July 23, 2021

RE: Increasing the use of biofuels in transport: consultation paper on the Sustainable Biofuels Mandate

These comments are submitted by the International Council on Clean Transportation (ICCT). The ICCT is an independent nonprofit organization founded to provide unbiased research and technical analysis to environmental regulators. Our mission is to improve the environmental performance and energy efficiency of road, marine, and air transportation, in order to benefit public health and mitigate climate change. We promote best practices and comprehensive solutions to increase vehicle efficiency, increase the sustainability of alternative fuels, reduce pollution from the in-use fleet, and curtail emissions of local air pollutants and greenhouse gases (GHG) from international goods movement.

The ICCT welcomes the opportunity to provide comments on New Zealand’s consultation paper on the Sustainable Biofuels Mandate. We commend New Zealand’s Ministry of Business, Innovation & Employment and Ministry of Transport for their efforts to promote a cleaner, lower-carbon transportation sector that uses less petroleum-based fuels. The comments below offer a number of technical observations and recommendations for New Zealand to consider in its efforts to introduce an ambitious and robust Sustainable Biofuels Mandate and maximize the policy’s benefits in mitigating the risks of climate change and reducing petroleum use.

We would be glad to clarify or elaborate on any points made in the below comments. If there are any questions, New Zealand government staff can feel free to contact ICCT staff.

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ICCT comments on New Zealand’s Sustainable Biofuels Mandate consultation paper

Summary of comments
New Zealand has proposed possibly the most progressive biofuel policy in the world and has the chance to become a global leader in low-GHG, sustainable fuels. Its consultation paper is commendable in seeking to exclude support for biofuels that cause deforestation and other land use change impacts.

New Zealand’s proposal to use a GHG target, rather than an energy, volume, or blending mandate, has the potential to deliver further GHG reductions by incentivizing lower-GHG pathways as well as facility-level GHG reductions. GHG targets in other jurisdictions risk perversely incentivizing worse-performing pathways by either excluding ILUC emissions accounting or relying on unavoidably imprecise ILUC emissions estimates. If New Zealand excludes all food- and feed-based biofuels, it will successfully evade this problem.

While New Zealand is already on track to introduce the world’s most sustainable biofuel policy, care must be taken in policy design elements to avoid unintended consequences. Excluding food- and feed-based biofuels but allowing rotational crops would flood New Zealand’s market with inexpensive corn and soy biofuel from Brazil and other countries already producing massive amounts of rotational commodity crops for food and feed markets. This risk can be eliminated by excluding food and feed rotational crops or by imposing strict additionality requirements. A detailed understanding of New Zealand’s tallow market is necessary to avoid diverting this resource from other uses, which would cause market distortion and land use change from producing substitute materials. Unrestricted use of used cooking oil biofuel in New Zealand’s policy could result in fraud that is difficult to detect, including imported virgin palm oil disguised as used cooking oil. Both these risks for tallow and used cooking oil can be addressed by applying a cap on the contribution of these fuels towards the GHG target. The last major biofuel sustainability risk for New Zealand to consider is for stemwood, the use of which for biofuel and bioenergy results in greater lifecycle GHG emissions than fossil fuels when the reduction of land carbon stocks is accounted for.

Restricting the GHG target to only sustainable feedstocks will not necessarily provide a strong enough signal to investors to scale up production of advanced technologies such as cellulosic biofuels because of the high capital costs for these facilities. New Zealand could consider targeted complementary measures such as capital grants or a Contracts for Difference mechanism to support emerging technologies.

Lastly, New Zealand could consider including renewable electricity-based pathways in the policy from the beginning. This would help provide the industry a signal to begin investing in renewable hydrogen and e-fuels. Requiring the renewable electricity used for these pathways to use power purchase agreements without other policy incentives would prevent this resource from being displaced from other uses and an indirect increase in fossil electricity. The GHG target could help incentivize electric vehicle deployment if credits are awarded in an effective way.
GHG reduction mandate

New Zealand has proposed an obligation for fuel suppliers to reduce the GHG intensity of their transport fuel mix by 1.2% in 2023, increasing to 3.5% in 2025.

Whether to introduce a GHG target or a target based on energy, volume, or blend level is a decision every jurisdiction pursuing alternative fuels must address. The main benefit of a GHG target is that it should incentivize lower-GHG biofuel pathways as well as incentivizing GHG reductions within each type of biofuel, for example through efficiency improvements or switching to lower-GHG process energy sources at a biofuel facility.

The main problem with GHG targets is that, by themselves, they generally do not provide a strong enough incentive to support emerging technologies — some of which may have substantial climate and sustainability benefits over mature technologies. California has experienced this problem: although its Low Carbon Fuel Standard (LCFS) was introduced in 2010, cellulosic biofuel was only supplied to the state starting in 2019, and in the first half of that year, constituted only 1% of total biofuel used for LCFS compliance. The remaining 99% represented biofuels produced using mature technologies, including starch and sugar ethanol fermentation, biodiesel, biogas, and hydروprocessed vegetable oil (HVO).

Another problem with GHG targets is that they cannot perfectly incentivize the best performing fuels if the GHG intensity of fuel pathways is significantly uncertain. This is generally the case for crop-based biofuels, which are associated with significant indirect land use change (ILUC) emissions. A GHG target would result in perverse outcomes if ILUC is not accounted for in the GHG intensity calculations. This is illustrated in Figure 1, which shows the credit value towards a GHG target that would be awarded for various biofuel pathways if ILUC is not taken into account in policy implementation, in the brown columns. The actual GHG savings achieved, when ILUC is accounted for, is shown in the blue diamonds. This example uses direct lifecycle and ILUC emissions from California’s LCFS. We see that the pathways that would receive the most credit value in the policy are not the same ones that deliver the greatest GHG savings, and the genuinely lowest-GHG pathways would receive only a moderate amount of credit under the program, compared to poorer-performing pathways.

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1 Data downloaded from https://ww3.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm
2 Calculated as the averages for approved pathways in California’s LCFS ("Current Fuel Pathway" spreadsheet downloaded from https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities), except for palm oil, which is taken from EPA (https://www.govinfo.gov/content/pkg/FR-2012-01-27/pdf/2012-1784.pdf)
Accounting for ILUC emissions substantially mitigates this problem but does not eliminate it. ILUC cannot be measured and is generally estimated using economic models. ILUC estimates vary enormously based on which economic model is used, what assumptions are used, and the region modeled. A good example of the divergence between ILUC estimates is the modeling performed for the International Civil Aviation Organization (ICAO) for the implementation of its Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) program, shown in Figure 2. Two ILUC models were used for this effort, and for several bio-jet pathways they diverged widely; for example, for Brazil soy hydroprocessed esters and fatty acids (HEFA), the GLOBIOM model (shown in blue) estimated ILUC emissions 95 gCO2e/MJ higher than the estimated by the GTAP model (shown in brown) (for context, the total lifecycle GHG intensity of fossil jet fuel is about 84 gCO2e/MJ). Within each model, there were also sometimes very different results based on which region the biofuel was assumed to be produced in. For soy HEFA, the GLOBIOM model estimated ILUC emissions 68 gCO2e/MJ higher for Brazilian biofuel than for U.S. biofuel. Large differences between the U.S. and EU were seen for Miscanthus Fischer-Tropsch (FT) jet fuel for both models – and in different directions, with the GTAP model estimating higher GHG benefits for

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U.S. Miscanthus FT jet fuel and the GLOBIOM model estimating higher GHG benefits for European biofuel. The implication here is that, even if New Zealand makes its best effort to model ILUC emissions for its biofuel or to use ILUC factors developed for other regions, there will still be a great deal of uncertainty in the total lifecycle GHG values it uses for its policy, and a GHG target could still reward some worse-performing fuels more than other better-performing fuels. This risk cannot be mitigated through improved modeling; with over a decade of experience modeling ILUC, the divergence between studies has not been reduced.

![Figure 2: Selected ILUC emission estimates for bio-jet fuel pathways used in ICAO’s CORSIA program.](image)

In its consultation paper, New Zealand suggests that its Sustainable Biofuels Mandate would not include feedstocks that “compete with food production and where relevant are not grown on land of high value for food production.” This is exactly the solution to mitigating the risk that a GHG target could incentivize the wrong pathways. If food- and feed-based biofuels are excluded from the policy, there would be essentially no ILUC emissions associated with the policy and thus no need to rely on highly uncertain ILUC emission estimates. Excluding food- and feed-based biofuels also partially mitigates the risk of failing to support emerging technologies because there are fewer conventional options available. With a food- and feed-based biofuel exclusion, the benefits of adopting a GHG target would outweigh the risks.

The right GHG target level to set depends hugely on which biofuel feedstocks are eligible, as well as how high the adopted ILUC factors are for food- and feed-based biofuel. If food- and feed-based biofuels are eligible and low or zero ILUC factors used, a higher GHG target would be achievable – although, perversely, much lower climate benefits would be realized in actuality. The narrower the feedstock eligibility list, the lower the target should be. While at face value such a policy may seem less ambitious than adopting a high GHG target, because high-ILUC feedstocks are avoided, the actual climate benefits are likely to be higher with a modest, constrained target.
If all food- and feed-based biofuels are ineligible, a 3.5% target for 2025 might be too high. For context, the EU has recently proposed a 13% GHG target for 2030. This target is much larger than what New Zealand is discussing because it includes a) food-based biofuels, which can contribute up to 7% of transport energy, with no ILUC accounting, b) a 2.6% energy target for renewable hydrogen and e-fuels, and c) renewable electricity used in electric vehicles. Considering only pathways that would be eligible in New Zealand’s proposal, the EU is proposing a 2.2% energy target for advanced biofuels (most eligible pathways in this group are cellulosic) and a cap of 1.7% by energy for waste oils and fats to contribute towards the GHG target. Combined, advanced biofuels and waste fats and oils will deliver in the ballpark of 3% GHG savings in 2030. By 2025, the EU is targeting only 0.5% advanced biofuels and will likely achieve less than 2% GHG savings from these categories by 2025.

In the New Zealand specific context for 2025, the most relevant feedstock is tallow. Due to its large cattle industry, New Zealand produces a great deal of tallow. The use of this feedstock in biofuel can be ramped up fairly quickly as biodiesel (fatty acid methyl ester – FAME) facilities are generally relatively quick to build. In contrast, cellulosic biofuel facilities typically take several years to commission, construct, and ramp up to full production. If New Zealand used all its tallow for domestic biofuel use, it could displace up to 10% of liquid fuel demand in the country, delivering perhaps a 8% GHG reduction. However, this is a big “if.” Tallow is a valuable commodity in many markets and much of this resource likely has existing uses in New Zealand. The tallow market should be better characterized before setting a final 2025 GHG target. A 2030 GHG target could be significantly more ambitious because by that point there will be sufficient lead time to build cellulosic biofuel facilities to process waste wood – another abundant resource in New Zealand. To this aim, it is important to signal a more ambitious target for 2030, and ideally, for later years. Because of their high capital expenses (CAPEX), it is risky for investors to fund cellulosic biofuel facilities without expectations of demand for their product for the lifetime of the plant, which can be 25-30 years. Long-term policy certainty is thus valuable for supporting advanced, high-CAPEX technologies.

New Zealand’s consultation paper presents the question of whether to set separate percentages for the GHG target for hard-to-abate sectors such as aviation. Especially if food- and feed-based biofuels are not eligible for the policy, setting separate percentages may not be necessary, and could even be detrimental. The main type of fuel of concern is ethanol, which can only be blended into gasoline and thus only used in passenger cars. As passenger vehicles is the transport segment expected to be electrified first, supporting ethanol may lead to stranded investments. If food- and feed-
based biofuel are ineligible, the only relevant ethanol pathways are cellulosic and imported molasses. For cellulosic ethanol, the investment may be worth it, even if ethanol demand evaporates in 2 decades. For one, ethanol can be converted to jet fuel through an alcohol-to-jet process, although this is likely to be more expensive than other bio-jet pathways.\(^9\) For another, some of the main challenges in ramping up the cellulosic biofuel industry are in developing sustainable biomass supply chains and in biomass pre-treatment. Any progress on this front will help support the production of cellulosic jet fuel and diesel in future decades.\(^10\)

There is less concern about stranded assets for other biofuel pathways. Biodiesel (FAME) is blended into diesel and marine fuel, and there is likely to be demand for these fuel types from the heavy-duty and shipping sectors for a longer period than gasoline. Generally, all drop-in diesel technologies (hydroprocessing and Fischer-Tropsch – FT) also product both jet fuel and propane as part of the product slate. Thus, any new hydoprocesing or FT facilities supported by New Zealand’s Sustainable Biofuels Mandate will produce some jet fuel regardless of how the target is set. Both hydoprocess and FT facilities have some flexibility in their product slate depending on the facility configuration. With even a relatively small added incentive for bio-jet fuel (for example, the 1.2x multiplier for advanced bio-jet fuel in the EU),\(^11\) biorefiners can heavily shift their product slates towards maximizing jet fuel. This comes at added cost and, importantly, reduced production efficiency.\(^12\) Less total transport fuel will be produced, and GHG savings achieved, if producers are maximizing jet fuel production. Shifting the product slate within an existing biorefinery produces more jet fuel in the short term but does nothing to ensure a greater supply of jet fuel in the longer term. This is why setting a higher target for the aviation sector can be counter-productive. The most efficient policy, achieving the greatest GHG reductions at lowest cost, would equally incentivize biofuel across sectors.

New Zealand could also consider setting a sub-target as part of the GHG target or a separate small energy mandate specifically for cellulosic biofuels, similar to the EU proposed approach. The UK has a “development fuels” target for cellulosic biofuels, renewable e-fuels, and other very advanced technologies, and only drop-in fuels are eligible.\(^13\) This could be an alternate approach to supporting fuel pathways that can decarbonize hard-to-abate sectors and would not incentivize fuel producers to make inefficient adjustments to their product slates.

\(^12\) [https://theicct.org/publications/cost-supporting-alternative-jet-fuels-european-union](https://theicct.org/publications/cost-supporting-alternative-jet-fuels-european-union)
Biofuel feedstock sustainability

New Zealand’s intention to avoid biofuel pathways that cause ILUC, as stated in the consultation paper, is commendable and places the country ahead of all others in terms of biofuel sustainability. No other country excludes all biofuel feedstocks that compete with food production. The closest example is the EU, which caps the contribution of food- and feed-based biofuels towards its 14% energy target (proposed to convert to a 13% GHG target) at 7% (or 2020 consumption levels in member states plus 1%, whichever is lower), and phases out the contribution of high-ILUC feedstocks (currently only palm oil) by 2030, with the exception of high-ILUC feedstock that achieves low-ILUC certification.\(^{14}\) The European Commission attempted to phase down support for food-based biofuels to 3.8% in 2030 in its 2016 proposal for a recast of the Renewable Energy Directive,\(^ {15}\) but this move was reversed by the European Parliament and Council in later negotiations. It is generally understood that phasing out support for food-based biofuel is not politically viable in the EU because the original policy, set out in 2009,\(^ {16}\) placed no limits on these pathways and supported the expansion of an industry with vested interests. New Zealand’s proposal not to include feedstocks that compete with food production from the beginning of its Sustainable Biofuels Mandate is much more likely to successfully direct support to genuinely low-GHG pathways.

Even with the proposed critical exclusion of feedstocks grown on high quality agricultural land, there are significant sustainability concerns with some pathways that would still be eligible: rotational crops, tallow and other animal fats, used cooking oil, and stemwood.

Rotational crops: also known as winter crops, cover crops, intermediate crops, double crops, or catch crops, rotational crops are grown in the winter or off-season. New Zealand’s consultation paper describes rotational crops as being grown “to improve soil quality as part of usual farming practice.” This practice sounds similar to the EU; for example, a survey by the European Commission’s Joint Research Center found that in Spain, France, the Netherlands, and Romania, 79% of surveyed farmers growing rotational crops do not harvest them.\(^{17}\) Both this report and an earlier one by Alliance Environment\(^ {18}\) found that farmers in the EU generally grow cover rotational crops for environmental benefits, and in particular to comply with national environmental regulation and qualify for Common Agricultural Policy (CAP) payments.

In other world regions, however, rotational crops are generally grown as regular commodity crops. For example, Brazil produces twice as much corn as a rotational crop

\(^{17}\) https://data.europa.eu/doi/10.2760/638382
as it does when corn is grown as a main crop; in 2020, rotational corn production reached 77 million tons.\(^{19}\) Soybeans are another common rotational crop in Brazil; the FAO projects “Soybean production will continue to grow over the next decade, and further land use expansion for soybeans is projected at the expense of pasture, although a third of the increase in harvested area will come from double cropping.”\(^{20}\)

While rotational cropping is only practiced on 2% of U.S. cropland, 80% of this is wheat and rye grown as commodity crops.\(^{21}\)

Although there is little data for the amounts of rotational crops produced worldwide, we can infer the relative prevalence of rotational cropping in world regions by comparing harvested area by total cropland area, shown in Figure 3, using data from FAOSTAT. Most regions, including Oceania, have ratios below 1, indicating that a fraction of cropland is not harvested each year. This may be due to leaving land fallow, temporarily using it for grazing, or crop loss due to adverse weather events. For Brazil, we see a marked increase in the ratio of harvested:cropland area over time, reaching over 1.2 in 2018. FAOSTAT states that multiple cropping on the same land area in the same year will count twice in the harvested area statistics for that year. This suggests that at least 20% of Brazil’s cropland area is double cropped, i.e. producing rotational crops in the winter. This finding is consistent with the report above that Brazil produces very large quantities of corn as a rotational crop. In Figure 3, we can see that rotational cropping in China is even more common. Ratios near one, including for Other Asian Countries and Africa, suggest that rotational cropping is likely common in those regions as well. A study using a similar analytical technique estimated that in tropical and subtropical areas, 44% (49.63 Mha), 13% (24.12 Mha) and 10% (13.49 Mha) of the rice, wheat and maize area, respectively are under multiple cropping.\(^ {22}\) The United Nations Food and Agricultural Organization (FAO) estimates that 12 percent of projected global crop growth through 2030 will come from higher cropping intensities.\(^{23}\)

\(^{19}\) http://www.soybeansandcorn.com/news/Oct9_20-Conab-202021-Brazilian-Soy-Production-up-7_1-Corn-up-2_6


\(^{22}\) https://doi.org/10.1016/j.gloenvcha.2020.102131

\(^{23}\) http://www.fao.org/3/y4252e/y4252e06.htm
Figure 3: Ratio of harvested area to total cropland area in world regions.

We can thus infer that, outside of New Zealand, the EU, and perhaps a few other examples, rotational crops are generally grown as regular commodity crops feeding into food and livestock feed markets. While supporting biofuels made from rotational crops domestically in New Zealand could reward an environmentally beneficial practice that reduces erosion and nutrient leaching and improves soil health, making rotational crops broadly eligible for the Sustainable Biofuels Mandate would incentivize imports of food- and feed-crops grown in the winter in Brazil, China, and other countries, diverting those resources from use in food and livestock feed and causing ILUC. It is clear from the statistics that there are massive amounts of these crops produced globally that could flood New Zealand’s Sustainable Biofuels Mandate with inexpensive first-generation biofuel, suppressing the incentive for the developing of a sustainable domestic biofuels industry.

This is not an easy problem to solve. Restricting biofuel availability to domestic production is likely to run afoul of the World Trade Organization (WTO). For example, Malaysia has filed a WTO suit in complaint of the EU’s high-ILUC phase-out, even though the EU’s restriction is based on a deforestation threshold and does not explicitly name palm oil or any particular producing country. Restricting eligibility to only sustainably produced cover crops is also very difficult. Diverting any material that would otherwise be used for food, feed, or other industrial uses, to biofuel will increase global

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demand and thus prices for that crop and cause ILUC. To effectively prevent ILUC, a policy measure would need to ensure that any rotational crop used for biofuel is additional and would not have been produced in the absence of the biofuel policy. This is the main criterion for palm oil to be certified as low-ILUC in the EU and thus exempt from the phase out of high-ILUC biofuel feedstocks.\textsuperscript{25} The key operational element of the EU’s low-ILUC protocol is a financial additionality test, in which project operators need to show that the production of the feedstock would not have been financially viable without the specific financial incentive of the Renewable Energy Directive. The European Commission has proposed detailed rules for implementing this additionality test;\textsuperscript{26} these rules could in principle be applied to rotational crop projects to determine whether rotational crops used in biofuel are additional, and thus genuinely avoid causing ILUC impacts. A consultant project commissioned by the European Commission to inform the proposed rules specifically evaluated 2 rotational crop projects using this additionality test.\textsuperscript{27} The project found that neither project would pass the low-ILUC financial additionality test, underscoring the difficulty in identifying projects that are both appealing to investors and actually low-ILUC. It is also important to understand that no sustainability standard yet exists that implements the EU’s low-ILUC requirements. Given the difficulties in assessing additionality of food and feed rotational crops, it may be easiest and safest to exclude it as an eligible category in New Zealand’s Sustainable Biofuels Mandate.

**Tallow and other animal fats:** Animal fats are produced as a by-product of meat and represent only 1-2% of the total value of the animal carcass.\textsuperscript{28} These materials are thus considered by some as a “waste.” In some countries, this is largely true; for example in Indonesia, animal fats are largely discarded.\textsuperscript{29} On the other hand, in the EU and U.S. they are heavily used in oleochemicals (for example soap-making), livestock feed, and pet food as well as some use for energy recovery through incineration.\textsuperscript{30} The diversion of animal fats from oleochemicals and livestock feed results in increased demand for substitute materials in those industries. For oleochemicals, the substitute material is likely to be vegetable oil, likely palm oil, as the globally least expensive oil. Many studies have found that palm oil cultivation is associated with very high GHG emissions,

\textsuperscript{26} https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12723-Detailed-implementing-rules-for-the-voluntary-schemes-recognised-by-the-European-Commission_en
\textsuperscript{28} https://theicct.org/sites/default/files/publications/ICF_LCFS_Biofuel_Categorization_Final_Report_011816-1.pdf
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deforestation, and biodiversity loss. For livestock feed, the substitute material may be palm oil, corn, or other grains. The production of these substitute materials results in both direct emissions from crop cultivation and also ILUC emissions. Some estimates place the indirect emissions of diverting animal fats for biofuel production so high that the animal fat biofuel results in greater GHG emissions than using petroleum. The environmental impact of using tallow and other animal fats for biofuel production in New Zealand will depend on the typical fate of these materials in that national context. Answering this question is key to understanding whether the use of animal fat biofuel for the Sustainable Biofuels Mandate is likely to deliver significant climate benefits, and also the appropriate level of the GHG target to set.

**Used cooking oil:** The use of used cooking oil that would otherwise be discarded in biofuel production produces high GHG benefits with virtually no adverse impacts. This is one of the most sustainable biofuel pathways. However, not all sources of used cooking oil will necessarily be sustainable. In the U.S., used cooking oil was traditionally collected for use in animal feed. While perhaps sanitarily and ethically questionable, used cooking oil in animal feed delivered calories and metabolic benefits to some types of livestock that require a certain fat percentage in feed. Almost the entire supply of U.S. used cooking oil has been diverted to biodiesel production, and the likely consequence is increased production of corn and vegetable oil as substitute materials for the livestock sector, with associated production and ILUC emissions.

A worse outcome is when used cooking oil is fraudulently produced. In a limited number of cases, biodiesel claimed to be produced from used cooking oil was found to actually be produced from virgin soy oil and the perpetrators prosecuted, and other similar pending fraud cases are ongoing. While such confirmed cases are limited, there is widespread speculation that used cooking oil fraud is rampant in Europe, driven by double counting incentives (each liter of advanced biofuels, as well as biofuels produced from animal fats and used cooking oil, counts as two liters towards the EU’s current 14% renewable energy in transport target). A growing share of European and California used cooking oil used in biofuel is imported from Asian countries, where palm

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oil is the dominant vegetable oil. There is thus speculation that some used cooking oil may be disguised virgin palm oil.\textsuperscript{37} Although the EU requires sustainability certification for all biofuels counted towards the Renewable Energy Directive targets, these certification schemes are widely criticized as not being robust enough to detect fraud.\textsuperscript{38} Used cooking oil fraud in particularly is thought to be very difficult to detect. Testing the free fatty acid content of biofuel, which is not routinely done during normal trade or sustainability certification, can detect biodiesel produced from 100% virgin vegetable oil disguised as used cooking oil biodiesel. However, because there is very high variability in the free fatty acid content of used cooking oil, there is no detectable distinction between genuine used cooking oil biodiesel and biodiesel produced from a blend of used cooking oil and virgin vegetable oil. Furthermore, hydrotreatment tends to eliminate chemical signatures of different feedstocks and so it may not be possible at all to distinguish renewable diesel produced from 100% virgin vegetable oil with that made from used cooking oil.

Europe has adopted an important measure to limit the risk of fraudulent used cooking oil: capping the contribution of biofuel from animal fats and used cooking oil towards the 14% renewable energy in transport target to 1.7%. In its recent proposal to revise the Renewable Energy Directive, this 1.7% cap is maintained. This cap also serves to limit the impact of displacing animal fats from other uses. Setting a similar cap, based on the domestic availability of used cooking oil and tallow that has no other uses, could be an option for New Zealand to reap the benefits of using its sustainable waste resources without risking significant unintended negative impacts.

**Stemwood:** From FAOSTAT statistics, it is clear that New Zealand has abundant wood resources, including waste wood. Waste wood can provide New Zealand with sufficient sustainable feedstock to support the development of a cellulosic biofuels industry, with the resulting fuel delivering high GHG reductions. ICCT cautions New Zealand, however, against including stemwood as an eligible feedstock for the Sustainable Biofuels Mandate. The use of stemwood, even pulp-quality logs of small diameter, for biofuels and bioenergy does not deliver climate benefits and likely even increases lifecycle GHG emissions compared to fossil fuels, when considered carbon stock changes over a reasonable timeframe. A review study by the European Commission’s Joint Research Center found that most lifecycle estimates place stemwood bioenergy at higher GHG emissions than fossil fuels;\textsuperscript{39} the results of this literature review are visualized in an ICCT blog.\textsuperscript{40} While some bioenergy proponents claim that increased demand for stemwood will result in improved forest management practices, resulting in enough additional wood production to offset the carbon stock loss of felling trees, there is little to no evidence to support such claims.\textsuperscript{41}

\textsuperscript{37} E.g. https://www.harvestmagazine.no/pan/biodiesel-fra-brukt-frityrolje-i-asia-mange-sporsmal-fa-svar
\textsuperscript{38} https://www.eca.europa.eu/en/Pages/DocItem.aspx?did=37264
\textsuperscript{39} https://publications.jrc.ec.europa.eu/repository/handle/JRC70663
\textsuperscript{40} https://theicct.org/blog/staff/trees-for-energy-jul2021
\textsuperscript{41} https://theicct.org/sites/default/files/publications/ICCT_bioenergy_demand_20190719.pdf
Complementary policies
The path to deep decarbonization of transport fuels and hard-to-abate sectors like aviation for New Zealand and for the world relies on advanced technologies that are not yet commercialized. Easily converted wastes such as tallow can deliver enough fuel to meet early biofuel targets, but there is soon a ceiling to available supply of waste fats and oils. The potential availability of sustainable biomass such as cellulosic wastes, residues, and energy crops is much higher. But the conversion of these materials to biofuel uses technologies that have yet to be commercialized, such as cellulosic ethanol, gasification combined with Fischer Tropsch, or fast pyrolysis. Another common feature of these technologies is that they have much higher CAPEX than more mature technologies such as hydroprocessing, although the feedstock costs may be lower. The high CAPEX of these technologies makes it difficult for projects to secure sufficient financing to begin construction; higher CAPEX generally means longer payback times for investors, and these projects are seen as risker than first-generation biofuel facilities. A GHG target, even if food- and feed-based biofuels are not eligible for support, may not represent enough policy support to overcome this investment barrier. Another problem is that even if the GHG target provides enough value through GHG credits to make an advanced biofuel product profitable, the variable nature of tradeable credits may still make investors wary. Complementary policies aimed at either offsetting the construction cost for new facilities, such as grants or investment tax credits, or price floor mechanisms may be necessary to fully support the development of an advanced biofuel industry in New Zealand. One option based on a concept used to promote renewable electricity in the UK is “Contracts for difference,” a system in which a reverse auction identifies the least cost project operators, and the government guarantees to provide enough subsidy to enable those project operators to reach their required biofuel price floor; this subsidy amount varies over time depending on market conditions in order to minimize government spending. Our research has found that this mechanism would be more cost effective than other policy options.

Renewable electricity pathways
New Zealand’s consultation paper proposes that only biofuels would be supported in the Sustainable Biofuels Mandate, and that a 2024 review would consider expanding the policy to green hydrogen, electricity, and synthetic liquid fuels. New Zealand could start to reap benefits by including these pathways in the policy now, as well as sending a clearer signal for investment in these technologies. There are, however, some detailed considerations for these pathways.

43 See Fig 2: https://theicct.org/sites/default/files/publications/Alternative_jet_fuels_cost_EU_2020_06_v3.pdf
Green hydrogen and synthetic fuels produced from green hydrogen (also known as e-fuels, power-to-liquids, and power-to-gas) can deliver very high GHG reductions if made from additional renewable electricity, other than biomass electricity (due to carbon stock reductions and other emissions associated with biomass use; see above). As with rotational crops, ensuring additionality of renewable electricity used for fuels production is both essential and complex. The risks are significant: due to high energy losses in production for e-fuels in particular, the GHG emissions associated with electricity production are essentially magnified in the e-fuel, which is further used in an inefficient internal combustion engine vehicle. Using grid-average electricity can result in e-fuels that have a higher lifecycle GHG intensity than petroleum.\(^{46}\) Even using 100% renewable electricity for e-fuels production can result in significant indirect emissions if that renewable electricity is diverted from other uses and replaced by fossil fuel-derived electricity. At least the solution here is easier than for rotational crops: requiring green hydrogen and e-fuel producers to have a power purchase agreement (PPA) with a renewable electricity generator and to demonstrate that the renewable electricity installation does not receive other policy incentives should be sufficient to adequately mitigate the risk of indirect effects.\(^ {47}\)

For renewable electricity used in battery electric vehicles, there are three main considerations. The first is to ensure that the credit value generated from this pathway is used effectively to further the aims of the program, which means to direct it either to increasing electric vehicle penetration, to increasing renewable electricity deployment, or a combination of the two. In its LCFS, public charging companies generate LCFS credits for all electricity used at their stations. California initially awarded LCFS credits generated from home charging of electric vehicles to utility companies with a requirement that a fraction of the value should be passed back on to consumers through lower electricity prices. This method was widely thought to be ineffective in promoting further electric vehicle uptake and was recently revised to direct credit value towards $1,500 rebates for new electric vehicle sales.\(^ {48}\) New Zealand could consider a similar mechanism to ensure that the incentive value for renewable electricity use in vehicles is effective in promoting further GHG savings.

The second consideration for including renewable electricity use in vehicles in a GHG target is that this pathway adds uncertainty to the overall target level. In California, roughly 15% of LCFS credits are generated through this pathway.\(^ {49}\) We expect electric vehicle uptake in the passenger car segment to increase rapidly over the coming decade, but there is also uncertainty around this growth rate. This increases the uncertainty around the contribution a renewable electricity pathway will make towards a GHG target in the 10-year, and possibly even the 5-year timeframe. This is not

\(^{46}\) https://www.transportenvironment.org/sites/te/files/publications/2017_11_Cerulogy_study_What_role_electrofuels_final_0.pdf  
\(^{48}\) https://www.cleanfuelreward.com/  
\(^{49}\) https://ww3.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm
necessarily a reason not to include renewable electricity in New Zealand’s GHG target, but an important consideration.

The third consideration is how to calculate the number of GHG credits awarded for each kWh of renewable electricity used in a vehicle. There are 3 approaches that have been used or proposed in different jurisdictions. In California, credits are awarded essentially on the basis of petroleum avoided per kilometer driven. Because electric vehicles are more efficient than internal combustion engine vehicles, one unit energy can be used to drive an electric vehicle further. California calculates the GHG savings for electricity use in vehicles by dividing the GHG intensity of grid electricity by 2.5 (the energy efficiency ratio) and subtracting this from the GHG intensity of gasoline.\(^5\) U.S. EPA has proposed not to make an efficiency adjustment for biomass-based electricity used in vehicles in the Renewable Fuel Standard.\(^5\) The current version of the EU’s Renewable Energy directive applies a 4x multiplier to renewable electricity used in vehicles. This is meant to capture both the greater efficiency of electric vehicles as well as the fact that only about half of charging in the EU is at public chargers, and home charging is difficult to measure. The European Commission has proposed a very different approach in the recent proposal to revise the Renewable Energy Directive. Only renewable electricity from public charging stations is eligible towards the GHG target, and its GHG savings is calculated as zero, compared to a fossil electricity comparator of 183 gCO2e/MJ. This is nearly double the liquid fuels fossil comparator of 94 gCO2e/MJ and has the effect of essentially doubling the credit value of energy use in electric vehicles compared to biofuels. This new proposal is quite logical in that it counts both the energy used in electric vehicles and the GHG emissions displaced on a post-combustion basis, whereas the California and U.S. crediting systems compare the GHG intensity of electricity (post-combustion) with liquid fossil fuels (pre-combustion).

\(^5\) https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities
\(^5\) https://www.govinfo.gov/content/pkg/FR-2016-11-16/pdf/2016-25292.pdf