There is already adequate residue biomass for 30% of our energy demand!

Abstract

As New Zealand transitions to a circular bioeconomy there will be an increasing demand for biomass, and increasing incentives to recover resources from organic waste for production of a wide range of products including bioenergy and biofuels, engineered wood products, biochemicals, and bio-based materials.

Simple analysis shows that the total potential supply of biomass and organic waste is substantial, provided there are policies and programmes that incentivise wise land use and that integrated agriculture and forestry land uses are encouraged. It is also assumed that the proposed revision of the Waste Strategy[1] is implemented.

This Information Sheet focuses on an immediate priority of ensuring that there is 10million tonnes of biomass pa, (27% of current annual plantation forestry production), plus enough organic waste, to meet an initial **target of 150 PJ of energy to replace fossil fuels.** This will allow a **greenhouse gas emissions reduction of 157 Mt CO_2-e pa by 2050**. This target could be achieved by earlier dates if Government policies and programmes focused on early achievement as an objective.

The gap between current bioenergy use (50 PJ) and the assumed immediate potential bioenergy demand (150PJ), is driven by process heat transition from coal, the emerging transport biofuels, and the potential need to replace natural gas. It can be easily met by better using existing biomass residues, with any gap met by diversion of some low-value export logs (20% of the 23 million tonnes (157 PJ) exported annually), increased areas of integrated farm forestry, and additional tree planting (back to 1990's levels). The build-up of the available biomass is summarised in Table 2. This biomass can be used for conversion to liquid, gaseous and solid biofuels if ambitious targets are set. This would also assume greater domestic processing of wood for wood products, which would produce increased quantities of residues which can be recycled into energy.

Biomass suppliers have been serving some dedicated users for many years now, but it appears demand is likely to increase greatly over the next decade through to 2050 and beyond.

The solid biofuels supply market to date has behaved as markets normally behave. As there has been an increase in demand and some areas have experienced constraints, new entrants have entered the market to increase supply. As forest owners and harvesters have recognised the increased demand for biomass they have started to take an interest in meeting that increase in demand.

This analysis shows that there is potentially adequate biomass to meet demand. Taking into account price limitations in specific regions from time to time, there are generally always other sources of biomass which will then become economic. The biomass supply market is robust, and with many options, so if we take action now we will meet demand, but if we do nothing then there will be a shortfall in supply.

[1] https://consult.environment.govt.nz/waste/taking-responsibility-for-our-waste/

The biomass supply market

The transition of New Zealand to be a circular bioeconomy as signalled by Government in late 2021[2] will be built upon the foundations of the growing bioenergy and biofuels sector, a strong forestry and wood processing sector, and a revised waste strategy[3].

The bioeconomy includes production of bioenergy, biofuels, bio-based chemicals, engineered wood products and bio-based materials from biomass and organic wastes.

The bioenergy sector already has a sound footing in the use of solid biofuels for heat, whereas the gaseous biofuels subsector is in transition through the emerging circular bioeconomy, with increased opportunities for the recycling of organic waste.

The liquid biofuels subsector is in its infancy but internationally is fast expanding to meet demand for sustainable decarbonisation of heavy transport. The proposed sustainable biofuels obligation will provide a strong incentive for investment in liquid biofuels, including eventually domestic production.

The lack of availability of coal and natural gas for heating arising from Government's climate change and oil exploration policies is resulting in the demand for solid biofuels increasing so that the price of biomass is getting close to the price for K logs currently being exported. The alternative is electricity which typically has an even higher price. These higher prices for biomass are opening up opportunities in new areas such as farm forestry.

Growth in the demand for biofuels is also being facilitated by the growing recognition that biofuels can often be a drop-in fuel to existing equipment, thus avoiding extensive capital investment in equipment that would be necessary for use of alternative low emission fuels such as electricity and hydrogen. The use of drop-in gaseous, solid and liquid biofuels can often be done very quickly and produces an immediate reduction of greenhouse gas emissions.

The supply of the solid biofuel market cannot be left to market forces alone. It has to be a managed market as there are significant market failures because of the long lead times involved (on both the supply and demand side where 30 years is the norm and that is beyond the time frame for most investors who struggle with even 12 year pay back periods.

There are no technology barriers limiting the supply of biomass. We have information barriers but mostly we have a lack of will and incentive to make the biomass supply market successful. Today when coal and natural gas are generally not available the main competition for fuel for heat supply is either electricity or biomass. Biomass has a lower cost but similar risk profile to electricity supply. (There is no more certainty of new electricity power stations being consented and built at a low cost than there is that landowners will produce more biomass.)

Biomass fuel supply is also able to be better managed by users as they all have the option of being able to grow their own biomass for own use, whereas there are few electricity customers who can generate their own electricity, except at the margin as economies of scale are significant for electricity generation but less so for biomass supply.

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[2] https://environment.govt.nz/publications/emissions-reduction-plan-discussion-document/

[3] https://consult.environment.govt.nz/waste/taking-responsibility-for-our-waste/

Figure 1 summarises the main components of the New Zealand bioenergy and biofuels sector. This highlights that the largest potential for bioenergy production is from residues from existing forestry and wood processing, with a smaller contribution from recycling of organic wastes. This analysis therefore leans heavily on the need for increased biomass recovery and obtaining increased quantities from new and improved woody and herbaceous plantings. It is expected that relative sourcing of organic waste will decrease over time from emerging efficiency improvements throughout the supply chain, and that the volume of these materials will be dependent on improved collection processes and due to population growth.

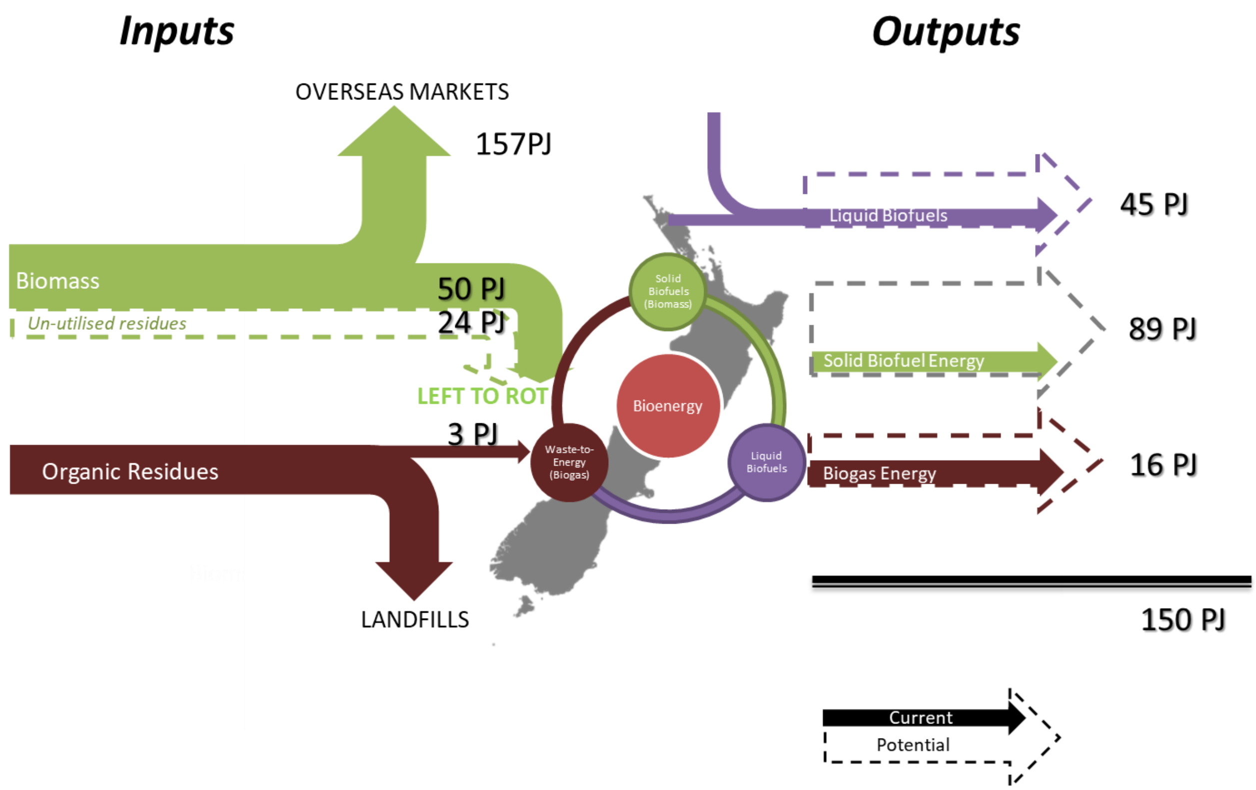

Figure 1: The New Zealand bioenergy and biofuels sector.

One part of the emerging circular bioeconomy is the work being undertaken to extract greater value from domestic processing of logs which are currently exported. For the purpose of this analysis it is assumed that because the new bio-based products will be high value, additional domestic wood processing is from logs diverted from the current export market and not from new plantings. It is assumed that minimal additional plantation forest planting is required to meet an expanded wood processing capability. With expanded wood processing there will be significant quantities of wood residues which will be available for production of energy and/or other bio-based products.

The economics of extracting biochemicals from biomass to replace petroleum derived chemicals and plastics etc is fast emerging internationally although New Zealand is behind in recognising the economic opportunities. For the purpose of this analysis it is assumed that the extraction of biochemicals is actually a facilitator for the use of biomass and waste organic material to produce energy products. An example is that the extraction of resins and chemicals from wood which leaves behind lignin and cellulose residues which are able to be used as an energy fuel.

Focusing on the use of biomass and organic waste to produce energy will not be in competition with these other bioeconomy activities, but will provide a foundation for them to occur. A key aspect is that the development of the supply chain for recovery and preparation of biomass will initially be for bioenergy and biofuels, but is then the same supply chain for these other possibly higher value bioeconomy applications

Sources of biofuel

The supply of solid biofuels from wood is well established within the wood processing sector where biomass for heat production is generally sourced from elsewhere in the same business e.g. sawmills and other wood processors. Many sawmills burn thir own sawdust and shavings. The wood processing industry is the largest user of bioenergy in New Zealand. Over the last decade many other non-wood sector heat users have been turning from fossil to biofuels and a trade in biomass suitable as a fuel has evolved. This has created a pool of aggregators of biomass who are suppliers of solid biofuel (often referred to as wood fuel). These solid biofuel suppliers have built their business on a range of industry best practices and are growing capacity as demand for solid biofuels grow[4]. The solid biofuels can be in the form of chip, pellets, briquettes or hog. The biomass needs to be prepared so that it meets specifications relevant to the application for which it is to be supplied. Biomass can only be sold as a quality fuel when it meets the relevant fuel specification.

Solid biofuel suppliers work under an accreditation system[5] to ensure quality and consistency of fuel supply. They have backup contracts from growers of the biomass (forestry, wood processors or farmers) from which they produce contract specification biofuel.

Liquid, solid and gaseous biofuels can also be produced by recycling organic waste. This may be from municipal solid or liquid waste, food processing residues, animal effluent, or agriculture crop residues (straw etc). The recycling of organic waste to produce energy also produces, in most cases, high grade biofertiliser and avoids the unnecessary disposal of the waste to landfill.

The[i] National Exotic Forest Description shows that currently the forest area (new planting) is expanding by 34,000 ha per annum. In the past (mid 1990s) we have had new forest areas being planted at over 90,000 ha per annum, so we could do a lot more than at present. 60,000 ha per annum of new planting (on top of the restocking) for 20 years would be well within reach with supportive policy settings.

Over the last 12 months around 22.7 million cubic metres of raw logs were exported. These logs contained around 157 PJ of renewable bioenergy. New Zealand's current forest harvest volume is around 37 million cubic metres per annum, so 60% of all the logs harvested are exported. There is long term potential to grow the area of forest and expand the harvest volume and the bioenergy potential this contains. In the long run we could have a further 20 million cubic metres per annum (138 PJ per annum) at least if we planted another 60,000 ha per annum for 20 years and kept 60% of that harvest for energy. Even greater additional planting would produce biomass that could be used for bioenergy and other bio-based substitution products.

At current log prices, the lower value portion of these logs is already competitive as a biofuel for heating and process heat. This resource also has the potential for conversion to biomethane to replace natural gas and to

[4] https://www.bioenergy.org.nz/news/wenz-partnership-formed-as-biomass-market-heats-up

[5] https://www.usewoodfuel.org.nz/solid-biofuel-suppliers

produce renewable LPG, as well as to produce liquid biofuels for the transport fleet which would complement and offer an alternative to the heavy electric vehicle initiatives.

New farm forestry is potentially the greatest untapped source of biomass to underpin a bioeconomy. Typically, around 6-9% of a farm is not highly productively used. This includes shelterbelts, managed erosion control, managed riparian planting, woodlots and the slopes and corners which are not suitable for farm use. Farm forestry can be a source of significant additional revenue for farms and is ideal for many species which could be the source of bio-chemicals, timber, logs and energy. If the He Waka Eke Noa proposals for farms to get credits for greenhouse gas mitigation are adopted, and farms can elect to include all their vegetation in either the NZETS or He Waka Eke Noa emissions accounting, then there will be good incentives for farmers to extend their farm forestry.

To assist getting adequate biomass available for energy and other bio-based products it is important that only native species can be included within the permanent NZETS category. All other species should be covered by the NZETS average accounting regime, or the NZETS stock change accounting, or He Waka Eke Noa schemes so that land owners are incentivised to use their land wisely. The greatest cost is if the planting of marginal land areas does not occur as we need to maximise the quantities of biomass coming to the market. If landowners have a choice of options – permanent native, NZETS average accounting, NZETS stock change accounting, or He Waka Eke Noa then landowners will be optimally incentivised to make the best decision and are likely to use vegetation to maximise emissions mitigation.

Demolition and construction biomass can be used as a fuel in some specific designs of boilers and work is underway by the Bioenergy Association to provide guidance on when this fuel can appropriately be used.

Other sources of biomass such as algae are not currently available except from lake and waterway clearance.

Ensuring adequate availability of biomass requires that we are aspirational in working to ensure that there is enough biomass of the right type, in the right place, at the right time, and at the right price. Currently we have limited short rotation forestry research, we have no effective programme for farm forestry and our multi-species research is being left to farm foresters who are doing it with little assistance and in a fragmented way. The analysis in this document assumes that these are addressed.

The analysis also assumes that the He Waka Eke Noa proposals are adopted and agriculture emissions are on a net emissions basis by recognising all farm mitigation opportunities. It is assumed that this gets farmers wanting to produce more biomass as a product of their farms[6]. A recognition of their mitigation from all vegetation, herbaceous and trees, incentivises the farms to produce more biomass. An integrated agriculture and forestry approach has resulted in ensuring there is enough biomass.

Demand for biofuels

In 2019 51.31 PJ of consumer energy was produced from biomass in New Zealand. This is 8.7% of total observed consumer energy of 557 PJ. This use of biomass to produce energy occurs principally in the wood processing sector, including pulp and paper manufacture. However the main growth in demand for biomass arises from Government policies to transition from fossil fuels for hospitals, schools, institutions and process heat.

[6] Managing exotic afforestation incentives

Bioenergy Association analysis has indicated that with the right policies and incentives, that around 150PJ of consumer energy could be produced from biomass by 2050, and earlier to 2035 if more progressive policies and programmes were utilised to speed up transition from fossil fuels in order to reduce greenhouse gas emissions. Table 1 provides a scenario of applications where the bioenergy or biofuels could be used by 2050.

Other scenarios could have greater levels of consumer energy from biomass and organic waste but the presented base scenario is considered realistic and achievable in the time periods to 2035 and 2050.

This analysis assumes that with encouraging circular bioeconomy policies from Government, biomass and organic waste would also be used as a feedstock for the manufacture of additional engineered wood products, extraction of biochemicals and the manufacture of bio-based materials to replace plastics and other products currently manufactured from petroleum and natural gas. Much of the biomass used to produce energy is a co-product of these other biomass-based products so additional demand for biomass may not be additive but included in the assumed quantities in this high level analysis.

Table 1: Base scenario – Where the demand for bioenergy and biofuels could come from in 2050

Application areas	**Energy from bioenergy or biofuels (PJ)**	
Solid biofuels		
Residential/commercial[1]	7	
Wood processing (existing)[2]	43	
Stationary heat (fuel switching)[3]	24	
Electricity firming[4]	15	
		89
Liquid biofuels		
Domestic aviation[5]	4	
Domestic marine[6]	2	
International aviation[7]	6	
International marine[8]	6	
Heavy land transport[9]	10	
Rail[10]	1	
Off road land transport[11]	15	
Stationary heat (fuel switching)[12]	1	
		45
Gaseous biofuels		
Electricity[13]	3	
Heat users (Circular own use)[14]	5	
Transport[15]	1	
rLPG[16]	1	
Biomethane to gas network[17]	6	
		16
		150

Assumptions:

1. 2019 MBIE Energy Data
2. Scion report to MBIE in 2021; 24.4 PJ is wood and 12.6PJ is black liquor
3. 2019 MBIE Energy Data. Food processing used 18.7PJ coal and 21.74PJ natural gas. Assume 60% converts to using biomass fuel

4. 2019 MBIE data shows 16.36PJ of coal was used for electricity generation. Assumes Huntly power station Rankine units use for dry year firming and contingency will convert to using biomass.
5. 2019 MBIE Energy Data 12.45PJ of jet fuel used by domestic aviation. Assume 30% produced domestically from biomass and waste.
6. 2019 MBIE Energy data 4.5PJ heavy oil used by domestic marine. Assume 50% replaced by domestic produced heavy fuels.
7. 2019 MBIE Energy Data 56.41PJ jet fuel used by international aviation. Assume 10% is replaced by domestically produced bio-jet fuel
8. 2019 MBIE Energy Data 11.94PJ of fuel oil was used by international marine transport. Assume 50% is replaced by domestically produced biofuels
9. 2019 MBIE Energy Data. 104.19PJ diesel consumed. Assume 10% of land transport converts to domestically produced renewable diesel by 2035 and 100% by 2050.
10. Kiwi Rail's freight trains used 40,689,890 litres of diesel for Financial Year 2018. OIA request. = 1.5PJ
11. EECA off-road transport report – 445ml of petrol and 1065Ml of diesel = 16.4 and 39.3PJ of fuel. 28% of off-road transport converts to domestically produced renewable diesel by 2035 and 100% by 2050.
12. There is no disaggregated data on how much fossil liquid fuels are used by food processing and the horticulture sector. A notional 1PJ is assumed.
13. 2019 MBIE Energy Data 3.3PJ of biogas producing mainly electricity and heat.
14. 2019 MBIE Data file. Food processing consume 21.74 of natural gas. Assume all 3PJ of biogas produced from organic food processing waste is used by the processor on-site.
15. 10.2 PJ of biogas could be produced from municipal WWTP and agriculture. Assume 20% is used as a transport fuel
16. 2019 MBIE Energy Data 9.41 PJ LPG used. Assume 30% produced domestically from biomass and waste.
17. 10.2 PJ of biogas could be produced from municipal WWTP and agriculture. Assume 50% is converted to biomethane and injected into the natural gas distribution network.

Where could the feedstock/source material come from?

There is a wide range of sources of biomass and organic waste which could be collected and prepared to be a source of energy to produce 150 PJ of energy. Assuming a conversion factor of 80% by the applications there would need to be around 190 PJ equivalent of biomass and organic waste available.

The Scion report, *Residual biomass fuel projections for New Zealand;2021*[7] provides an overview of the quantities of biomass which can be recovered from a range of sources. Nationally the projections estimate that there will be 8,439,000 green tonnes per annum of biomass available in 2025, and 8,684,000 green tonnes per annum of biomass in 2050. Not all is recoverable. Assuming a level 1 recovery level for collection and treatment into being a solid biofuel there would be 7.6 million green tonnes per annum available as solid biofuel. The Scion report does not however discuss the additional sources of biomass which could be produced from additional plantation plantings, extensive farm forestry by the agriculture sector, and the quantities of biomass residues which will come available from additional processing of our wood within New Zealand. Also not included are the opportunities for growing energy crops as adequate quantities of residues are expected to be available.

The Scion report shows that there is a gap between the biomass which can be available from existing sources and future demand. However preliminary analysis shows that the gap between supply from existing sources and demand can easily be met from additional farm forestry, plantation forestry and residues from additional wood processing, with any shortfall being met by the diversion of low value export logs.

A scenario of possible future biomass from all sources to meet demand is set out in Table 2, with the assumptions shown. Other scenarios are possible. Highlighted are the areas where additional tree planning is expected to occur.

[7] https://www.usewoodfuel.org.nz/resource/residual-biomass-fuel-projections-for-nz

Table 2: Base scenario for sourcing biomass to supply 150PJ of bioenergy

			2050		
			Energy PJ		Quantity
Biomass					
	Municipal				
		Municipal wood wastes[18]	2.4		266,000 tpa
		Arborist[19]	0		158,000 tpa
	Agriculture and horticulture				
		Horticulture[20]	0.9		126,000 tpa
		Agriculture crop residues[21]	6.2		351,000 tpa
		Shelterbelt[22]	0.6		82,000 m^{3}pa
		New farm forestry[23]	16.9		
	Wood processing				
		Existing wood processing[24]	43		
		Port bark[25]	18		262,000 tpa
		Pulp log[26]	5.6		817,000 m^{3}pa
		New wood processing residues[27]	13.1		
	Forestry				
		Harvested carbon forest	2		
		Production thinnings[28]	16		232,000 m^{3}pa
		Waste thinnings[29]	3.6		192,000 odt pa
		Pruning residues[30]	0.5		25,000 odt pa
		Inforest landing residues[31]	11.3		1,643,000 m^{3}pa
		Cutover - ground based[32]	8		1,164,000 m^{3}pa
		Cutover - hauler/cable[33]	1		145,000 m^{3}pa
		Wilding forest	0.2		
		New plantation forestry residues[34]	10		
	Non residual sources				
		Sawmill chip	11.6		1,688,000 tpa
		Diversion from export K grade logs[35]	31.4		4,546,000 tpa
		Douglas Fir production thinnings[36]	0.9		
		Energy crops[37]	0		
				172.6	
Organic					
	Waste[38]				
		Municipal WWTP	0.6		
		Municipal organics	15		
		Food processing residues	18		
		Pulp and paper effluent	0.6		
		Dairy effluents	6.8		
		Pig and poultry organics	17		
		Crop residues and supplementary crops	14		
		Gas capture at landfill	3		
	Non residual sources				
		Energy crops[39]	0		
				17.4	
				190.0	

Assumptions:

The main assumptions around the availability of biomass are set out in *Residual biomass fuel projections for New Zealand;2021*[8] and the assumptions around the availability of organic wastes are set out in *Biogas and Biomethane in NZ – unlocking New Zealand's renewable natural gas potential*[9].(the BECA/Firstgas report)

Specific assumptions for this analysis are:

18. Scion report to MBIE in 2021; 24.4 PJ is wood and 12.6PJ is black liquor S
19. Assumed all to go to composting
20. 80% recovery level 1
21. 80% recovery level 1
22. 80% recovery level 1
23. Based on an assumption that 6-9% of farms areas are not highly productive and some of that area could be used for farm forestry. Estimated as being easily achieved if suitable programmes and policies are implemented. In a number of areas where land is mores suited to forestry than other production activities the percentage of a farm that is in farm forestry could be much greater.
24. Scion report 23.8 PJ is wood and 12.6PJ is black liquor Mm
25. 90% recovery level 1J
26. After incumbent supply. Recovery level 95%
27. Assumes that current work by Te Uru Rakau to increase wood processing capabilities are successful.
28. 80% recovery level 1
29. 50% recovery level 1
30. 50% recovery level 1
31. 80% recovery level 1
32. 70% recovery level 1
33. 10% recovery level 1
34. A notional estimate recognising that the forestry sector is likely to expand
35. K grade logs. (includes K, KI, KS and KIS grade logs) and 75% recovery level 1. In some regions diversion of these logs is not far off occurring.
36. 75% recovery level 1
37. Not necessary
38. Table 1 P28, https://www.biogas.org.nz/resource/biogas-and-biomethane-in-nz-report
39. To meet the target biogas production from energy crops is not required. This is an opportunity which could become economic when additional biomethane is required to reduce use of natural gas.

With regard to this scenario additional assumptions around biomass availability are:

1. To give a size comparison. With a 25-year rotation and using all the wood produced you would need 193 ha per annum or 4,831 ha in total to produce 1 PJ of biomass fuel. Up to 45-48PJ could be available by 2040 from harvesting all the 190,000 ha Kaingaroa Forest as an energy crop, which is not being suggested[10].

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[8] https://www.usewoodfuel.org.nz/resource/residual-biomass-fuel-projections-for-nz

[9] https://www.biogas.org.nz/resource/biogas-and-biomethane-in-nz-report

[10] It is estimated there was nearly 11.5 million hectares of farmland in 2017. Te Uru Rākau – New Zealand Forest Service estimates that 2.8 million hectares of this could be suited to afforestation. Between 1990 and 2019 it is estimated 769,702 hectares of that farmland was converted to forest, as follows:

1990-1999 – 490,101ha

2000-2009 – 167,989ha

2010-2019 – 111,612ha

The Ministry for Primary Industry's most recent Afforestation and Deforestation Intentions Report estimates that exotic afforestation accounted for 33,600 hectares in new planting in 2020, and 45,300 hectares in 2021. Of this, around 77 percent is intended for production ad 23 percent intended for permanent forest.

2. The current export of logs (excluding K and pulp grade logs) would continue. However diversion of other grades of log is a possibility and could occur if markets change from where they currently are. The diversion of low grade logs from export markets has the added benefit of providing the forest owner with secure long-term domestic markets, reducing their exposure to politically-driven purchasing decisions by countries that may be already capable of supplying their own logs.
3. In this scenario it is assumed that there is no need for energy-only crops as residues from existing plantings is adequate. However there may be a need for limited areas of energy only crops in some regions due to mis-matches in demand for fuels such as coal and gas and supplies of suitable residual biomass. Another consideration is that in some cases it might be cheaper to grow some biomass (e.g., short rotation forestry) rather than try and extract what might be very expensive residuals (prunings or cutover residues in very remote forests). The use of denser energy fuels (i.e., Pellets) to offset transport costs may also fill demand gaps.
4. Cofiring with fossil fuels in existing equipment is an assumed transition pathway to manage capital expenditure so some equipment may not be fully using biomass until the latter years of the period.
5. The availability of drop-in fuels for use in existing equipment is assumed as this avoids the need for unnecessary capital expenditure. Some drop-in biofuels may be higher cost but may be a financially sound decision if their use avoids the need for capital expenditure.
6. Over time it is assumed that significant quantities of logs not exported will go to wood processing and that it is primarily only the residues of plantation forestry, farm forestry and wood processing which are used as a source of fuel for energy.
7. Growth in the manufacture of engineered wood products i.e., the growth of structural timber (beams and columns etc), will produce ‘new or an increasing source of biomass residues as bi- product’ obviously they will use A grade timber and create biproduct as chip and shavings etc
8. New plantings will be a mix of farm and plantation forestry according to integrated sustainable land use criteria. Farm forestry is supported by the additional revenue stream from selling biomass from managed shelterbelts, managed erosion control and managed riparian plantings.
9. Exotic species are excluded from the permanent forest category under the NZETS. Existing carbon-only forests (excluding native plantings) are included in the NZETS average accounting or NZETS stock change accounting categories and are sustainably managed with harvesting to provide permanent sequestration.
10. Farmers have the ability to integrate farm forestry into their businesses and gain recognition under the NZETS or He Waka Eke Noa for all on-farm vegetation sequestration. Much of the needed new farm forestry (Managed shelterbelts, riparian plantings, erosion control, woodlots and slope planting) can be integrated into pastoral agricultural operations and, in many cases, forestry and carbon can help underpin, rather than replace, extensive agriculture[11].
11. Landowners have a choice of options for registering their vegetation – permanent native, NZETS average accounting, NZETS stock change accounting, or He Waka Eke Noa. This results in landowners

[11] A significant proportion of post-1989 forest land in the ETS is on ‘poor quality’ land, classified as Land Use Capability classes 6 to 8, which is often more suited to forestry than agriculture. It accounts for around 88 per cent (308,664 hectares) of the total area in the ETS (349,076 hectares).
Around 89 percent of the registered forest in the ETS is exotic, mostly radiata pine. The balance of 11 per cent is indigenous species, at 37,000 ha. The registered exotic forests are comprised of 255,000 ha radiata pine and 57,000 ha of other exotic species.
In 2021, forests in the ETS sequestered 6.7 million tonnes of CO_2 which is equivalent to the annual emissions from 2.5 million cars.

being optimally incentivised to make the best land use decisions and use vegetation to maximise emissions mitigation.

12. There is an increased recognition of additional carbon sequestration including pre-1990 forestry and on-farm vegetation including trees.
13. Entry of agriculture into He Waka Eke Noa which provides recognition of mitigation of greenhouse gas emissions is supported by programmes and policies funded by recycling farm levies. Assumes that farmers have a choice whether to include small planting areas under the ETS or He Waka Eke Noa, and that farmers are incentivised to supply biomass from farm forestry as a wood fuel to offset use of fossil fuels for heat and transport.

The Beca/Firstgas report *Biogas and Biomethane in NZ – unlocking New Zealand's renewable natural gas potential* highlights the opportunity to recover biofuels and biofertiliser from organic residues. These are diverse sources with multiple ownership models (councils, industry, farmers, etc.) and various competing uses, which will require a holistic view and a more complex range of policies and incentives to encourage their use for bioenergy production. In accordance with the waste hierarchy, priority focus needs to remain in reduction of the organic residue volume generated. However, the single most effective lens to be applied for the unavoidable waste is to look for maximum reuse of inherent components of material for the NZ economy and communities.

Internationally energy crops are grown to provide biomass for production of solid, gaseous and liquid biofuels. The analysis shows that energy specific crops are unlikely to be required in the short term because adequate residues will be available. However it is expected that in some situations it will be sound practice to have some energy crops to supplement the residues or be a strategic reserve. If transport biofuels goes to its full potential then additional forest planting will be required but energy crops again only as a strategic reserve.

Because the quantities of biomass which could come available from these additional sources is limited only by constraints arising from good land management practices the quantities shown are well within the capability of the forestry and agriculture sectors to provide.

This report only focuses on the goal of getting enough biomass to meet the demand of 150 PJ of bioenergy and biofuels, with a focus of achievement by 2035 but recognising that some elements of the transition to a circular bioeconomy can not be achieved by that date and 2050 is more realistic. However 2035 should be the target where possible. Additional energy and non-energy products would require additional vegetation plantings which is feasible but has not been included in this assessment.

There is no doubt that if we take appropriate and early action that there can be adequate additional biomass available for much of what would be required for a bioeconomy producing bioenergy, biofuels, engineered wood products, and biochemicals and other new bio-based products. New Zealand has 1.7~ million ha of plantation forests (excluding roads, landings, waterways, riparian areas and unworkable land such as bluffs / gullies). The Scion study[12] of availability of biomass from additional plantation forest planting to produce 30% of transport biofuel showed that this could be achieved from an additional 243,000ha of forestry on non-arable land.

[12] https://www.liquidbiofuels.org.nz/resource/nz-biofuels-roadmap

Other previous studies[13] into the use of short rotation forestry have shown that there is a potential of 1.7M m^3 of biomass (11.5PJ pa) available from managed riparian plantings and we could be looking at 37.1 M m^3 per annum of harvest off around 70,000 ha per annum. Equivalent to 255PJ p.a. of energy.

Another previous study[14] indicated that the available suitable land area for short rotation bioenergy forestry was identified at 4.4 M hectares, with a priority area of 240,000 hectares (in line with the Climate Change Commission's advice to government) this could supply 37 PJ pa, which would reduce the equivalent of approximately 3 Mt CO_2-e emissions from fossil fuel sources.

While it is clear that New Zealand has the potential for additional biomass for probably all potential energy and non-energy applications within a bioeconomy there needs to be a lot of work undertaken with land owners on identifying the optimal integrated forestry and agriculture land uses from economic, environmental and climate change perspectives.

Policies and programmes necessary to achieve the biomass supply target

In order to meet demand for biomass residues for production of bioenergy and biofuels (plus other future uses or products) there needs to be a coordinated across-government programme of action which is proactive rather than reactive as at present. The programme of work needs to be focused on ensuring that there is adequate biomass of the right species, at the right place, at the right time and at the right price, to meet targets, and that recovery of bioenergy and biomaterials from unavoidable portion of organic waste is optimised. Policies need to be focused on what can we do with "the biomass we have", rather than "what can we do to ensure that we have adequate biomass resource available to maximise the social, environmental and economic benefits to New Zealand." Policies and programmes need to be focused on the latter.

A policy focus for supporting solid, liquid or gaseous biofuels which are a drop-in fuel for continued use of existing equipment would provide the quickest achievement of emissions reduction, but instead of relying on import of gaseous and liquid biofuels, those policies would need to be supported by biomass supply initiatives.

The regional markets for biomass and organic waste require better information to potential suppliers and users of biomass and organic waste. Currently there is uncertainty of biomass and organic waste availability because of lack of long term market supply and demand information:

- Assist better regional collection of demand data so that biomass and organic waste suppliers can see the future market and build their capacity to meet that demand with the right fuel at the right time.
- Extend the published MPI wood price indices to include regional data suitable as a benchmark for solid biofuel pricing analysis.

Implementing the liquid biofuels mandate will incentivise the use of liquid biofuels but to avoid the biofuel all being imported there needs to be programmes to support the domestic production of liquid biofuels at least similar to the support currently being provided to the expansion of electric vehicles, hydrogen production and distribution, and the Lake Onslow electricity project. The justification for a greater level of support for domestic

[13] https://www.mpi.govt.nz/forestry/funding-tree-planting-research/hill-country-erosion-programme/#about-hcep

[14] Alan G. Jones, David Palmer, Serajis Salekin, Dean Meason, Peter Hall (2021). Strategic review of short rotation bioenergy forests. Scion report to MBIE.

production of transport biofuels is that the biofuels are a drop-in fuel thus avoiding the need for heavy vehicle, aviation and heat plant owners to have to incur extensive unnecessary capital expenditure to replace good serviceable equipment.

Transitioning to a circular bioeconomy post 2035 can be achieved from additional tree planning, additional diversion of logs from export, increased production of engineered wood products, and energy crops for production of biomethane to replace natural gas.

Biomass

For investment in additional forest planting and supply chain capacity it is critical that there is confidence that future demand will eventuate and is supported by strong, consistent and long term Government policies eg the transport fuels obligation is seen to be a long term policy and not likely to change at the whim of politics.

Obtaining additional biomass from a number of sources of biomass such as transfer between uses will be determined by market prices, for example, whether K logs are sent for export or are used to produce wood fuel. The price heat users are prepared to pay for wood fuel is already increasing because the low cost energy options from coal and natural gas are no longer available and to transition to a low emissions heat supply the alternative is often high cost electricity (Biomass fuel is $10-20/GJ cf electricity at around $36/GJ). At these prices K logs are already becoming attractive as a source of biomass for energy. Sourcing biomass from the existing forestry sector would be materially increased if there was more regionally focused information available to forest owners and harvesters on the future requirements of the bioenergy and biofuels markets.

New plantation forest planting will be determined by the future demand for wood for either export or domestic processing. Residues from harvest and wood processing are a co-product. As a consequence, a strong demand for plantation or commercial farm forestry will produce more residues.

While collection of forest residues or diversion from other uses will principally be determined by economics, the area where policies and programmes can result in the biggest increase in biomass fuel availability, is the agriculture and horticulture sectors. This is an area which has generally been ignored or mismanaged.

Government's implementation of a Forestry and Wood Processing Industry Transformation Plan (ITP) to:

- lift productivity across the sector,
- produce more products from logs,
- contribute more to New Zealand's economy, and
- unlock the sector's potential to support climate change goals

should be a pathway into creation of a circular bioeconomy with new bio-based products which would increase biomass residues available for energy. The recycling of biomass residues into energy ensures a maximum circularity of all biomass produced and will maximise the financial return for forestry and agriculture. Biomass residues are often the by-product of biochemical extraction from plant material.

Organic waste

Implementation of the proposed Waste Strategy so that encourages recycling is critical to empowering communities to transition to recycling rather than disposing to landfill of organic wastes. This needs to be supported by a proactive promotion of a circular economy.

To reinforce the Waste Strategy Government should establish a policy of Zero avoidable organic waste to landfill by 2040. There are proven technologies which can process all organic waste, including mixed waste into energy.

The recovery of organic waste for bioenergy production will be significantly increased if the revision of the Waste Strategy is quickly finalised and implemented as proposed in November 2021. The revised strategy encourages adoption of a circular approach to resource use which provides incentives for recycling of organic waste into energy. These via anaerobic digestion or thermal treatment. The policy should be supported by a ban on recyclable organic waste being disposed of to landfill after 2030.

Assistance to food processors to recycle their organic wastes via anaerobic digestion or thermal treatment would result in additional quantities of biogas being manufactured. This has multiple environmental and economic benefits. With additional biogas being produced this either reduces the demand for natural gas for on-site use, or provides additional quantities upgradable to biomethane as a replacement for natural gas. A renewable gas mandate similar to the liquid biofuels mandate would incentivise the recycling of organic waste into energy.

The adoption of the He Waka Eka Noa scheme where GHG mitigation is offset against farm animal emissions would provide incentives for farmers to utilise farm organic waste to produce gaseous biofuels which would allow farmers to avoid the need to purchase energy, thus improving farm operating costs, and assist farms to become net zero GHG emitters.

Specific proposals

Policies promoted by the Bioenergy Association for getting 170PJ of biomass and organic waste include:

Municipal sourced biomass

- Incentives which encourage the collection and separation of packaging, construction and demolition wood so that it can be recycled into energy.
- A regulatory environment which assists the recycling of municipal biomass into energy.
  - Guidance on consenting of heat plant to combust/thermally process all sources of biomass
  - Improved National Air Quality Standards and Regional Air Plan Rules so that where appropriate biomass combustion/thermally processing is permitted.
- Provide demonstration sites for preparing municipal biomass to be able to be used as a solid biofuel.

Agriculture and horticulture sourced biomass

- Encourage farms to have Integrated Land Management Plans, so that trees are planted on the 6-9% of a farm which is not highly productively used to produce additional revenue streams to farmers, while maintaining traditional farm productive activities. The Integrated Farm Management Plan should include for environmental, nitrogen, water, vegetation and greenhouse gas emissions for all areas of the farm.
  - Research and provide information to farmers on the cost and benefits of integrating farm forestry into normal farm operations so that they optimise land management objectives and produce additional revenue streams.

- Encourage farms to plant trees for shelter, erosion control and riparian protection that are also harvestable to provide a revenue to farmers.
  - Research and provide information and guidance on species and design of farm forestry to improve biomass residue recovery.
  - Expand research and assist market development of species suitable for farm forestry eg cypress, short rotation, herbaceous to increase the sources of residues
  - Develop model business cases for farm forestry
  - Establish demonstration plantings
  - Research and provide information on use of wood and herbaceous residues for extraction of biochemicals and manufacture of bio-based products additional to energy.
  - Disseminate information to farmers through existing farmer activities and field days.
- Through He Waka Eke Noa revise the structure of how the greenhouse gas emissions accounting applies to agriculture so that farmers are incentivised to reduce emissions:
  - Adopt a nett emissions approach
  - Allow credits for emission mitigation
  - Improve credits calculation methodology so that all farm vegetation emissions reduction are recognised
  - All farms to have Environmental Management Plans which include for all potential environmental effects including greenhouse gas emissions credits and liabilities.

  (With modification to include all vegetation, regardless of when originally planted, the He Waka Eka Noa proposals would achieve these and provide the right incentives for increased farm forestry. Exotic species should be excluded from the permanent category and farmers should have the option of being in the NZETS or the He Waka Eka Noa schemes, or a mix of both. NZETS could be either by average or stock accounting. Farmers should also get recognition for the emissions contribution from sale of biomass to be used as solid biofuel to offset use of fossil fuels.)

- Assist small biomass suppliers (farmers) to create cooperative entities to aggregate biomass extraction from their respective farms to provide a continuous supply of biomass as a biofuel from a group of farmers.
  - Develop guidance and demonstration of establishment of biomass supply cooperatives.
  - Provide model contracts
- Assist the expansion of capabilities of biomass recovery and preparation into biofuels:
  - Research to improve knowledge and efficiency of biomass residue recovery technologies
  - Provide information on densification of biomass close to source to reduce transport costs
  - Provide guidance and demonstration on recovery, storage, transport and densification of biomass
  - Capital assistance for machinery/equipment to comminute biomass into a quality feedstock for conversion to solid/liquid or gaseous bioenergy

Wood processing residues

- Assist expansion of wood processing so that there is an increased availability of residues available for energy.
  - Government to adopt a national 'wood first' policy
  - Expand Scion wood processing research programme into new products from wood.
- Establish guidelines for the recycling of treated wood into energy.

Forestry residues

- Provide annual regional reports on the production and use of biomass in all its forms and applications so that all sector participants have good information on each region's future expectations of biomass supply and demand.
- Provide information on the value to forest owners of recovery and sale of residual biomass.
  - Provide regional information on expected future demands for biomass for local processing, including for energy.
  - Collect and publish information on domestic use of biomass as an extension of the MPI published information on export quantities and prices.
- Assist the expansion of capabilities of biomass recovery and preparation into biofuels:
  - Research to improve knowledge and efficiency of biomass residue recovery technologies
  - Provide information on densification of biomass close to source to reduce transport costs
  - Provide guidance and demonstration on recovery, storage, transport and densification of biomass.
  - Capital assistance for machinery/equipment to comminute biomass into a quality feedstock for conversion to solid/liquid or gaseous bioenergy

Non-residual sources of biomass

- Improve knowledge on who are log exporters and who are biomass aggregators so that lack of knowledge of the biomass supply and demand market and its participants is not a barrier to purchase of biomass as an energy fuel.

Municipal and food processing residues

- Education and demonstration of the principles of a circular economy and how biogas can be a foundation for a circular bioeconomy..
  - Demonstration of cross-sectoral benefits of AD for waste, energy, fertiliser sectors and communities and in particular why it can lead to more resilient businesses.
  - Sourcing of case studies of accelerating AD adoption from other countries
  - Examples of business case for organic waste producers on recycling options.
  - Carbon accounting methodology for mitigation
  - Building the expertise and capability of equipment suppliers, advisers and designers to support and stimulate a fast-growing circular bioeconomy

- Provide annual regional data on quantities and characteristics of municipal and food processing residues in a format that encourages recycling of food wastes into energy.
    - Each producer of municipal and food processing residues to annually report quantities and types disposed of in a non-recyclable way.
    - Each region to report on the flows of municipal food processing residues so that it is easy for those with residues available to be contacted by those who can recycle those residues
- Establish incentives for recycling of food wastes into biogas
    - provide neutral generic best practice and financial viability information from demonstration examples of AD applications
    - Establish and provide a neutral advisory service to assist investors and regulators be comfortable so that they proceed with projects
    - Mandate organic waste collection.
    - Government to establish a green gas obligation for the natural gas sector to progressively increase the percentage of biomethane that is blended into natural gas distribution.
    - Support research into the production from biogas of a renewable energy replacement to LPG.
- Provide information to Councils on organics recycling options
    - Education and support to local councils to navigate a systematic change in waste management away from seeing it as a cost, to seeing it as an economic and wellbeing opportunity
    - Address the synergies between AD, composting, hydrothermal liquifaction and landfill/other thermal treatment of difficult to recycle organics
    - Establish case studies with technical and financial information.
    - Provide demonstration information on the separation of organic wastes
    - Develop and disseminate information to Councils.
    - Disseminate success stories
- Demonstration of the application of the products from recycling organic wastes.
    - Vehicle fuel
    - Upgrading to biomethane
    - Direct use in existing boilers
    - Comparison between biomethane and green hydrogen
- Establish incentives for the use of anaerobic digestion digestate
    - Establish a Biofertilizer Certification Scheme.
    - Development of credible testing of biofertiliser and establishing of a forecast for nutrient values to encourage farmer use
    - Support field trials of the use of certified biofertilisers as a replacement for synthetic soil fertilisers.
    - Information and user education
    - Carbon sequestration potential of digestate

Agriculture and horticulture crop residues

- Research and identify quantities of agriculture and horticulture crop residues that could be recycled into energy.
- Establishment of regional organics recycling centres
    - Demonstration case studies
    - Examples of techniques for managing variable feedstock supply
- Assist the expansion of capabilities of biomass recovery and preparation into biofuels:
    - Research to improve knowledge and efficiency of biomass residue recovery technologies
    - Provide information on densification of biomass close to source to reduce transport costs
    - Provide guidance and demonstration on recovery, storage, transport and densification of biomass.

Non-residues organics

- Growing and storing supplementary crops for support of AD facilities
    - Information on species and their suitability for augmenting AD performance.

Greenhouse gas emissions reduction

20 PJ of bioenergy and biofuels results in 1.8Mt/year CO_{2e} being avoided[15]. With the proposed 172.4PJ of energy from biomass this is 155Mt/year CO2e being avoided.

4.6 PJ pa of biogas energy is equivalent to 1,815 kt CO2e pa of emissions avoided (landfill) or offset (replaces fossil fuels)[16]. With the proposed 17.4 PJ of energy from organic waste, this is 6,865 kt CO_{2e} pa of emissions reduced.

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[15] https://www.usewoodfuel.org.nz/resource/is48-GHG-reduction-using-wood-energy

[16] https://www.biogas.org.nz/resource/is47-role-of-biogas-in-transition-to-low-carbon-economy