This is 65.58 PJ of renewable energy out of a consumer demand of 590.51PJ. process heat requires 245PJ of energy.

In 2016 Gross GHG emissions were 78.7Mt CO2-e and net emissions 56.0 Mt CO_2-e

Considering only process heat and the use of waste, by 2050 16.8PJ of additional renewable energy could be available from biomass and waste under an encouraged transition scenario and 24.6 PJ pa under an accelerated transformation scenario[2,3]. This would result in GHG emission reductions for process heat and use

[2] Bioenergy Association Information Sheet 48, *Reducing greenhouse gas emissions to achieve "Zero Carbon by 2050" using biomass energy for industrial and commercial heat*

[3] Bioenergy Association Information Sheet 47, *The role of organic waste, and waste water treatment plants.*

of waste of 1620 and 3611 kt CO2-e pa respectively. This would be an increase of 2.8 and 4.2% of total consumer energy coming from biomass and result in a 2.9 and 6.4% reduction in net emissions.

The use of liquid and gaseous biofuels for heavy transport (Marine, aviation and rail), sourced by import or domestic production, could by 2050 under an accelerated transformation scenario replace 68PJ of fossil energy and reduce greenhouse gas emissions by 5000 kt CO_2-e pa. This would result in biomass providing a total of 92.6PJ of energy which would be 27% of consumer energy demand and a total greenhouse gas emissions reduction of 8611 kt CO_2-e pa which would be an emissions reduction of 15.4% over 2017 levels.

The level of reduction in greenhouse gas emissions from bioenergy and biofuels below 2017 levels and the amount of energy produced are set out in Figures 1 and 2.

Figure 1: Greenhouse gas emission reduction below 2017 levels (kt CO_2-e pa)

	Reduction of use of fossil fuels in process heat[1, 5] (kt CO2-e pa)			**Methane reduction from waste to energy[2] (kt CO2-e pa)**			**Emissions reduction from use of biofuels in transport (kt CO2-e pa)**		
Year	BAU	Transition[3]	Transformation[4]	BAU	Transition[3]	Transformation[6]	BAU	Transition[3]	Transformation[4]
2030	200	400	700	0	180	1450	200	200	1500
2040	500	1000	1500	+20	210	1640	400	400	3500
2050	700	1300	1800	+40	320	1811	800	800	5000

Figure 2: Energy increase above 2017 levels[7] (PJ)

	Reduction of use of fossil fuels in process heat[1, 5] (PJ)			**Methane reduction from waste to energy[2] (PJ)**			**Emissions reduction from use of biofuels in transport (PJ)**		
Year	BAU	Transition[3]	Transformation[4]	BAU	Transition[3]	Transformation[4]	BAU	Transition[3]	Transformation[4]
2030	2	4	8	0	1.1	3.2	3	3	20
2040	5	11	17	0.05	1.5	3.9	6	6	48
2050	7	15	20	0.1	1.8	4.6	12	12	68

Notes

1. Bioenergy Association Information Sheet 48 – Greenhouse gas emissions reduction using biomass energy for industrial and commercial heat, September 2018
2. Bioenergy Association Information Sheet 47 – *The role of organic waste and biogas in the transition to low carbon economy in New Zealand*, November 2018
3. Based on implementation of NZEECS
4. Requires greater incentives than set out in NZEECS. Transport biofuel based on Scion Biofuels Roadmap, 2018
5. Assumes that a significant volume of low temperature process heat currently produced from coal or gas can be substituted by heating from electricity by use of heat pumps.
6. Assumes complete diversion of domestic, commercial and industrial food waste from landfill plus domestic green waste to newly build anaerobic digestion facilities.
7. To achieve the encouraged transition scenario quantity of coal fired process heat substitution requires around 74,000kt/year of wood fuel which is within the wood fuel supplier's capability to supply. To achieve the accelerated transformation scenario quantities of substitution will require development of additional sources of biomass.
8. In 2016 2.7PJ of energy was produced from biogas. It is assumed that the biogas from landfill remains constant at the 2016 levels to 2050 with increases from some landfills being offset by decreases in biogas production at other landfills.
9. The GHG offset from farm operations due to farming coming into the ETS has not been calculated and will be additional to the emissions reductions identified in Figure 4.
10. The quantum achievable in the transport sector is currently being evaluated.

Actions required

To get above business as usual and the encouraged transition scenario to the outcomes of the accelerated transformation scenario and beyond requires some key actions. These include:

Process heat

- Encouragement for additional processing of logs to occur within New Zealand.
- Focus on improving the efficacy of the supply of biomass fuel from plantation forestry, wood processing, and farm forestry eg use the One billion trees programme to produce future biomass fuel.
- A support programme to assist farmers to offset biological emissions by use of bioenergy based activities eg farm forestry to produce woody biomass fuel, treatment of waste to reduce nutrient runoff to waterways to offset NZ ETS liabilities.
- R & D into the treatment and use of non traditional biomass fuels eg stover, and their use for co-firing with coal as a transition for existing coal plant. Investigate torrifaction of biomass to make green coal.
- Implement Government support policies
    - Procurement and lifecycle analysis policies
    - Revise Crown Loan criteria
    - Accelerated depreciation
    - Suspensory loans
- Provide guidance, demonstration and assistance to owners of heat plant to reduce emissions and operating costs.

Reducing methane emissions from waste

- Establish a National Policy Statement setting a policy of Zero organic waste to landfill by 2040
- Introduce policies to encourage early investment in processing waste to produce energy and other high value products
- Provide guidance, demonstration and assistance to territorial authorities for upgrading and optimising WWTP for beneficial treatment of trade wastes providing reduction of emissions and operating costs.
- Provide guidance, demonstration and assistance to business and territorial authorities for the planning, assessment and implementation of single or multi-stream treatment of food and organic liquid and solid waste to produce energy and other products.
- Assistance to agricultural organic waste producers to reduce methane emissions.
- R&D into the high value uses of biogas such as a vehicle fuel and as a feedstock for the manufacture of bio-based materials.

Transport biofuels

- Provide guidance on the use of biomethane as a vehicle fuel.
- Use imported biofuels as a transition pathway to provide an incentive for domestic manufacture
- Establish specific programmes for marine, heavy road vehicles, rail and aviation so that R&D is demand driven.
- Include production of biofuels within a wider transition to the manufacture of bio-based products within a low emissions economy based on wise use of renewable natural resources.