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[redacted] Withheld under section 9(2)(a)

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I am sorry to say this proposal of biofuel to liquid fuels as a means of reducing carbon energy dependence joins the multitude of underwhelming climate appeasement policies. Why do I say this?

Firstly the conversion of sunlight to biomass is typically 0.5% which creates problems of scale. There is very little recognition of the biophysical limits[1] of biofuel production. For example the Scion[2] report proposes an area three times the size of Stewart Island (6.5 times Tongariro National Park) to satisfy the wood fibre for 30% of our domestic liquid fuel. Proposed alternative supplementary crops of sugar beet and canola compete for arable land. Fats and oils could make a modest impact on the decarbonisation of liquid fuels, but the resource is small.

In their own words: "The Scale, complexity and timeframes are daunting"

Secondly the EROI (energy returned over energy invested) for wood to ethanol is typically 2 to 3 [3,4]. EORI declines further for higher specification aviation fuels. For a fully functioning universally literate society with all the health and social services requires an EROI of at least 5 [5] ; that is an excess useful energy of 100 – 200 Gj/capita. A progressive substitution of biofuels for energy dense fossil fuels may well lead to a cataclysmic loss in the standard of living.

Thirdly implementation of the policy will be too little too late. There is an increasing urgency to implement carbon reduction policies within the next decad*e.* As the price of carbon in Europe reaches more than 50 euro/tonne, New Zealand is likely to face punitive tariffs unless we follow our trading partners' lead.

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[1] Trainer Ted 2020; De-growth: Some suggestions from the Simpler Way perspective, https://doi org/10.1016/j.ecolecon.2019.106436

[2] https://www.researchgate.net/publication/329772863_New_Zealand_Biofuels_Roadmap_Technical_Report

[3] Tiziano Gomiero; Sustainability2015, 7, 8491-8521; doi:10.3390/su7078491

[4] https://www sciencedirect.com/science/article/pii/S0301421513003856

[5] Lambert et al; 2013, https://www.researchgate.net/deref/http%3A%2F%2Fdx.doi.org%2F10.1016%2Fj.enpol.2013.07.001

Transport fuels have been rightly identified as a major contributor to the country's carbon foot print[6]. The question that is not being addressed is there a better option than converting biomass to liquid fuels?

Alternative policies to Biofuels:

1. **Decrease the carbon footprint of our light vehicle fleet by reducing vehicle size and numbers**. Ownership of a car for personal transport has increased from 600/1000 persons in the early 2000s to 800/1000 persons currently. The current average fuel consumption is 8L/100 km. The rate of increase of vehicles is 80,000 p.a. The requirements of most families would be met by a compact hybrid such as a Jazz HEV with a fuel consumption of 2.84L/100 km (urban) to 4.5 L/100 km (motorway). At 64 g to 100g/ km the carbon footprint is not too much different from a Leaf BEV at 60g to 70g/km[7] when the carbon intensity of electricity generation is accounted for. It should also be recognised that the embodied carbon dioxide of a lithium battery is 147 kg/KWh. (3.5 tonne to 13 tonne CO2 per vehicle). Except for trade vehicles the cost of ownership per year should increase for any engine capacity over 1.5L.
2. **Hydrogen as a fuel and a route to liquid fuels**. First Gas has a systematic plan of maximizing its existing distribution and storage assets.[8] In New Zealand Hiringa Energy in partnership with Waitomo fuels will supply the hydrogen fuelling sites. The network will begin refueling operations in 2021, expanding to eight stations across the North and South Islands by 2022 as part of the first phase network infrastructure plan, servicing all of the North Island and 82% of the South Island heavy freight routes. The second phase expansion will increase the network to at least 24 stations by 2025, providing coverage for 95% of all heavy vehicle routes throughout New Zealand. <u>The government should support the capital investment required</u>. One of the criticisms of hydrogen is the cost currently at $7/kg by electrolysis but reducing at scale to $2 to $3/kg. But what if the price of hydrogen was <$1/kg with no emissions? Is this possible? A Canadian company, Proton Technologies, is making this claim. Whitecap Resources has signed (Dec 2020) a licence for a 500 ton/day production facility[9]. When oil fields are abandoned, they still contain a lot of oil. The worldwide oil recovery is at an approximate average of 20%–35% of the IOIP[10] (initial oil in place). Even depleted oil fields are hydrogen rich energy dense fuel deposits, conveniently located and accessible through existing well infrastructure. Proton's technology extracts this hydrogen by injecting air into the well and combusting the residual hydrocarbons. At 700°C water is either present or introduced and hydrocarbons react to form hydrogen and carbon dioxide. Pure hydrogen is extracted down well via a palladium copper membrane. The other combustion gases are left in situ.
3. **Carbon Recycling** International CRI, has operated an industrial scale direct conversion of CO_2 to renewable methanol in Iceland since 2012. In 2015, CRI scaled up the plant from a capacity of

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6 Air NZ carbon inventory report 2020 https://p-airnz com/cms/assets/PDFs/air-nz-ghg-inventory-report-2020.pdf

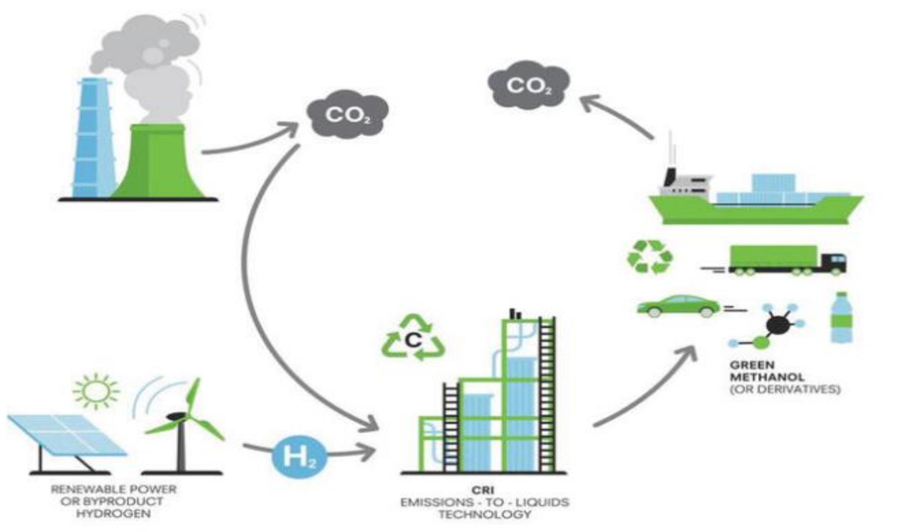
7 New Zealand's electricity generation dataset: A Life Cycle Inventory for carbon footprints https://www.lcm.org.nz/sites/default/files/files/ILCD%20NZ%20Electricity%20Final%20Report2.pdf

8 https://firstgas.co.nz/wp-content/uploads/Sent-Firstgas-Submission-Hydrogen-Vision.pdf

9 https://fuelcellsworks.com/news/big-hydrogen-production-plans-of-proton-technologies/

10 Muggeridge et al); Recovery rates, enhanced oil recovery and technological limits Philos Trans A Math Phys Eng Sci. 2014 Jan 13

1.3 million liters of methanol per year to more than 5 million liters a year which can be sold profitably[11]. The plant now recycles 5.5 thousand tons of CO_2 a year. All the CO2 comes from the Svartsengi geothermal power station and the hydrogen is generated by the electrolysis of water from geothermal and hydro energy. As shown in Figure 1, the plant uses electricity to make H_2 which reacts with CO_2 in a catalytic reaction for methanol production. New Zealand is in the unique position of having already established the infrastructure of a gas to gasoline plant at Motanui. Construction began in 1981 and was completed by June 30, 1985, ahead of schedule and about 17 percent under the original budget of US$1475 million. It was designed to convert 52–55 PJ per annum of natural gas into 570, 000 tonnes (14, 450 barrels per day) of high octane gasoline. The conversion of gas to gasoline (GTG) took place in two stages: first gas to methanol (GTM) and second methanol to gasoline (MTG). Although methanol is still produced the MTG stage became uneconomic and was closed in 1999. It is time to re-evaluate recommissioning this stranded asset which could provide a scalable route to aviation fuel. To be truly sustainable an alternative route to methanol production other than natural gas is required. Utilizing CO_2 and converting it into fuels is called carbon capture and recycling (CCR).[12] [13]



Apart from geothermal CO2 New Zealand has a number of point sources of CO2 which are currently vented to the atmosphere.

Conclusion

The quickest way to a reduction in meeting our CO2 targets is to constrain ownership of light vehicles and increase investment in public transport infrastructure. The more intractable problem is sustaining long distance air travel for trade and tourism without reliable access to a SAF aviation fuel. For this purpose there are more economical and scalable technologies to consider than biofuels.

11 http://www.mefco2.eu/pdf/3.%20Presentation%20on_Power%20to%20Methanol%20Solutions%20for%20Flexible%20and%20Sustainable%20Operations%20in%20Power%20and%20Process%20Industries.pdf
12 https://www.frontiersin.org/articles/10.3389/fchem 2018 00446/full
13 https://www.intechopen com/books/carbon-dioxide-chemistry-capture-and-oil-recovery/carbon-dioxide-conversion-to-methanol-opportunities-and-fundamental-challenges