[redacted]

5 October 2021

Dear [redacted]

Re: OIA: February 2021 EECA Board Agenda Item - EECA submission to the Climate Change Commission's 2021 draft advice for consultation

Thank you for your Official Information Act (OIA) request to the Energy Efficiency and Conservation Authority (EECA) on 8 September 2021 for the following information: "*all docs, correspondence, advice, and any other material relating to:*

- *The submission to the Climate Change Commission's 2021 draft advice for consultation. This includes but is not limited to drafts, suggested edits, other agencies/ministers/board/internal feedback. I am happy to refine this to between 15 Dec 2020 and 8 sept 2021.*
- *All EECA board meetings advice/correspondence etc relating to climate change, emissions reduction the ERP, and emissions reduction plan. I am happy to exclude administrative emails from this scope. I am happy to refine this to between 15 Dec 2020 and 8 sept 2021."*

EECA has provided a number of documents and emails that are within the scope of request. Those related to the Climate Change Commission submission include drafts of the submission with significant comments or changes. It does not include every minor draft of the submission as this would require substantial manual collation. These documents are:

- *Initial skeleton of EECA submission on Climate Change Commission advice*
- *EECA – Climate Change Commission – Liquid Biofuels (email with attachments)*
- *Board paper – EECA submission to Climate Change Commission*
- *EECA submission to CCC – draft advice for Board*
- *EECA submission to CCC – Andrew Caseley (CE) comments*
- *EECA submission to CCC – Elena Trout (Chair) comments*
- *EECA's submission to the Climate Change Commission – (email with word document attached)*

A limited amount of this information has been withheld under s 9(2)(g)(i) of the Official Information Act in order to maintain the effective conduct of public affairs through the free and frank expression of opinions by officials in the course of their duty.

Below is also a link to EECA's final designed version of the submission, published on EECA's (and also available on the Climate Change Commission's) website:

https://www.eeca.govt.nz/assets/EECA-Resources/Research-papers-guides/EECA-submission-to-the-Climate-Change-Commission-2021.pdf

EECA has also provided the board paper that relates to climate change and the emission reduction plan. Some of the paper's content has been withheld as out of scope of the request, and also under s 9(2)(f)(iv) to maintain the confidentiality of advice tendered by Ministers of the Crown and officials. This document is:

- *Agenda Item 5.3 – Energy and Emission Policy Update and EECA Involvement and Impact*

Note that since the Emissions Reduction Plan information was provided in the above paper, the Minister for Climate Change has announced Cabinet has agreed to begin consultation on the Emissions Reduction Plan in early October and requires that the final plan be released by the end of May next year in line with the 2022 Budget.

You have the right under section 28 of the Act to seek a review by the Ombudsman of the response EECA has provided to your request.

Yours sincerely,

[redacted]

Andrew Caseley
Chief Executive

INITIAL SKELETON OF EECA SUBMISSION ON CLIMATE CHANGE COMMISSION ADVICE – FEB 2021

Principles for our submission

- Be bold and visible
- Don't comment on government policy
- Audience is primarily to assist in the development/improvement of the CCC's advice, but also to get EECA's position on public record.

Submission contents

1. **Narrative/high level**
    a. EECA role/position
    b. Energy efficiency/renewable energy – role to play
    c. Relative focus areas /priorities
    d. Key themes?

2. **Sectors (HIP and Transport)**
    a. CCC Recommendations: agree/disagree/comment (including data/assumptions)
    b. EECA: what we are doing and how we can help
    c. Remove versus reduce?

EECA resourcing

Sector	P&E	EII
Transport	Dan	Tyler (Jeremie for biofuels?)
HIP	Mitch	Vince? Michael?
Building and urban form	Dan?	Gareth
Multi sector (ETS, shadow price, behaviour change)	?	?

Timeline

- 5 February? Early thinking to Managers, asking for their input
- 17 February In-progress draft to Jesse for review
- 19 February Draft to Marcos for review
- 24 February Draft submission to Andrew
- 26 February Draft submission to Board
- 2 March Board considers and approves submissions
- 14 March Consultation closes

Nesta Jones

From: Jeremie Madamour
Sent: Thursday, 18 March 2021 1:19 pm
To: [redacted]@climatecommission.govt.nz; [redacted]@climatecommission.govt.nz; [redacted]@climatecommission.govt.nz; [redacted]@climatecommission.govt.nz; [redacted]@climatecommission.govt.nz; [redacted]@climatecommission.govt.nz; [redacted]@climatecommission.govt.nz
Cc: Daniel Barber; Mitchell Trezona-lecomte; Basil Issa; Michael Henry
Subject: EECA - Climate Change Commission - Liquid Biofuels: Early submission and Liquid biofuel research
Attachments: Biofuel - EECA's early partial submission.docx; Biofuel Insights - Final Report - Mar 17v2.pdf

Hi,

As discussed during our Q&A session, please find attached:

1) EECA's early submission in relation to liquid biofuels (note that there might be changes in our final submission, but hopefully this will be useful to start thinking about it)
2) Sapere's liquid biofuel research

The research takes a holistic approach and consider the emissions reduction potential of liquid biofuels through several lenses:

- Lifecycle emissions reductions ;
- Blending limits ;
- Technology readiness ;
- Supply and demand constraints

The main conclusions are:

- Biofuels are not all low-emissions, and some are even worse than oil from a life-cycle perspective.
- There is an opportunity in the short term to reduce 3 to 6% emissions from diesel and 1 to 6% from gasoline, relying on imported biofuels, produced from sustainable feedstock.
- In the long run, drop-in biofuels present the best potential to reduce emissions more significantly. However they rely on technological development not yet mature.
- Providing these technical development, a domestic production of drop-in biofuels from forest residue could lead to total lifecycle emissions savings of 3.8%-5.4% p.a by 2030, increasing to 9%-21% p.a. by 2035, and 38% p.a. by 2050.
- Overall through to 2050, the total investment costs would be between $3.4 and $8.2 billion.

This is a research report so it aims at staying as factual as possible, and stating clearly the assumptions when we attempted to assess future trends.
To complement that, EECA is also preparing a position paper explaining the conclusions we draw from this research in the wider context of NZ's transition.

This is shared in confidence ahead of the publication on EECA's website in a couple of weeks.

Kind regards

Jeremie Madamour
Senior Advisor, E2I

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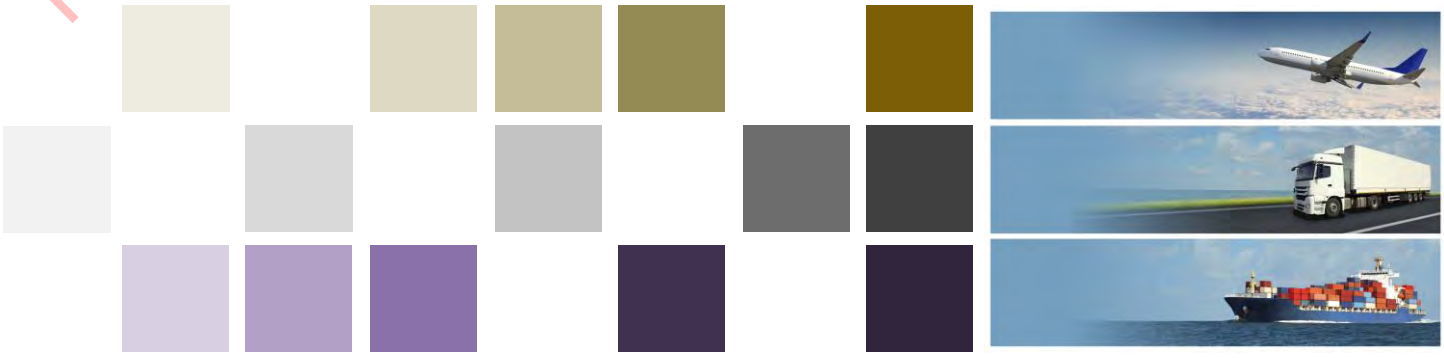
Biofuel Insights

An independent report prepared for EECA

Corina Comendant, Toby Stevenson

17th March 2021



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Abbreviations

ASTM	Formerly American Society for Testing and Materials
ATJ	Alcohol-to-jet
BEV	Battery electric vehicle
BTL	Biomass to liquid
CARB	California Air Resource Board
FAME	Fatty acid methyl ester
FCHV	Fuel cell heavy vehicle
FT	Fischer – Tropsch process
GHG	Greenhouse gas
GVM	Gross vehicle mass
HEFA	Hydro- processed and fatty acids
HVO	Hydrotreated vegetable oil
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
ICE	Internal combustion engine
IEA	International Energy Agency
ILUC	Indirect land-use change
IMO	International Maritime Organisation
IRENA	International Renewable Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
JRC	EU Joint Research Centre
LCA	Lifecycle analysis
LUC	Land-use change
MIA	Motor Industry Association
OEM	Original equipment manufacturer
RED	Renewable Energy Directive
SAF	Sustainable aviation fuel
SOC	Soil organic carbon
UCO	Used cooking oil

Executive summary

This paper aims to inform discussions about potential pathways of biofuel uptake and the associated emissions reductions in New Zealand's light and heavy road transport, aviation and shipping.

The paper is not a feasibility study of biofuel uptake in New Zealand. The purpose is to explore potential pathways of emissions reductions given available information on feedstock supply, technology maturity and fuel blending walls.

Emissions reductions are estimated on a lifecycle basis for both conventional and advanced biofuels. A lifecycle approach covers emissions produced during both the production and combustion of fuels, which allows capturing the total emissions impact from an atmospheric perspective.

For conventional biofuels, emissions during production, and especially as a result of land-use changes for feedstock cultivation, can be significant. On a lifecycle basis, biodiesel from vegetable oils can in fact lead to more emissions than fossil fuels, either due to direct expansion of oilseed crops into natural vegetation, or due to indirect increase in palm oil consumption when existing supplies of other vegetable oil feedstock can no longer satisfy established demand.

Lifecycle emissions from biodiesel produced from waste oils and animal fat are generally less than those from fossil fuels, but biodiesel needs to be blended with fossil fuels, and the blending is limited by technical considerations (typically 5%-7%). Similarly, a 10% blending limit is typically applied to bioethanol. The emissions reduction potential for conventional biofuels (for the energy equivalent of final fuel) is therefore low: 3%-6% for a B7 fuel, and 1%- 6% for an E10 fuel.

These blending walls, together with limited imports of bioethanol and limited domestic production of biodiesel, mean that the emissions reduction potential from biofuels in New Zealand through to 2024 is minimal (around 0.4% p.a.).

Compared to these conventional biofuels, advanced biofuels from biomass have much lower emissions related to land-use change. Furthermore, they can generate greater emissions savings because they can be blended at higher limits, or even used neat (undiluted). Emissions reductions are in the range of 21% to 50% for a final fuel containing 50% drop-in fuel, depending on the feedstock and conversion pathway.

Our analysis assumes that from 2025, technology developments would enable some domestic production of advanced biofuels to commence. Biomass feedstock would be increasingly used to produce drop-in diesel, drop-in aviation fuel and drop-in petrol, and tallow would be used to produce renewable aviation fuel. We find that there is enough local output of inedible tallow to meet around 20% of biofuel demand from aviation (assuming some tallow is also used for biodiesel production). For biomass feedstock, we assume supply would be available up to the estimates in Scion's Biofuel Roadmap for different scenarios.

To determine biofuel uptake beyond 2025, we assume two scenarios of technology pathways for the production of biomass-based advanced biofuels, largely determined by developments over the 2030-2035 period. In the progressive scenario, biomass-based drop-in fuel output ramps-up gradually; in the accelerated scenario, output grows exponentially.

We find that biofuel uptake would increase from 0.88 PJ (28.38 million litres) in 2022, to 8-11 PJ (257-335 million litres) by 2030, with a maximum output beyond 2040 of 43 PJ per annum (approx. 1,280 million litres per annum). By 2030, annual drop-in fuel output would reach 167-246 million litres, of which 120 -198 million litres would be from biomass feedstock.

By 2030, these biofuel pathways would lead to total lifecycle emissions savings per annum of 3.8%-5.4%, increasing to 9%-21% by 2035, and 38% by 2050. These emissions reductions are relative to a baseline of projected emissions from petrol-fuelled light-vehicles, diesel-fuelled heavy vehicles, fossil-fuelled aviation and shipping viewed together, having accounted for increased vehicle electrification, air travel and freight volumes in the future.

To achieve these emissions reductions, significant capital investments would be required. Through to 2025, the average annual investment cost would be between $39 and $93 million, primarily to scale-up production of biodiesel and renewable aviation fuel (HEFA). Over the 2026-2030 and 2031-2035 periods in the progressive scenario, additional investment costs of $51-$116 and $115-$254 million per annum would be required respectively to scale-up production of drop-in fuels from biomass feedstock. In the accelerated scenario, the additional investments required would be double and four-times higher than the estimates in the progressive scenario over the two periods respectively. Overall through to 2050, the total investment costs would be between $3.4 and $8.2 billion.

Introduction

Sapere has been commissioned by EECA to answer some of the key questions centred on the application and use of various types of biofuels in the transport sector as an alternative to fossil fuels.

In particular, this paper seeks to address the following questions. The paper's structure follows the order of these questions.

- What conversion technologies are used to produce biodiesel and drop-in diesel fuels (henceforth referred to as 'biofuels'), and what are the suitable applications in transport?
- What are the key issues regarding the compatibility of biofuels with existing engines and fuel infrastructure?
- What standards and blending limits are being applied to ensure compatibility / miscibility of fuels?
- How should biofuels be assessed in terms of their environmental impacts?
- What is the potential demand and supply of biofuels in New Zealand?
- What are the key aspects that need to be considered for a biofuel uptake in New Zealand's transport?

Setting the scene

The transport sector is New Zealand's second biggest source of GHG emissions, contributing 21.1 per cent to total emissions over the 1990-2018 period.[1] The sector is also by far the biggest contributor to the increase in New Zealand's gross emissions since 1990. De-carbonising the transport sector is therefore an important requirement for New Zealand to meet its international target of 30 percent reduction below 2005 over the next decade, and its domestic target of net-zero GHG emissions (except methane) by 2050.

To de-carbonise New Zealand's transport, a suite of options will have to be explored. As well as fuel switching, these include improved heavy freight fuel efficiencies, behavioural changes that will affect demand for fuel for light vehicles[2], and an optimised freight system that can move less-time-constrained freight to lower-carbon modes.[3] However, given the size of the task, transitioning to alternative fuels for transport will be key.

Some alternative fuels lend themselves better than others to different applications in transport. Early signs from global development suggest that passenger cars, delivery vans and two- and three-wheelers will be the first to be electrified (BNEF, 2020). From a technical perspective, electrification suits household transport in NZ because 95% of daily travel is less than 120 km, which is generally within the range of today's battery electric vehicles, noting that the range is likely to increase in the future (MoT, 2017). However, light passenger BEVs are currently more expensive to own, with their total cost of ownership projected to reach parity with conventional vehicles in the mid-2020s (MoT, 2017).[4] Until a significant uptake of BEVs due to improved battery economics, biofuels could be an alternative for light vehicles at least in the short-term. Early gains in emissions reductions from light vehicles is important given the 2030 target and the significant contribution of these vehicles to overall transport emissions (Figure 1).

By contrast to light vehicles, in high duty cycle transport, electric batteries have limitations particularly for heavy loads. In these applications, lithium-ion batteries would need to store enough energy to allow trucks to travel over long distances, with the resultant vehicle weight reducing payloads. Furthermore, for very heavy trucks there are productivity penalties associated with refuelling and charging times during the day,[5] although these penalties are likely to be addressed in the future.[6] Because hydrogen is much more energy dense, fuel cell technologies are well placed to address the battery size and weight issue. However, fuel cell heavy vehicles (FCHVs) are much more expensive, and local hydrogen infrastructure is in its early stages of development. These issues shift the focus on the

[1] MfE's 1990-2018 GHG inventory https://www.mfe.govt.nz/sites/default/files/media/Climate%20Change/infographic%E2%80%93new-zealand%E2%80%99s-gross-greenhouse-gas-emissions-1990-2018.pdf

[2] e.g. remote work reducing commuting needs, increased use of public transport, ride sharing.

[3] e.g. from road transport to rail or shipping.

[4] This will be the main driver for BEV uptake from them on.

[5] EV productivity penalties refer to the fact that the heavier a vehicle weight is, and the longer away-from-base refuelling times are, the greater number of EV vehicles would be required to perform the same transport service as an ICE vehicle (MfE, 2020).

[6] (Concept, 2019) estimate that the current productivity penalty for very heavy vehicles is 18% improving to 6% in the future.

role that biofuels can play in de-carbonising heavy freight, which currently accounts for a quarter of road transport emissions (Figure 1).

Figure 1 – Domestic transport GHG emissions by mode (2017)

Source: based on (MoT, 2020)

Similarly, sustainable aviation fuel (SAF) is likely to be the primary tool utilised by the aviation industry to reduce its carbon footprint over the next decade. Battery electric technologies have been proven for small planes, but these are yet to be developed and commercialised for larger aircrafts travelling longer distances. Electric flight and hydrogen-powered propulsion are years away from application at scale (WEC, 2020).

In shipping, the International Maritime Organisation has introduced strict regulation on fuel sulphur levels, which means that 70 per cent of the fuels currently used by the sector worldwide need to be modified and changed. Biofuels have very low sulphur levels and are a technically viable solution to low-sulphur fuels meeting either the very low or ultralow sulphur fuel oil requirements (IEA Bioenergy, 2017). They are one of the few options for decarbonising shipping without installing new engines, particularly for large vessels such as container ships that transport New Zealand goods.

How are biofuels produced?

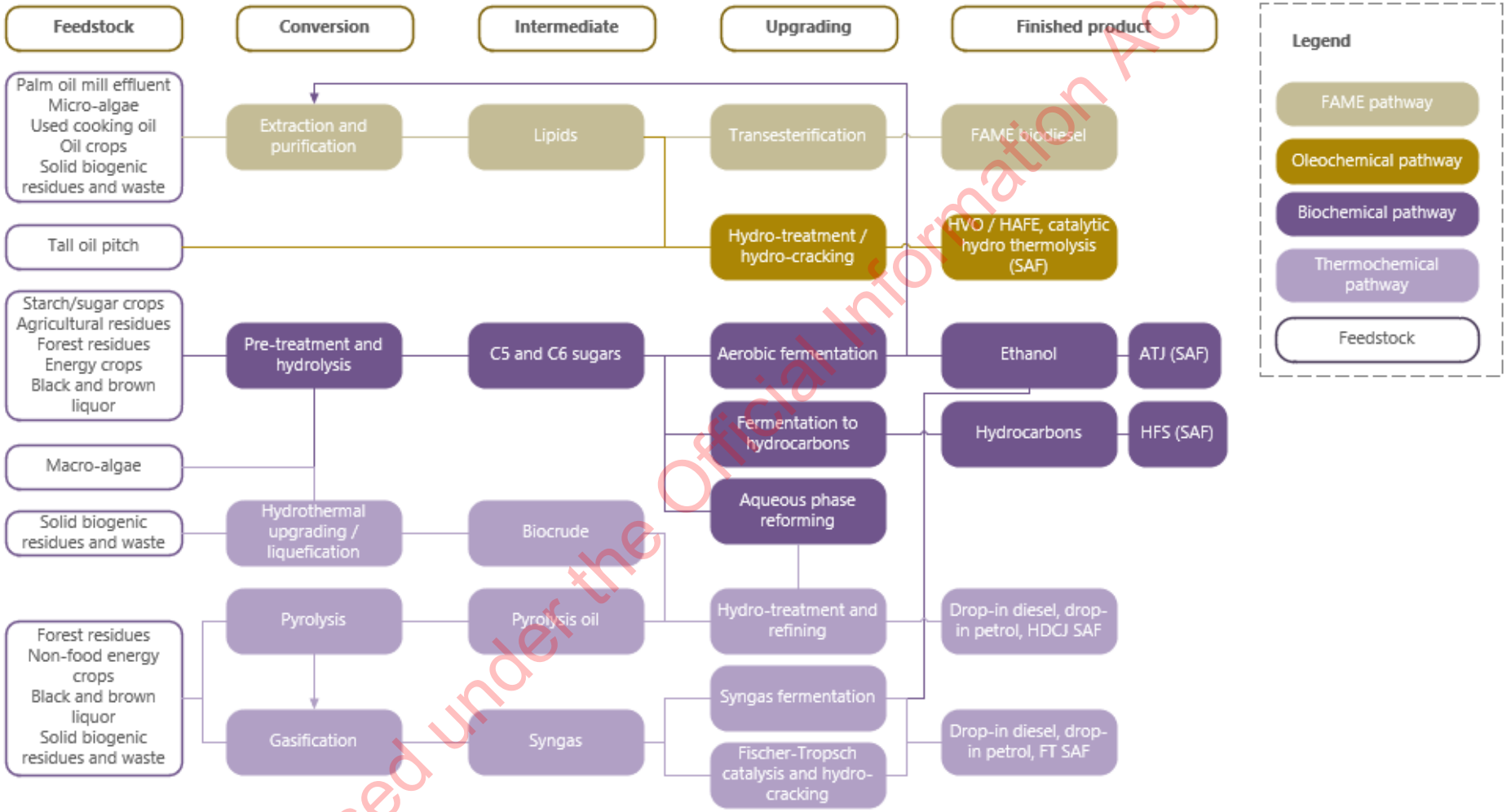
Summary

- Currently, most biofuels production is from conventional feedstocks and conversion technologies. Most biodiesel is produced from vegetables oil, although there is increasing production from waste oils (used cooking oil, animal fat). Most bioethanol is produced from agricultural crops.
- There are three key pathways for advanced biofuels production: (i) the hydro-treatment of lipids producing renewable diesel/aviation fuels (HVO/HEFA fuels), (ii) biochemical processes that have been particularly explored for the production of aviation fuels, and (iii) the thermal conversion of biomass to fluid intermediates that can be upgraded to hydrocarbon fuels.
- These pathways differ by the feedstocks used, conversion technologies and technology maturity, HVO/HEFA fuels are already commercially available. Thermochemical pathways are better positioned than biochemical ones due to their relatively higher yields.
- Thermochemical technologies are in demonstration or pre-commercialisation stages. Biomass gasification is a well-proven technology but has not yet been commercialised at lower scales needed for biomass feedstocks. Pyrolysis for biofuel production has been gaining a lot of attention in recent years, however major issues remain due to the high oxygen and water content of pyrolysis oil, which is problematic for biocrude upgrading at a refinery.

Biofuels refer to specific type of fuels that are derived from natural sources such as plants, animal wastes, forest residues, and other organic material. There are various production pathways for biofuels, resulting in different finished liquid products depending on the intended end use (Figure 2). An important question is the extent to which the finished product can replace existing petroleum fuels, as this can be constrained by engine compatibility issues. It is important to understand this limiting factor because it affects the degree to which different biofuels can contribute to overall transport emission reductions. From the engine-compatibility point of view, biofuels that have different properties than petroleum fuels, thereby creating the need for a blend wall, are called blending substitutes, whereas biofuels that are functionally equivalent to petroleum fuels are referred to as 'drop-in' fuels, referring to the fact that they can be 'dropped-into' the existing infrastructure (petroleum distribution and refining, fuel specifications etc.) (Karatzos, et al., 2014). Note that the 'drop-in' property does not necessarily mean these fuels can currently fully replace conventional petroleum fuels. Final fuels must meet a number of quality specifications, and blend walls may still be applied to drop-in fuels depending on how they are produced and how they are used. This is particularly relevant for aviation fuel.

This chapter provides and overview of production pathways for blending substitutes and drop-in fuels, leading into the chapter discussing blending limits.

Figure 2 – Biofuels production pathways



Source: Sapere based (IRENA, 2016), (Wood Mackenzie, 2010), (ICAO, 2018).

Production pathways for blending substitutes

The most common blending substitutes are bioethanol, which can be used as a blend for petroleum engines, and biodiesel (or FAME - fatty acid methyl esters) which is used with diesel engines (also referred to as 'biodiesel'). Ethanol can also be converted to jet fuel range of hydrocarbons (alcohol-to-jet, or ATJ) via chemical catalysis.

Currently, most bioethanol is produced by the fermentation of corn, wheat, sugar beet or sugar cane. Bioethanol produced in this way is referred to as first-generation because it competes with land that could otherwise be used for food or feed crops. More advanced technologies involve hydrolysis and fermentation of lignocellulosic biomass to produce second-generation (or advanced) bioethanol. This advanced pathway has shown great progress with the deployment of early commercial plants (Figure 3), is currently the cheapest and most developed advanced biofuels route, with several proprietary technologies available (IRENA, 2016).

Biodiesel can be produced from different oils (e.g. rapeseed, soy, cooking oils, and animal fats) by reacting these oils with an alcohol to form ester compounds (a process called trans-esterification). This reaction is necessary because unprocessed vegetable oils and animal fats are not acceptable as transportation fuel due to their very low cetane, inappropriate cold flow properties, high injector fouling tendency and high kinematics viscosity level (WWFC, 2019). FAME biodiesel is considered a first-generation (or conventional) biofuel on the basis that the technology is mature and commercially available at large scale (Karatzos, et al., 2014).[7]

Production pathways for drop-in fuels

Drop-in biofuels are functionally equivalent to current petrol, diesel, jet and related fossil derived transportation fuels. Within this category, a distinction is sometimes made between drop-in diesel made from biomass and that produced by reacting fats and waste oils with hydrogen (e.g. in (Suckling, et al., 2018). The latter category is also referred to as 'renewable diesel.'

Drop-in fuels can be produced via the following processes: (i) oleochemical; (ii) biochemical; (iii) thermochemical, and (iv) hybrid (Figure 2).

Oleochemical processes

To date, drop-in biodiesel has been primarily produced through oleochemical processes, which require a hydroprocessing step to catalytically remove oxygen from the fatty acid chains present in lipids.[8] The products are known as hydrotreated vegetable oil (HVO) or hydro-processed esters and

[7] Note that there is no one single definition for what constitutes conventional or advanced biofuels. This categorization depends on several factors, e.g. technology maturity, type of feedstock, GHG emissions reduction, and product type and quality (see Appendix A).

[8] Lipids are fatty acids (or derivatives thereof) that are insoluble in wate but soluble in organic solvents. They include man natural oils.

fatty acids (HEFA).[9] Currently HVO is increasingly produced from waste and residue fat fractions sourced from the food industry, as well as from non-food grade vegetable oils (Neste, 2020).

This technology is well developed (Figure 3), and entails relatively low technological risk and low capital expenditure compared to other emerging drop-in biofuel production routes. HEFA-SPK is the only in five technology for aviation biofuel production that is currently technical mature and commercialised (IEA, 2019). Because of their relative commercial maturity, HEFA/HVO fuels are considered conventional biofuels in some literature.

Biochemical processes

Biochemical processes involve the conversion of biomass to longer chain alcohols and hydrocarbons. Biochemical conversion is particularly used to produce sustainable aviation fuel (alcohol-to-jet) from alcohol molecules made from sugar/starch bearing plants, lignocellulosic materials or innovative processes (e.g. LanzaTech).[10]

Another process uses genetically modified microorganisms to convert sugar into hydrocarbons or lipids. In some cases, these microorganisms produce synthetic iso-paraffin substances that can be converted into a product with characteristics similar to that of aviation fuel. This process is called HFS-SIP (Synthetic Iso-Paraffins produced from hydroprocessed) process.

Thermochemical technologies are well positioned to account for a considerable share of drop-in fuel capacity growth over the near term. This is primarily because biochemical processes typically provide lower yields of higher oxygenated intermediates that can command higher value in the growing bio-based chemical market (Karatzos, et al., 2014).

Thermochemical processes

Thermochemical processes involve the thermal conversion of biomass to fluid intermediates (gas or oil) which are then catalytically upgraded / hydroprocessed to hydrocarbon fuels. Three main types of processes are known:

Pyrolysis is the controlled thermal decomposition of biomass to produce oil, syngas and biochar. Pyrolysis oil can be produced via fast or slow pyrolysis. Generally, fast pyrolysis produces a higher percentage of oil, while slow pyrolysis more char. Although the technology requires a dry feedstock, the final product contains both oxygen (40%-50% of weight) and water (15%-30% of weight), which are problematic for a refinery. Furthermore, because pyrolysis oil is acidic, it requires purposefully selected metals in the processing equipment (BioPacific Partners, 2020).

There has been widespread research[11] and commercial activities on pyrolysis, however current production is limited. A full-scale plant producing bio-crudes is yet to be completed (BioPacific Partners, 2020).

[9] Note that the reference to vegetable oils in the HVO term is a legacy from before 2010 when only vegetables oils were used as feedstock.

[10] The waste gas from steel mills is fermented to ethanol by bioengineered microbes, which is destined to the ATJ process to obtain jet fuel

[11] It has been studied in detail since early 1980s (Karatzos, et al., 2014).

Hydrothermal liquefication uses high pressure, high-temperature water with catalyst to convert the biomass to a bio-crude. Compared to pyrolysis oil, this process better deals with wet biomass, has lower oxygen content, and does not create the same acidity problems. For these reasons, the technology has been gaining attention in the last five years (BioPacific Partners, 2020).[12]

Technology providers are at different stages of development, including in terms of using different feedstock and improving on the conversion technology. As it stands, the base technology has gone through several scale-ups from the pilot stage through to the demonstration stage (Figure 3). .

Gasification of biomass or bio-oil produces synthesis gas, comprised of mostly H2 and CO. Syngas can also be upgraded to drop-in liquid biofuels via the Fischer-Tropsch process (FT). The FT process has its origins in the 1920s in Germany when access to oil was problematic (Karatzos, et al., 2014), but today represents a variety of similar processes. When biomass feedstock is used, it is also referred to as 'biomass-to-liquid' (BTL).[13] It can be made from a range of raw materials containing lignocellulosic matter, such as, agricultural waste, forestry waste or used paper. The FT process produces molecules with better cold flow properties which can then be blended directly into diesel (Wood Mackenzie, 2010). Depending on the hydrocarbon chain length, Fischer-Tropsch products may be blended with gasoline, diesel or jet fuels for use in road, rail, shipping or aviation (IRENA, 2016).

The Fischer-Tropsch technology is well-proven, however it benefits from scale. Although it is a standard technology used by the petrochemical industry, it is too large for biomass facilities. Developers' focus is therefore on improving the FT scalability (BioPacific Partners, 2020).[14]. However, both the biomass gasification and the conversion of resulting syngas to FT fuels are very capital intensive, with a current capex of $6.71-$10 per litre p.a. final fuel (see Figure 16 and Appendix J). This is higher than the capex for the pyrolysis pathway ($3.51–$8.8 per litre p.a.),[15] and significantly higher than for biodiesel ($1.41 -$1.47 per litre p.a.).

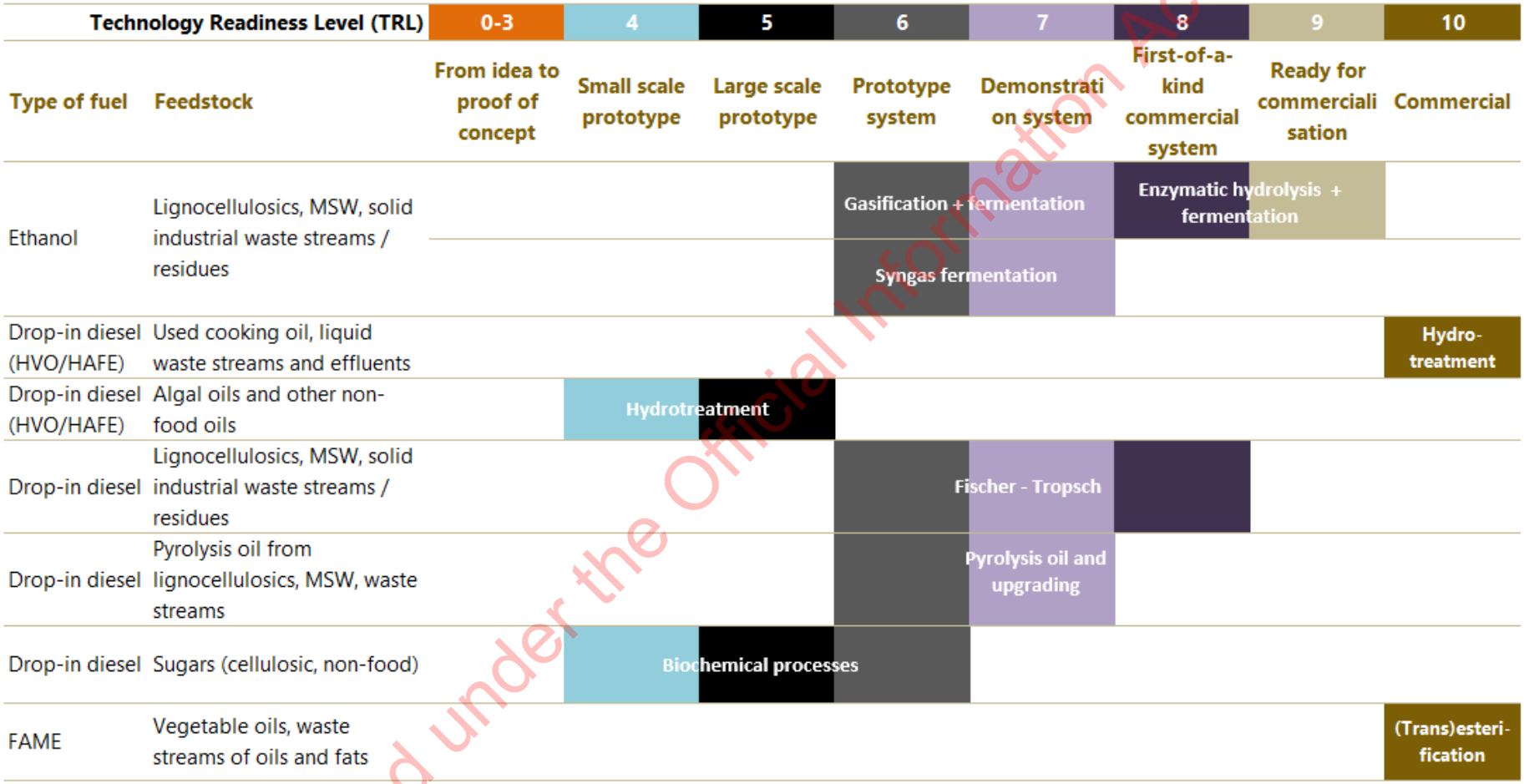
[12] It is worth noting that despite the lower oxygen content, it is still higher than conventional crudes, and water treatment is still necessary.

[13] FT process also applies to methane-based fuels (such as natural gas), power (multiple renewable sources exist) or coal into paraffinic diesel fuels, commonly referred to a GTL ('gas-to-liquid'), PTL ('power to- liquid') or CTL ('coal-to-liquid'). Together, these processes are known as XTL.

[14] Another focus is addressing the gas quality issue by optimising catalysts.

[15] The higher estimate reflects own H2 production.

Figure 3 - Commercialisation status of advanced biofuels conversion technologies



Source: (IRENA, 2016), (Maniatis, et al., 2017), (BioPacific Partners, 2020)

Why are blending limits applied?

Summary

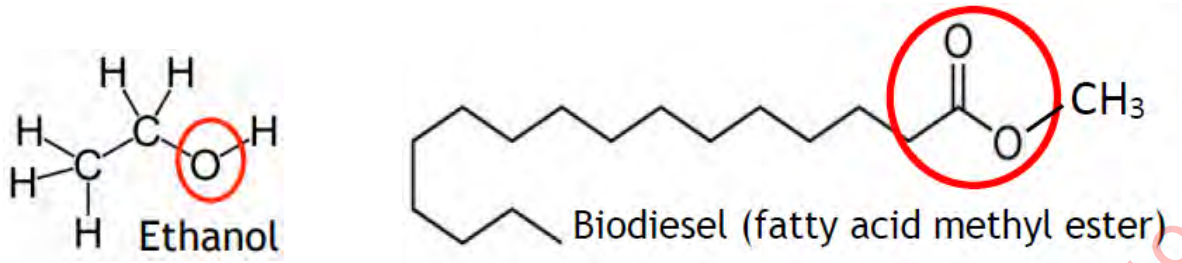
- Conventional biofuels have different chemical properties than fossil fuels, and blend limits are applied to ensure fuel compatibility. Globally, the mandated limits for road transport are typically low – 10% for bioethanol, and 5-7% for biodiesel, with some exceptions. For example, Brazil is expected to increase the biodiesel blend ration from 11% to 12% over the next decade, whereas the current blend requirement for bioethanol is 27% (OECD-FAO, 2020). Equipment manufacturers can allow higher biodiesel blends for specific fleets.
- In marine transport, due to poor performance in cold waters, blending limits of up to 7% of biodiesel are applied.
- Advanced biofuels are miscible with fossil fuels, which allows them to be blended in higher proportions with fossil fuels, or even be used neat. They are considered 'drop-in' fuels because they can be used with existing petroleum infrastructure, and can be blended in much higher concentrations. By contrasts, conventional biofuels require separate distribution channels (e.g. trucks) and storage tanks.
- Concentration limits can also be applied to drop-in fuels to ensure that the final fuels comply with the fuel standard specifications in a particular jurisdiction. In aviation, limits of up to 10% or up to 50% of drop-in fuels are applied depending on the conversion pathway.

Bioethanol and biodiesel are subject to blending limits due to their oxygen content

Both bioethanol and biodiesel are functionally different from the petroleum fuels they can substitute. Petroleum-derived fuels are oxygen-free, whereas bioethanol and biodiesel are only partially de-oxygenated (Figure 4). The presence of oxygen is highly problematic, as it can oxidise fuel components, reactors and pipeline metallurgy to cause corrosion. The oxygen content imparts polar and hydrophilic properties that have been of concern for original equipment manufacturers (OEM), especially at higher blends (see more details in Appendix B).

Due to these properties, blend walls have been applied limiting the concentration of bioethanol and biodiesel in the final transport fuels. These limits are stipulated and regulated by governments after consultations with automobile manufactures and oil companies (Karatzos, et al., 2014)

Figure 4 – Chemical composition of bioethanol and biodiesel



Source: (Karatzos, et al., 2014)

Bioethanol. For bioethanol, a blend wall of 10% has long been considered the maximum blend rate for conventional engines, although the majority of new cars currently have automaker approval for E15 (a blend of 15% ethanol) (BNEF, 2020b). For older cars, burning blends higher than E10 requires changes to the combustion cycle and also may require replacement or alterations to certain fuel lines or engine components (Rusco, 2012). Flex-fuel vehicles, can deal with this to some extent, allowing much higher blends, e.g. 85% in EU and US and even 100% in Brazil (IRENA, 2013).[16] The 85% limit is set to reduce ethanol emissions at low temperatures and to avoid cold starting problems in cold weather. In New Zealand, up to 10% of ethanol blended with petrol can be legally sold at petrol stations (MIA, 2021).

Biodiesel (FAME). For biodiesel, blend walls of up to 5% (B5) and 7% (B7) have been used in the US and Europe respectively. For higher blends (e.g. B20 or B30), the viscosity of fuels is an issue; they can only be used in dedicated fleets depending on specific OEM requirements. In New Zealand, the blend walls as indicated by engine manufactures are 5%-7% for light vehicles (MIA, 2020a), and 5%-30% for heavy vehicles depending on vehicle make and engine specifications (MIA, 2020b).

Neither bioethanol nor biodiesel are suitable for aviation because they do not fulfil the key jet fuel requirements such as stringent cold flow viscosity and high energy density specifications (Karatzos, et al., 2014). The latter issue is also caused by the oxygen presence in fuels which reduces their energy density (Appendix E). For marine uses, blends above B7 have not been preferred as they as perform poorly in cool waters, although there has been some effort going into developing biodiesel blends of up to 20% with marine diesel/gas oil (IEA Bioenergy, 2017). We are not aware of biodiesel being used in NZ coastal shipping currently.

Drop-in fuels can also be subject to blending limits to comply with standards

The functional equivalence between petroleum and drop-in fuels means that drop-in fuels must meet certain bulk properties such as miscibility with petroleum fuels, compatibility with fuel performance specifications, good storability, transportability within existing infrastructure, and usability within existing engines. From a chemical perspective, drop-in fuels are biomass-derived hydrocarbons that have low oxygen content, low water solubility and a high degree of carbon bond and saturation. The

[16] E85 used in EU and USA is anhydrous ethanol, whereas E100 used in Brazil is hydrous ethanol.

exact specifications of such fuels are determined by several physiochemical properties such as viscosity, carbon number, boiling point range, freezing point etc. (Karatzos, et al., 2014).

Using the generalised term of 'drop-in' fuels can be confusing because it implies that these products can fully substitute conventional fuels in all circumstances. In fact, the nature of this substitution directly depends on engine specifications and fuel quality standards in a jurisdiction. Because different engines are made to work with different fuel specifications which are determined by standards, the same drop-in fuel may require a lower or higher (or even no) blend limit in the final fuel depending on the engine it is used with. For example, Neste's Renewable Diesel (an HVO fuel) can be used neat with engines accepting EN 15940 fuels (the EU standard for paraffinic diesel – see Appendix O), but cannot be used neat under the EN 590 standard (the EU standard for B7) because its density is lower than what is allowed under that standard (Neste, 2020). However, in the US the ASTM D 975 standards does not have density requirements, so the allowed concentrations could be higher under this standard.

Given the above, 'drop-in fuels' can be classified as 'neat drop-in fuels' or 'drop-in fuel blends.' The distinction is particularly relevant in aviation, where maximum blend limits are applied to all drop-in fuels to ensure strict quality control conditions (see Table 10 in Appendix O). ICAO refers to the 'drop-in' fuel concept as a 'drop-in jet fuel blend' defined as

> A substitute for conventional jet fuel, that is completely interchangeable and compatible with conventional jet fuel when blended with conventional jet fuel. A drop-in fuel does not require adaptation of the aircraft/engine fuel system or the fuel distribution work, and can be used 'as is' on currently flying turbine-powered aircraft (p. 9 in (ICAO, 2018)).

On this basis, the concept of 'drop-in' fuels particularly refers to the fact that it can be used with the existing infrastructure, neat or in relatively higher concentrations. By contrast, bioethanol and biodiesel cannot be used directly with the existing petroleum infrastructure due to their hydrophilic nature that creates risk of fuel contamination from the segmenting slugs used in pipeline transfers.[17] These fuels must be blended through separate distribution channels, and instead of using existing pipelines, biodiesel must be transported via trucks, rail or coastal shipping, increasing the carbon footprint of the supply chain (see more details in Appendix C).

Different standards are used to control fuel compatibility

Standards define properties that are important for the operability, durability and tailpipe emissions of vehicles. Standards are important because they allow engine manufacturers to test their engines, determine engine compatibility with different fuels, and provide warranties linked to engines operating on specific fuels. Standards are evolving to keep up with developments in biofuel production.

Several organisations have adopted and continue to revise biodiesel specifications and guidelines. For FAME biodiesel, ASTM International sets standards for B6-B20 and B100, which are used in the US. The EU has its own Committee for Standardization (CEN) which sets standards for fuels and blends used in

[17] In practice, there are operational solution to this issue.

road transport. Sustainable aviation fuels used in aviation must pass certification by ASTM. European and ASTM standards are discussed further below. Appendix N provides a summary.

In New Zealand, the Engine Fuel Specifications Regulations (EFSR) 2011 establish the requirements and test methods for neat and blended biodiesel and bioethanol. Currently, the blend limit for biodiesel is 7%, and the EFSR does not include fuel specifications for higher blends. Similarly, it does not include specifications for paraffinic diesel fuel from synthesis or hydrotreatment, under which HVO fuels would fall. With the forthcoming update to the EFSR, there is an opportunity to include the specifications guided by the EU standards for these fuels (see Appendix O for more details on international standards).

What is the lifecycle emissions reduction potential of biofuels?

Summary

- Biofuel life-cycle emissions analysis allows estimating GHG emissions that are emitted both during the production and combustion of biofuels. Emissions from biofuel production can be significant , particularly as a result of land-use changes associated with the growth of biofuel feedstocks.
- For FAME and HVO products, vegetables oils can result in significant emissions from land-use change. Biofuels produced from these feedstocks can in fact result in higher emissions than from fossil fuels.
- Emissions from biodiesel production from waste oils are generally less than from fossil fuels but the savings potential (for the same MJ of final fuel) – of 3% to 6% for a B7 blend – is low due to the blending wall.
- Similarly, emissions from bioethanol production are also low due to the blending wall - 1% to 6% for an E10 blend.
- Advanced biofuels from forestry residues and energy crops have the highest emissions reduction potential due to their low land-use change impact and higher blend concentrations. On an energy basis, emissions savings are in the range of 21% to 50% for final fuels containing 50% drop-in fuels, depending on feedstock and conversion pathway.
- The concept of biofuel sustainability is wider than GHG emissions reductions. It includes impacts on biodiversity, water resources, competition for food, and regional development. EU's sustainability criteria for biofuels are a useful guide.

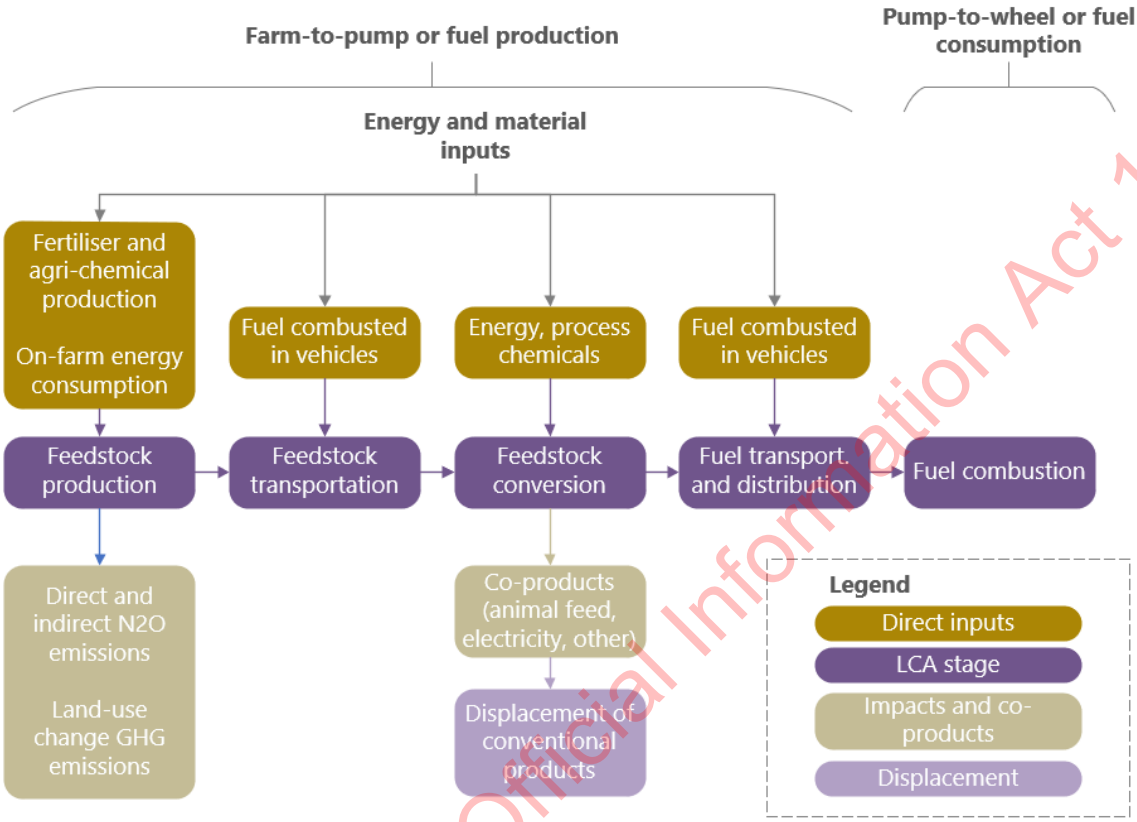
Emissions life-cycle analysis (LCA) is a methodological approach that aims to quantify GHG emissions across all of the stages of a product's lifecycle. For biofuels, this lifecycle covers both farm-to-pump (or well-to-tank) and pump-to-wheel (or tank-to-wheel) emissions, i.e. all stages from extracting, capturing and growing the primary energy carrier to vehicle re-fuelling and fuel combustion. This is illustrated in Figure 5.

One key benefit of LCA is that it identifies where an environmental impact is transferred from one stage to another (burden shifting), allowing mitigation or avoidance to be targeted. Furthermore, a life-cycle analysis can also help identify impacts that would have otherwise been omitted if only pump-to-wheel estimates were made. In the context of biofuels for example, feedstocks that require a significant amount of nitrogen fertiliser can result in significant N_2O emissions. Another example relates to land-use changes from feedstock growth.

There are a number of models used to determine emissions at different stages of the biofuel lifecycle, with different jurisdictions having a preferred model. For example, California Air Resource Board uses a modified version of GREET for its regulatory purposes, Canada Federal Government uses GHGenius, whereas in the EU the Joint Research centre (JRC) is in charge of updating the input data for calculating default emissions factors (see Appendix F). A key point is that, except GHGenius, these models do not include land-changes (LUC) emissions in their default estimates, although they allow

users to model LUC as needed. GHGenius includes default land management emissions in most biomass production systems (e.g. soybean and palm) (Bonomo, et al., 2018).

Figure 5 – Generalised LCA stages for biofuels



Source: based on (Dunn, et al., 2017)

In the literature, there is also a lack of consensus on how to estimate indirect emissions from the use of wastes and residues as feedstock for biofuels when these products already have other productive uses. In some cases, environmental gains from biofuels combustion can be negated if these feedstocks are taken away from other uses where they are replaced with higher emitting sources of energy. For example, animal fats can be used for process fuel at the rendering facility, or used for energy in heat and power more generally. Displacing animal fats from these uses, could lead to other, more emissions-intensive fuels for energy (Mallins, 2017).

Nevertheless, for the feedstocks analysed here, available data suggests that emissions from land-use change in particular is the key parameter that determines the relative emissions performance amongst different groups of biofuel feedstocks. This is discussed in more detail below.

Advanced biofuels have low land-use change emissions. Fuels from vegetable oils have the highest emissions

Most biofuels today use feedstocks grown on land that can otherwise be used for food, feed or material production. An increase in biofuel consumption can lead to cropland expansion through direct or indirect land-use changes.

Direct land-use changes occur when land that would otherwise been in agriculture, producing food or feed crops, is converted to produce feedstock for biofuel production. In this process, the soil organic carbon (SOC) content can either be emitted or sequestered depending on the type of crop used.

Indirect land-use changes occur when land is converted to food, feed or biomass production from other states (e.g. forest or natural grasslands) to compensate for the loss of commodity production displaced by biofuel production. It can result in more intensive farming to raise yields or bring new land into food supply chains. It can also result in the displacement of high carbon stock land such as forests, wetlands and peat lands, leading to biodiversity loss and carbon emissions.

Estimating impacts from ILUC changes is complex and controversial in the scientific community (Prussi, et al., 2020c) . This is because ILUC cannot be observed or measured, so modelling is required. Techniques to estimate ILUC typically involve models that attempt to capture economic linkages that drive land-use change on an international scale. These are generally of two types: (i) computable general equilibrium models that consider all markets to be in equilibrium at each time step; and (ii) partial equilibrium models that consider the agricultural sector in detail, with the other sectors treated at a much higher level ((Dunn, et al., 2017).

Given the different modelling approaches used, it is also difficult to accurately separate direct land-use change effects from those that are indirect. For this reason, in this paper these effects are grouped together as 'land-use change effects.' Furthermore, the net impact from land-use change also depends on the treatment of waste and residues, and co-products that result from biofuel production. For example, the production of diesel from soybeans can co-generate 4.2 tonne of dry soy meal per tonne of diesel (Hoefnagels, et al., 2010), which could then displace soy meal that would otherwise be imported. How emissions from co-products generation are treated can significantly affect LCA emissions estimates – this explains some of the variation in biofuels emissions observed in the literature (see Appendix D for an overview of methods).

Figure 6 and Figure 7 below show that emissions from land-use change (LUC) can be substantial depending on the feedstock used.[18] Focusing on the LUC impacts alone, the following key points emerge from the figure:

- For the given feedstocks, emissions from land-use change can be significantly higher than emissions from biofuel processing, particularly for vegetable oils (Figure 6).
- The LUC impact is significant for vegetables oils. In Europe, although most cropland expansion (e.g. for rapeseed oil) is on abandoned land, expansion into other natural vegetation is still significant. Overall however, most of the LUC emissions for vegetable oil

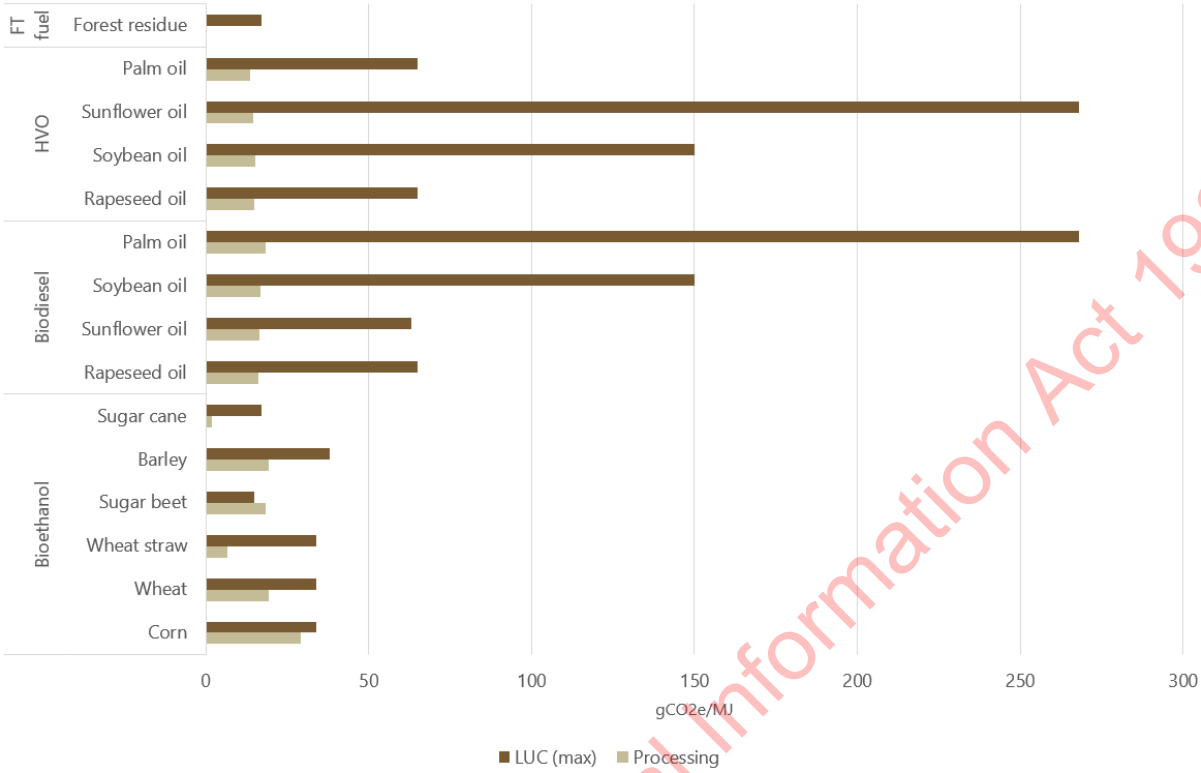
[18] The figure presents the maximum LUC emissions estimates reported in the literature reviewed.

is due to drainage of peatlands in Indonesia and Malaysia, particularly for palm oil (Ecofys et al., 2015). It has been estimated that 45% of palm oil expansion between 2008 and 2016 was onto land that was forest in 1989 (European Commission, 2019).[19]

- For the other vegetable oils, LUC emissions occur due to substitution effects as result of changing market conditions for co-products. Biofuel production often results in large volumes of co-products that can be used for power generation or animal feed. The use of co-products can therefore lead to net cost reductions from the cultivation of a specific crop, which in turn determines the most economic use of land. If these co-products are replaced with other feeds, the cultivation of a specific crop can become uneconomic.[20] In this case, the outstanding demand for oilseeds that are no longer available locally can be indirectly offset through the additional production of palm oil elsewhere in the world, causing net LUC emissions. Although this substitution effect is relatively limited, it still transfers some of the peatland emissions from palm oil to other vegetable oils (Ecofys et al., 2015). In a decreasing order, the largest LUC emissions are from palm oil, soybean oil, sunflower oil, and rapeseed oil.
- Conventional feedstocks for ethanol, such as sugar and starch, have much lower LUC emissions impacts. The LUC value for corn is lower than that for wheat and barley because corn has higher yield and because wheat co-products are more easily substituted with other protein sources, resulting in small oil palm expansion (due to the substitution effect above) (Ecofys et al., 2015).
- There is a wide range of estimates for animal fat feedstock, including or excluding non-land indirect changes. The latter is mainly related to displacement effects in oleochemical applications, and in heat and power generation. For example, if animal fats are diverted from use in soap, they may be substituted with cheap palm oil or soybean oil which can increase deforestation through land conversion (Baldino, 2019).
- Advanced biofuels result in low, and even negative, LUC emissions. This is because of the offsetting sequestration effect of new land covers (e.g. short-rotation plantations) or carbon sequestration in soil due to no-till practices. For perennial grasses (e.g. miscanthus, switchgrass) and short rotation woody crops, land-use change can negate other GHG emissions primarily because these crops tend to build soil carbon where they are grown (Valin, et al., 2015). By contrast, forestry residues can result in carbon soil loss through increased erosion and reduction of carbon inputs, although these effects can mitigated with only partial residue removal and sustainable management practices (Searle, et al., 2017).

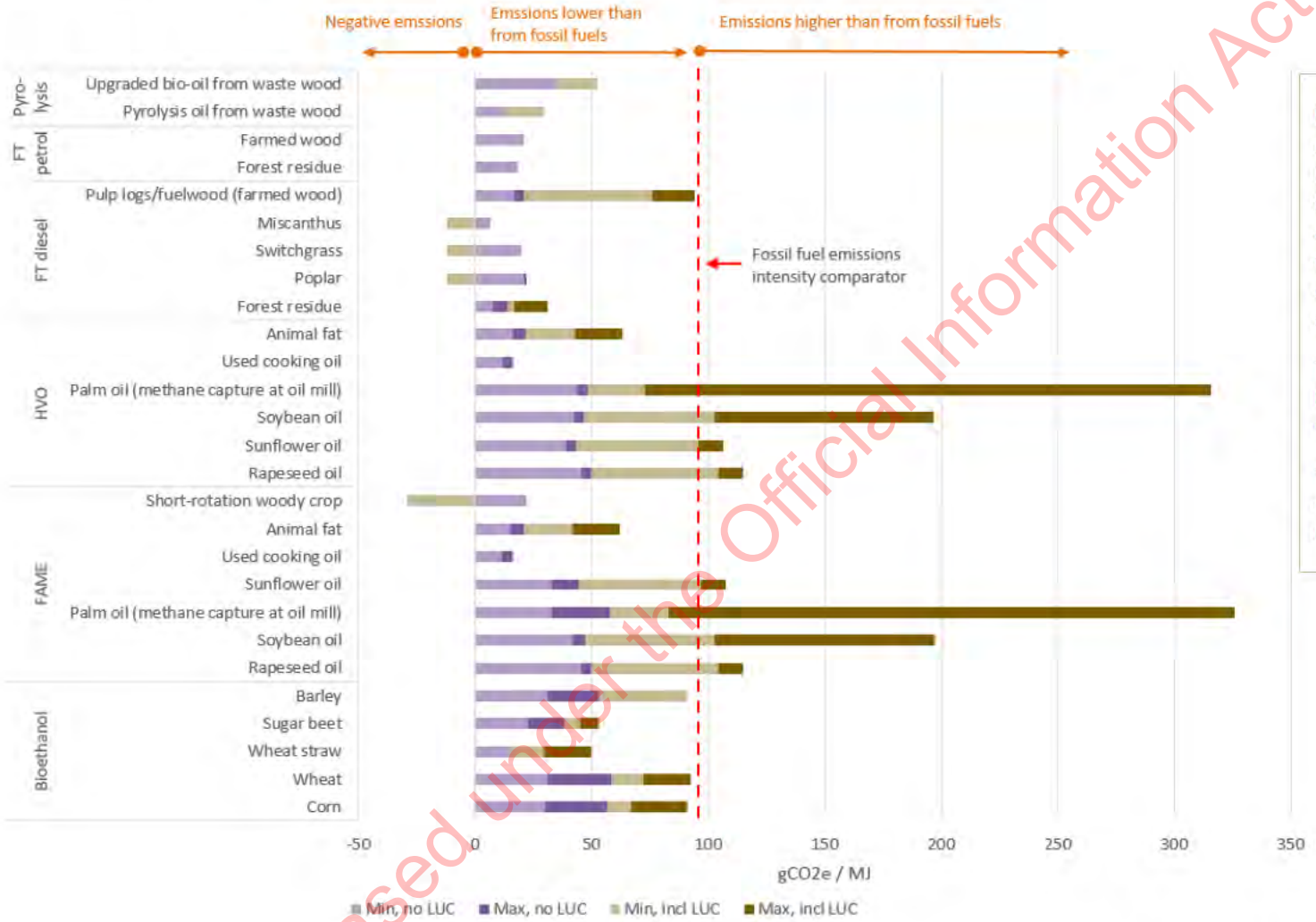
[19] The carbon stored in trees and soil is released when forests are cut down or peat lands drained.
[20] For example, ethanol production from corn results in DDGS (distiller's dried grain with solubles), which can also be used for animal feed.

Figure 6 – Comparison of LUC emissions and emissions from biofuel processing



Source: Processing emissions - EU RED II; LUC emissions - (Ecofys et al., 2015), (Hoefnagels, et al., 2010)

Figure 7 – LCA emissions from biofuels, including land-use change



Note: The light and dark purple bars show estimates without LUC impacts, whereas the light and dark gold bars add incremental LUC impacts. The darker purple and gold colours add an upper bound for estimates without and with LUC impacts respectively. The shading of colours simply aims to show the variability of estimates from different sources.

The estimates are for biofuels consumed in Europe, except for liquid fuels from pyrolysis which are based on US numbers.

The vertical red line shows the fossil diesel comparator on an LCA basis as used in the EU RED (94 gCO2e/MJ).

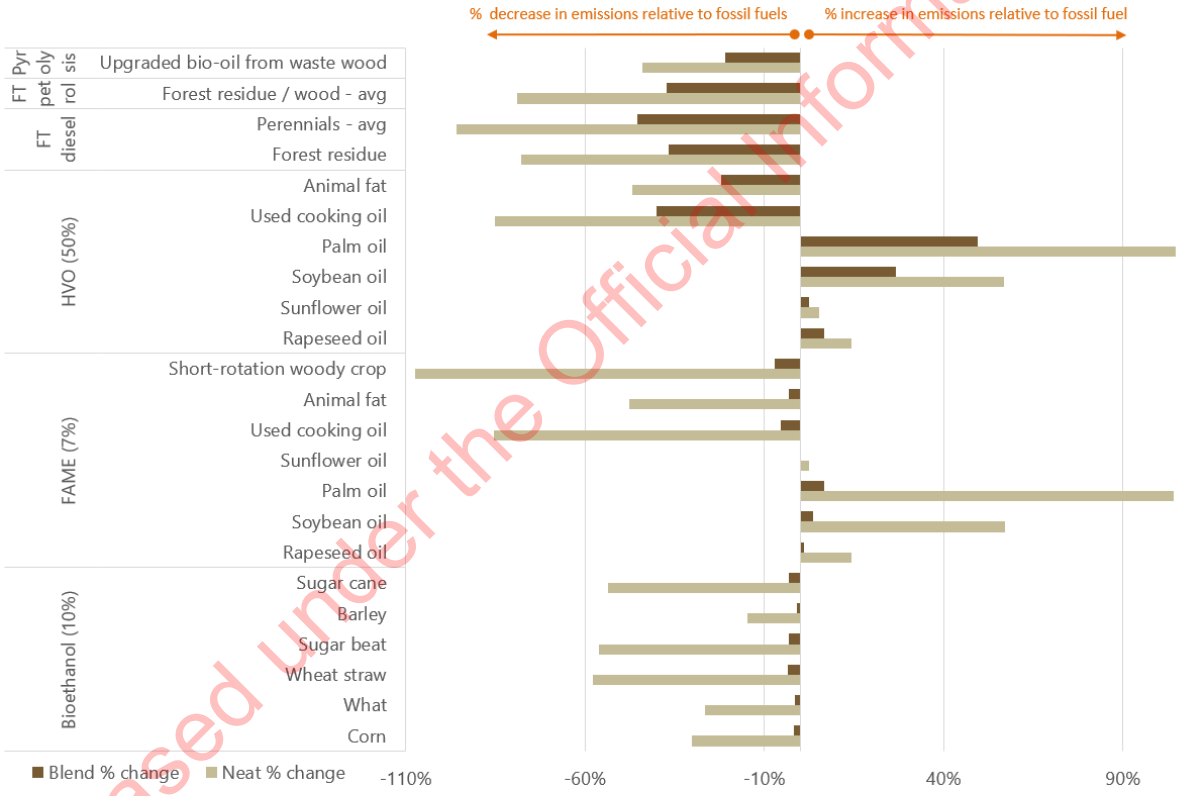
Source: Sapere based on (Camia, et al., 2018), (Flach, et al., 2019), (O'Connor, 2013), (Hoefnagels, et al., 2010), (Searle, et al., 2017), EU RED II, (Transport & Environment, 2016), (Ecofys et al., 2015)

Advanced biofuels have a higher emissions savings potential when accounting for blending limits

The previous section discussed biofuel lifecycle emissions on an energy basis, measured as gCO2e/MJ. In reality, the blend walls discussed previously will limit the amount of biofuel energy that can be consumed, which will affect the real emissions reduction potential depending on feedstocks and conversion technologies.

Figure 8 shows the overall emissions impact depending on the blend wall used (10% for bio-ethanol, 7% for biodiesel, and 50% for drop-in fuels). The comparison is with lifecycle emissions from fossil fuels (94 gCO2e/MJ), which include supply and combustion emissions. Appendix E includes the assumption on energy content for neat and blended fuels. Appendix G provides the detailed emissions reduction estimates by biofuel pathway.

Figure 8 – Comparison of emissions savings for neat vs blended biofuels, including LUC impact



Source: Sapere analysis. Fuels from pyrolysis and FT processes are assumed to be blended at a 50% concentration.

The figure suggests the following key points for the real-world application of biofuels:

- Liquid biofuels from vegetable oils can have higher lifecycle emissions than fossil fuels, although there can be exceptions on a case-by-case basis where net LUC impacts are shown to be minimal. As a general rule, therefore, these feedstocks are not suitable for de-carbonising transport fuel use.
- Bioethanol have lower emissions, but the blend walls significantly reduce the potential for emissions reductions. These range between -1% and -6% for a 10% blend wall.

- Similarly, a 7% limit for biodiesel from waste oils results in emissions reductions of between -3% and -6%. A 50% limit on HVOs from waste oils results in emissions reductions of -23% (animal fats) or -43% (used cooking oil).
- Advanced biofuels from waste oils and biomass residues have the highest emissions-reduction potential, both due to the higher blend wall and lower LUC emissions. The emissions reduction potential for final fuels containing 50% drop-in fuels is between -21% and -50% on energy basis
- Of advanced fuels, those produced from upgraded pyrolysis oil have the least emissions savings mostly due to the hydrogen produced from natural gas that is required in the conversion process. However, if hydrogen were produced from bio-oil instead, emissions savings via the pyrolysis route could improve by 37%. However, this would considerably increase per-unit capital costs as 30% of the bio-oil would be used for hydrogen production rather than final fuel (O'Connor, 2013).[21]

The concept of biofuel sustainability is wider than GHG emissions

Although the analysis above has focused on GHG emissions specifically, it is worth noting that biofuel production can result in wider environmental and societal impacts. These include biodiversity loss due to deforestation, water resource depletion, competition with food, and regional development impacts as a result of land-use changes.

New Zealand does not currently have rules establishing criteria by which biofuel sustainability can be assessed, and the EU provides an example. In particular, the Article 29 of the EU RED II Directive specifies the following sustainability criteria (not exclusive):

- Biofuels produced from waste and residues derived from agricultural land are allowed (for the purpose of RED II) so long as where operators or national authorities have monitoring or management plans in place in order to address the impacts on soil quality and soil carbon.
- Biofuels made from raw material from land with a high biodiversity value or high-carbon stock are not allowed.
- Biofuels made from forest biomass must come with proof that the country where the feedstock originated has monitoring and enforcement systems in place to ensure the legality of harvesting operations, forest regeneration of harvested areas, areas designated for nature protection purposes are protected etc.

To deal with the second issue of indirect impacts, which are much more difficult to measure, RED II sets limits on the share of individual biofuels produced from food and feed crop (maximum 7% of final consumption in the road and rail transport sectors of a Member State). Furthermore, the EU regulatory context allows distinguishing between high- and low ILUC-risk biofuels, supported by a

[21] See table 7-7 in (O'Connor, 2013).

recent technical report that was commission for this specific purpose.[22] High-risk ILUC biofuels (produced from food and feed crops for which significant expansion of production area into land with high-carbon stock is observed) are capped at 2019 consumption levels in Member States, declining to zero by 2030.

An important point is that the sustainability of the same type of feedstock can differ from case to case, depending on land impacts. For example, under the EU setting above, palm oil can qualify as either high- or low ILUC- risk feedstock, depending on whether it is grown on existing land or abandoned / severely degraded land (European Commission, 2019).

The box below summarises the general criteria by which feedstocks are assessed for the purposes of being accepted into the list of sustainable raw materials in EU RED II (Annex IX). As well as the criteria related to land use discussed above, it is worth noting the reference to the waste hierarchy[23] in assessing biofuel feedstocks. This is important because some biofuel pathways could result in diverting raw material from a higher value use, e.g. animal fats that are used in the chemical industry to make soaps, or pulpwood used to make paper.[24] In other words, there is an opportunity cost associated with use a resource for biofuel production. A recent paper by (Transport & Environment, 2020) has highlighted several gaps in RED's current classification of some feedstocks, calling for an additional oversight of such opportunity costs.

Box 1 – Principles guiding assessment of feedstock sustainability in EU RED II

To be added to Annex IX of EU RED II, a raw material needs to be assessed with regard to the following principles listed in Article 28(6)

(a) the principles of the circular economy and of the waste hierarchy established in Directive 2008/98/EC;
(b) the Union sustainability criteria laid down in Article 29(2) to (7);
(c) the need to avoid significant distortive effects on markets for (by-)products, wastes or residues;
(d) the potential for delivering substantial greenhouse gas emissions savings compared to fossil fuels based on a life-cycle assessment of emissions;
(e) the need to avoid negative impacts on the environment and biodiversity;
(f) the need to avoid creating an additional demand for land.

[22] See (European Commission, 2019).
[23] The hierarchy is: (a) prevention; (b) preparing for re-use; (c) recycling; (d) other recovery, e.g. energy recovery; € disposal.
[24] We note that RED II allows the use of 'recycled carbon fuels' produced from solid waste streams of non-renewable origin which are not suitable for material recovery in accordance with the waste hierarchy. However, these feedstocks have not yet been included in RED II Annex IX.

What is the potential demand for liquid biofuels in NZ transport?

Summary

Note: estimates provided in this section reflect potential demand purely from a fuel compatibility perspective, i.e. abstracting from possible supply.

- Due to blending walls for biodiesel and bioethanol, maximum potential demand for these fuels on an energy basis is relatively small: 6% of current demand for diesel fuels by heavy trucks and marine, and 6% of current demand for petrol fuels by light vehicles respectively. Biodiesel is not suitable for aviation.
- The potential incremental demand for drop-in diesel is much higher at around 44% of total energy required by diesel heavy trucks, marine and aviation (assuming a 50% blending limit for drop-in fuels).
- Similarly, the potential demand for drop-in petrol is 47% of total energy required by light petrol vehicle, assuming the same blending limit.

From a fuel compatibility perspective, potential demand for drop-in diesel is much higher than for conventional biodiesel due to higher blending limits

In this section, we present the maximum potential from a fuel compatibility perspective only. In reality, the demand for biofuels will also be significantly impacted by economic factors such as maintenance costs and final fuel price, which will affect the total cost of vehicle ownership. The economic factors are discussed further below.

For aviation and shipping, data on current fuel consumption is based on MBIE oil tables which include energy consumption by domestic aviation and navigation.[25] For heavy trucks (GVM[26] > 10 ton), consumption is estimated based on vehicle configuration as per the NZTA vehicle fleet data,[27] fuel economy estimates by (Haobo, et al., 2019), and vkt estimates by GVM band from the Motor Vehicle Register (see Appendix L). Current fuel consumption by petrol light vehicles assumes a fuel economy of 8.98 litres per 100 km, [28] which is applied to total distance travelled by light petrol vehicles based

[25] We note that the data for domestic navigation is not just coastal shipping but is likely to include recreational activities too.

[26] Gross vehicle mass

[27] https://nzta.govt.nz/resources/new-zealand-motor-vehicle-register-statistics/new-zealand-vehicle-fleet-open-data-sets/

[28] Based on MoT's 2018 vehicle fleet statistics. This number applies to the 2,000-2,999cc vehicle category, which is representative of the light vehicle fleet.

on the NZTA vehicle fleet statistics for 2018. The 2021 distance is estimated from historical values assuming a 2% growth p.a. (the average for 2014-2018 period).

Projections of total fossil fuel fuel demand (the baseline) are estimated based on assumptions in the base case scenario of MoT's 2017 Transport Outlook[29] for:

- vkt travelled by light petrol vehicles[30]
- vkt travelled by heavy ICE diesel vehicles (including projections of freight growth),[31] and
- million km travelled by domestic air
- freight movements by coastal shipping.[32]

The following key assumptions are made (see Appendix L for more details):

- All light vehicles can switch from petrol to E10.
- For heavy trucks, most of which run on diesel, we are able to determine the proportion of fossil energy consumption that can be replaced with blended fuels using NZTA's vehicle fleet data and OEM requirements based on compilation of information from engine manufacturers by the NZ Motor Industry Association (MIA) (see Appendix M). We also assume that as heavy trucks are retired (assuming a lifetime a 20-year lifetime), they are replaced with engines that can accept higher FAME biodiesel blends, B30 in particular as follows: old trucks are replaced with trucks that can run on B30 in proportion to the share of heavy vehicles that have less than a year since registration. We estimate this to be 4% currently. The switch to B20 is in proportion to the current share of heavy vehicles with registration under 10 years (43%). The remainder (53%) are replaced with trucks running on B7. The link to the year of truck registration is used as a proxy for fleet composition in terms of age and therefore likelihood for engine to use newer configurations allowing higher blends.
- For heavy trucks that do not accept biodiesel, we assume a blend of 50% conventional fuel and 50% drop-in fuel. We assume a blending wall for drop-in fuels to reflect possible restrictions that may be needed to meet fuel quality standards. For example, although the EU standard for paraffinic fuels does not require limits for diesel-like hydrocarbons, in practice HVO is blended up to 30% (Neste, 2020). Drop-in fuels from lignocellulosic drop-in fuels are not commercially available yet so we cannot comment on the observed blending limit for these fuels. However, we recognise that the direction is for such limits to be increased or even removed as standards for new fuels are being developed. Therefore, the 50% limit is a conservative assumption when viewed over the long term.
- In shipping, we assume a blend wall of 5% for biodiesel.
- In aviation, 50% of aviation fuel consumption can be replaced with drop-in fuels. In the shorter to medium term this is mainly HEFA-SPK which is commercially available. Over the

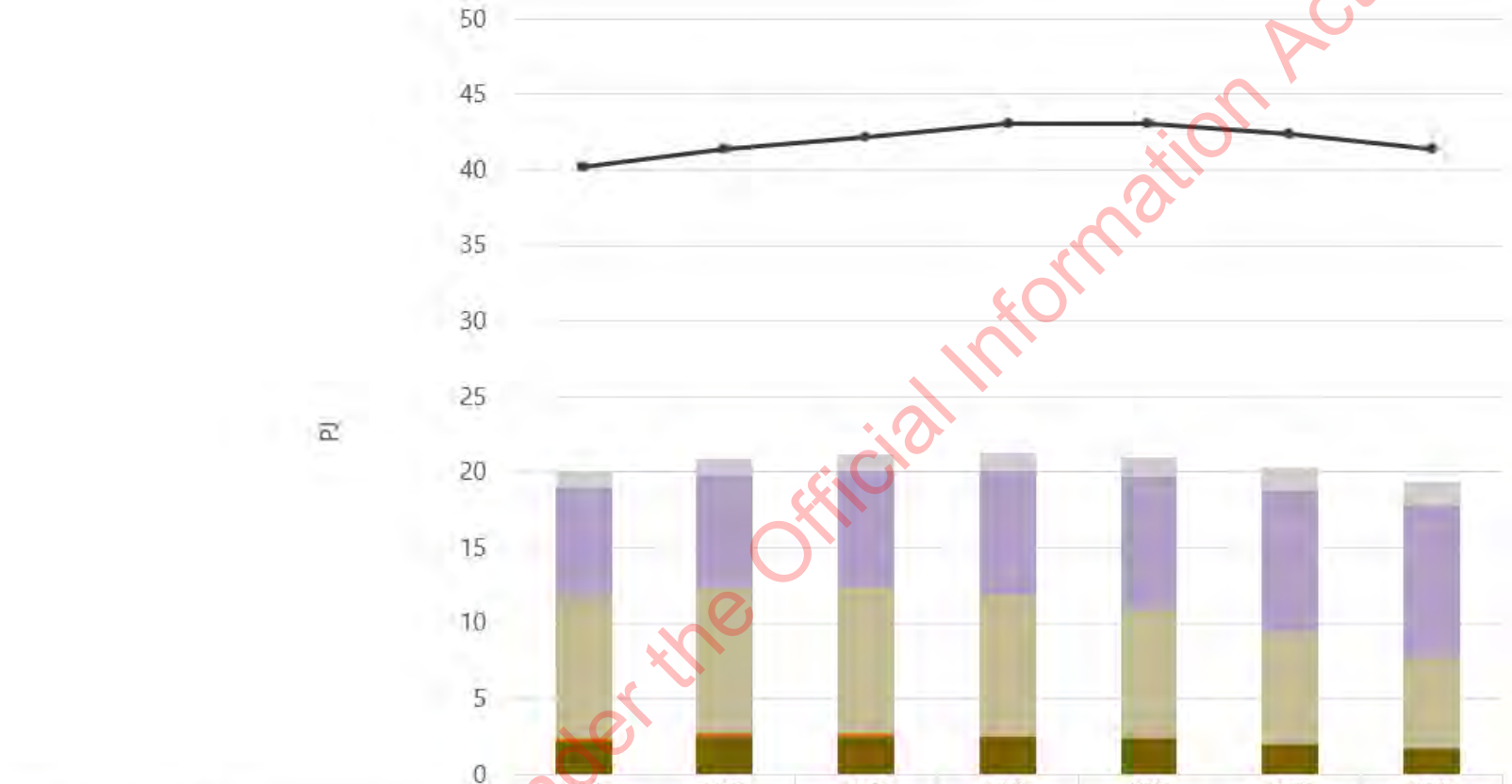
[29] https://www.transport.govt.nz/assets/Uploads/Report/TransportOutlookFutureOverview.pdf
[30] The decline in vkt travelled by petrol vehicles is due to the increasing electrification of the fleet through to 2050.
[31] In MoT's study, vkt travelled by heavy ICE diesel vehicles decline y/y due to increased electrification of the fleet.
[32] These are assumed to be constant through to 2032, and increase by 1.84% p.a. from then onwards.

long term, other advanced biofuels could be used for which an ASTM standard has been approved, e.g. FT-SKA. We also assume a constant fuel economy through to 2050, although we recognise there are ongoing improvements made to increase fuel efficiency (NZ Government, 2016).

Key findings:

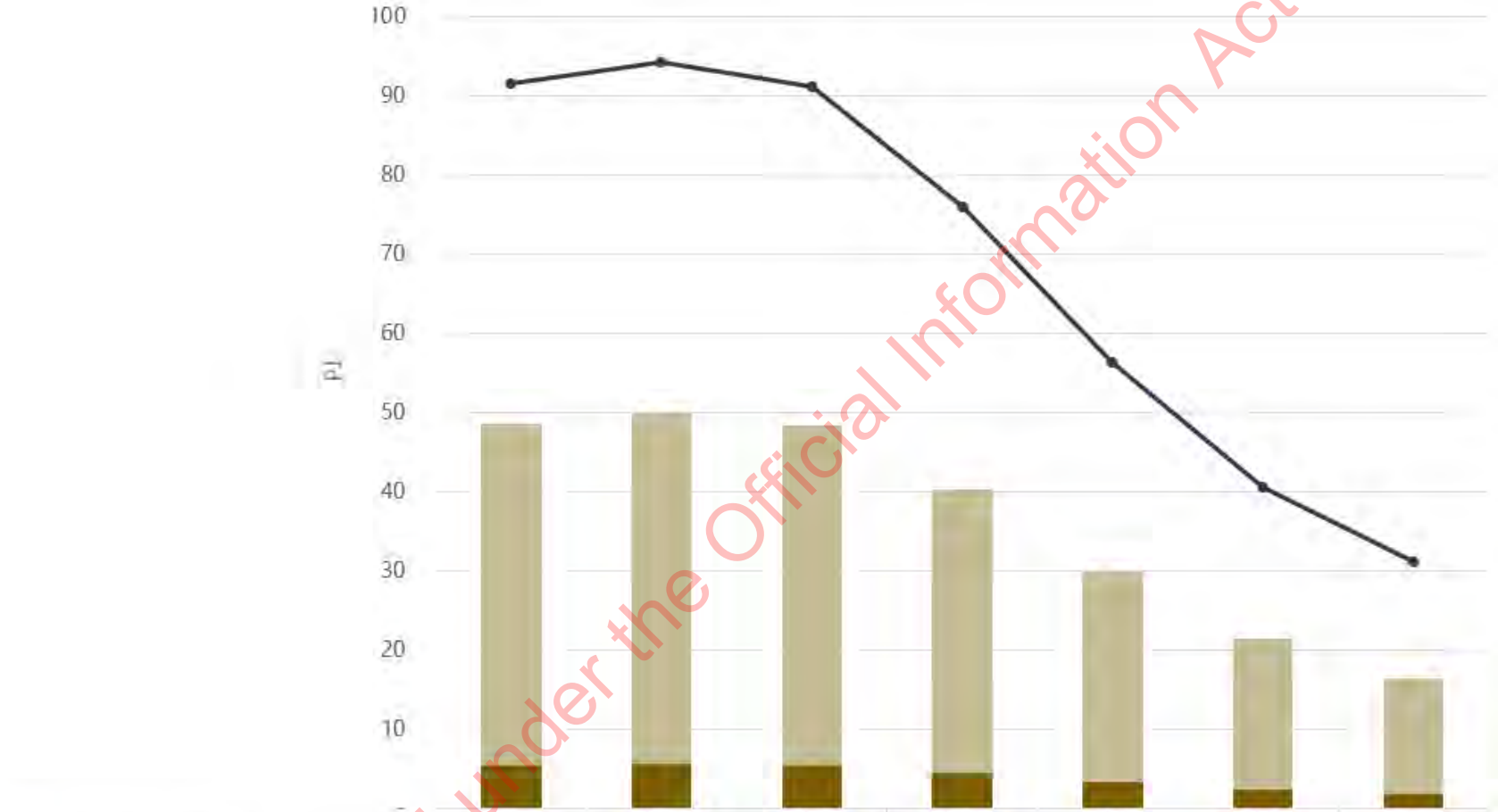
- Total potential demand for biodiesel out of total diesel energy consumed is 6% currently, dropping to 5% by 2050 (Figure 9). This low share reflects the blending walls applied across heavy trucks and shipping. On an energy basis, the proportion of heavy trucks that can use the higher blends (B20 or B30) is 4% today and 3% by 2050. In other words, the share of biodiesel out of total energy consumption is largely driven by the ability of heavy trucks to operate on these higher blends.
- Total potential demand for drop-in fuels blended at 50% is 44% today and 43% in 2050. This means that biodiesel and drop-in diesel can account for 50% of total diesel energy demand today, and 48% in 2050.
- Results are similar for light vehicles running on petrol. Total potential demand for bioethanol is estimated to be 6% of total energy consumption by petrol light vehicles (Figure 10). This stays constant though to 2050 because it is assumed that all petrol vehicles can use an E10 blend (which means that the proportion of bioethanol doesn't change). The potential demand for drop-in petrol (at 50% concentration) is 47% of total energy required.
- We note that the estimates for bioethanol and biodiesel demand reflect an upper limit. The availability of drop-in fuels over the long-term could increase demand for such fuels at the expense of conventional biofuels due to the former fuels having more beneficial technical and environmental characteristics.

Figure 9 – Potential demand for biofuels (incl. maximum demand for biodiesel)



	2021	2025	2030	2035	2040	2045	2050
Marine drop-in diesel	1.1	1.1	1.1	1.2	1.3	1.5	1.6
Aviation biofuel	7.2	7.3	7.7	8.2	8.7	9.4	10.0
Heavy trucks that can only accept drop-in diesel	9.4	9.7	9.7	9.4	8.5	7.4	6.1
Marine biodiesel	0.2	0.2	0.2	0.0	0.0	0.0	0.0
Heavy trucks that can run on biodiesel	2.19	2.51	2.52	2.49	2.39	2.05	1.70
Fossil energy demand by diesel heavy trucks, shipping and aviation - baseline	40.23	41.40	42.20	43.05	43.09	42.41	41.42

Figure 10 – Maximum potential demand for bioethanol



	2021	2025	2030	2035	2040	2045	2050
Drop-in petrol demand	43.01	44.25	42.87	35.74	26.47	19.05	14.61
Neat bioethanol	5.43	5.58	5.41	4.51	3.34	2.40	1.84
Fossil energy demand by light vehicles - baseline	91.45	94.08	91.15	75.98	56.27	40.49	31.07

Source: Sapere analysis

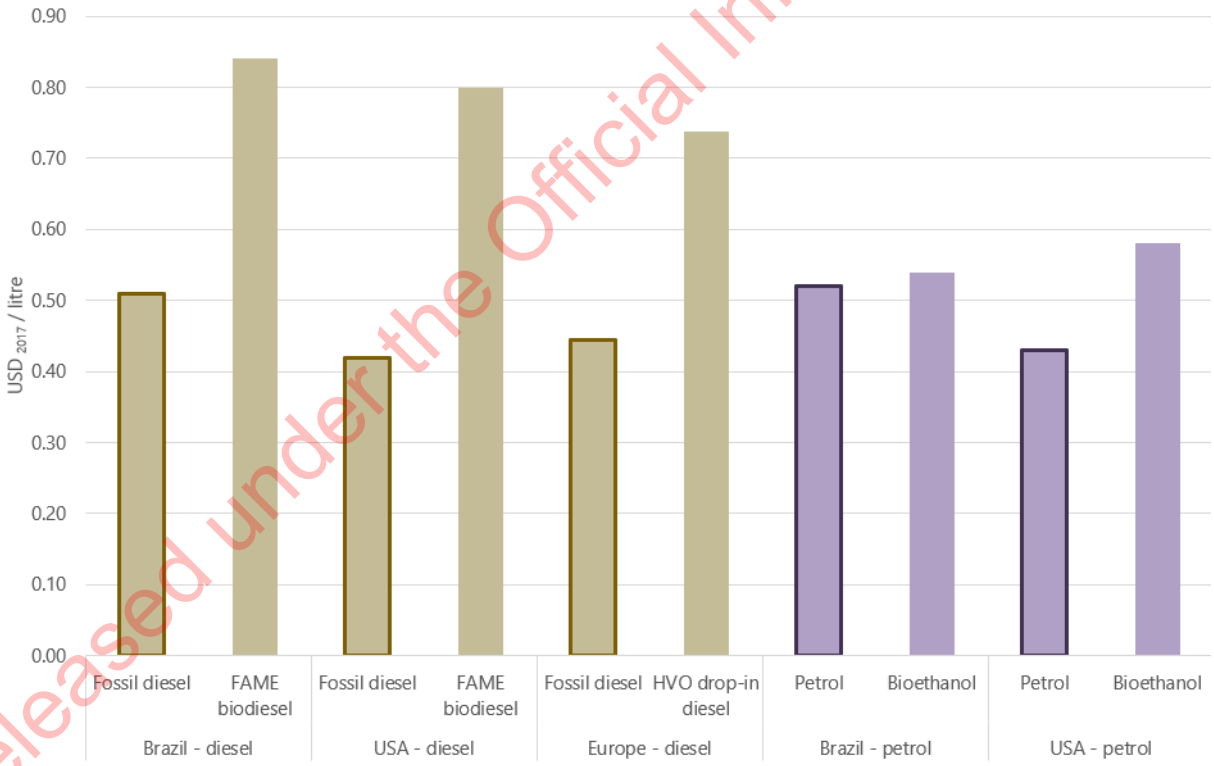
Actual demand for biofuels will be affected by higher vehicle ownership costs

The estimates of potential biofuel demand from the previous section assume full uptake of biofuels in accordance with the OEM's fuel requirements for different types of engines. In practice, this uptake will be significantly affected by the economics of switching from current to cleaner fuels.

First, production costs for commercially available biofuels (mainly conventional bioethanol, FAME biodiesel and HVO) is much higher than that for fossil diesel (Figure 11), contributing to a higher retail prices which can be double for a neat biodiesel compared to fossil diesel.[33]

We note, however, that a higher carbon price would reduce premia for a blend due to ETS savings in the cost of fuel at the pump. The current retail diesel price contains an ETS component (around 9 cents/litre at a carbon price of $32/tCO2e). The higher the blend and the carbon price, the lower the premia for biodiesel or drop-in fuel. This is shown in Figure 12. Here, blended fuel prices are shown as proportion of 2019 NZ fossil diesel prices, assuming B100 price is roughly twice that of fossil diesel, reflecting the US production cost ratios from Figure 11.[34]

Figure 11 – Biofuel production costs vs fossil fuel production costs



Source: Bioethanol and FAME costs from (IEA, 2017); HVO costs from (Maniatis, et al., 2017)

[33] Based on our current market analysis.
[34] We note that this double ratio was also observed during 2020 based on conversations with NZ fuel importers.

Figure 12 - Relationship between biodiesel blend premia and carbon price (excl GST)

Source: Sapere analysis

Second, the operating and maintenance costs associated with bioethanol and biodiesel could increase as a result of the fuel switch. This is because the unfavourable chemical properties of these fuels may require an increased frequency of vehicle servicing (e.g. oil change, fuel filtration elements) for higher blends. There could also be additional operating costs for paraffinic fuels. When a high concentration of paraffinic components is used, lubricity additive is needed in the final blend to protect fuel injection equipment against excess wear. However, we note that lubricity additive is also needed for conventional winter grade or sulphur-free diesel fuel (IEA-AMF, 2021b), so the additional cost for paraffinic fuels would not be as high in colder climate.

Furthermore, the low energy of biodiesel (33.5 MJ/litre neat), and particularly of bioethanol (21 MJ/litre neat), caused by the oxygen content means fuel consumption and refuelling frequency may be higher. We note that the use of closed-loop control systems of diesel consumption could help mitigate this issue for biodiesel (Wood Mackenzie, 2010).[35]

[35] The increase in oxygen content of the fuel with open-loop control systems reduces peak power and torque, and increased volumetric fuel consumption, in line with the quantity of FAME blended into the diesel.

What is the outlook for biofuels supply?

Global market

- Over the next decade, it will be difficult to secure reliable international supply of biodiesel produced from non-vegetable oil feedstock (i.e. with low land-use change emissions). This is due to increased demand for such feedstock from the EU, which has been the main exporter of biodiesel. Australia's exports of biodiesel are expected to be insignificant.
- Although the global bioethanol export market has been dominated by USA and Brazil, New Zealand has not imported from those countries. Most of the bioethanol currently in the NZ market is imported from Australia, and we expect this trend to continue. Proximity brings the benefit of lower shipping costs and the ability to engage with local producers to ensure fuels are produced sustainably. However, exports of biodiesel from Australia over the next decade are projected to continue to be small at around 1.8 PJ p.a.
- A key trend in OECD countries is the shift towards advanced biofuels. This is driven by the need to overcome blending limits and sustainability concerns linked to conventional biofuels. Technology learning curves and the direction of EU and US policy support suggest that global uptake of advanced biofuels will start to grow from 2025.

Domestic production

- There is enough local supply of inedible tallow to meet 56% of biodiesel demand (on an energy basis) from heavy trucks and marine, and up to 28% of drop-in fuel demand from aviation. However, this supply is uncertain due to high competition for it from overseas. Tallow-based biodiesel currently sold in New Zealand is imported from Australia. Small volumes of biodiesel are produced from domestically sourced used cooking oil.
- Domestic bioethanol is primarily produced from whey, but output is extremely small (0.13 PJ), with feedstock supply susceptible to weather events (e.g. droughts). Most of bioethanol currently in the market is imported from Australia, but supplies have declined.
- New Zealand's biomass resources suggest significant potential for advanced biofuel production, however the rate at which this production can scale strongly depends on technology learning curves. Current technology projections suggest that a total production of 39 million litres of drop-in fuels is possible by 2025 gradually increasing to 2030 (at around 19% p.a.). From 2030, the rate at which production can be further scaled is uncertain. The optimistic scenario is that by 2035 the technology is mature enough to allow production of drop-in diesel and drop-in petrol to meet all diesel[36] and half of petrol demand[37] respectively. The less optimistic scenario is that this happens 5 years later - by 2040. Note also that these assessments do not consider other uses for biomass feedstock, which could affect the volumes available for biofuel production specifically.

[36] All diesel demand from heavy trucks, marine and aviation.
[37] All petrol demand from light vehicles.

Available domestic supply of feedstock for conventional biofuels is small or uncertain

Biodiesel and HVO/HEFA

In New Zealand, there is enough inedible tallow to produce around 3.35 PJ of fuel energy (~100 million litres of FAME biodiesel)[38] per annum. However, there is significant competition for domestic tallow from international producers in jurisdictions with supportive biofuel policies. Currently, NZ tallow is exported to Singapore for manufacturing into biodiesel (Meat Industry Association, 2020). In 2018, Z Energy started producing FAME biodiesel from domestic tallow at its Te Kora Hao plant in Wiri South Auckland, which had initial capacity of 20 million litres p.a., with a potential scale-up of production to 40 million litres p.a. (Z Energy, 2016). However, in 2020 international competition for domestic tallow, which significantly increased the price for this feedstock, has led Z Energy to hibernate its biodiesel plant. Currently, the plant is used as a biodiesel import terminal, where mineral diesel and neat biodiesel are blended. This neat biodiesel is made from tallow feedstock, and is imported from Australia.

Another producer of biodiesel in New Zealand is Green Fuels. Their output is relatively small - around 500,000 litres biodiesel p.a. from used cooking oil (Rural Delivery, 2016). Potential FAME biodiesel production from canola oil as a break crop in grain farming was estimated to be another 20 million litres (PCE, 2010), [39] however this would require trade-offs with alternative uses of land. Only small quantities of used cooking oil are available.

In the figure below we compare the maximum potential demand for FAME biodiesel from section 0 with known capacities for domestic production. MBIE renewables statistics[40] indicate that around 0.02 PJ of biodiesel p.a. were domestically produced in 2015-2017. We assume this to be production by GreenFuels[41] that will continue for the foreseeable future.[42] We also assume a maximum output of 20 million litres of FAME biodiesel from Z Energy's Te Kora Hao plant in Wiri South Auckland.

[38] As per (PCE, 2010).

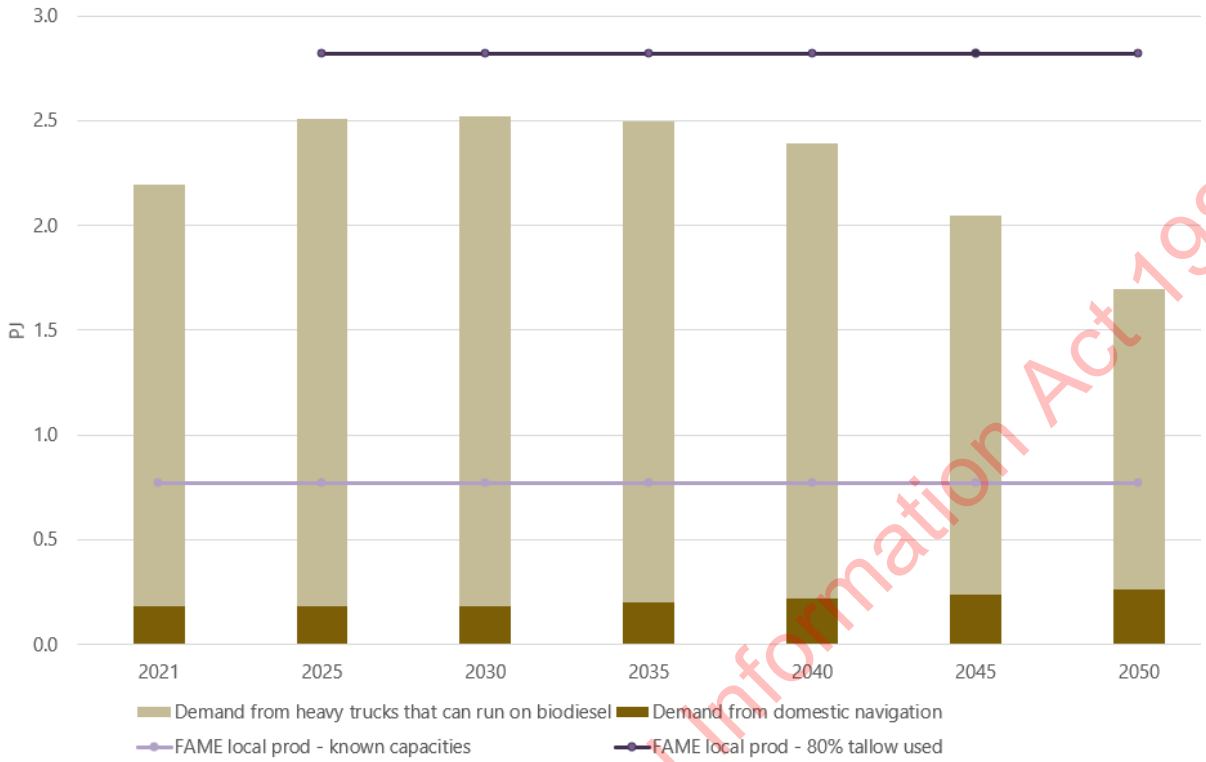
[39] New Zealand has almost 700 specialist grain farmers. If each of them planted a 20-hectare break crop of canola every year and obtained a yield of 4 tonnes of seed per hectare, that would be sufficient for at least 20 million litres of FAME.

[40] https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-statistics/renewables-statistics/

[41] Z Energy made its first biodiesel sales in 2018-2019 based on their 2019 Annual Report.

[42] We discuss uncertainties on feedstock supply later on.

Figure 13 – FAME demand and domestic production



Source: Sapere analysis

The figure suggests that current capacity would meet biodiesel demand from the marine sector, but would only partially meet potential demand from heavy trucks. However, it also suggests that there is enough feedstock in New Zealand to meet all biodiesel demand from these two sectors. Existing plant capacity is at around 28% of maximum demand, but it could be easily scaled up to meet 50% by 2025.[43] The scale-up from the current built capacity of 25 million litres FAME p.a.[44] to 45 million p.a. would require up to $26 million in investment costs[45]. We should note that tallow could also be used for drop-in fuel production, e.g. HEFA-SPK for aviation. However, the residual supply[46] of tallow feedstock (producing up to 2 PJ or up to 59 million litres of fuel) would only cover up to 28% of aviation demand for drop-in fuels today, and 26% by 2030. The reported capital costs for such plants are $0.7-$2.5 per litre p.a. (ICCT, 2019). If additional production capacity were built to produce HEFA-SPK on the basis that tallow feedstock is available, then the investment costs would be $41-$148 million.

[43] This refers to Z Energy's plant that can be scaled up to produce 40 million litres.
[44] Z Energy + Green Fuels
[45] Based on Z Energy plant's capital costs of $26m for 20m litres p.a. The scale-up of the plant may cost less than the initial greenfield investment.
[46] Total tallow supply less volumes required to produce 40 million biodiesel. If only 80% of total tallow output is used for biofuels, then HEFA production could meet around 20% of total aviation demand for biofuels.

Another option to meet demand would be to import biofuels and blend them locally. Z Energy is doing this currently, but the volumes are limited. As discussed in section 0, global trade in biofuels is small, and most of production is targeted at domestic consumption bolstered by policy support.

The uncertainty around global feedstock supplies is particularly evidenced by Gull's recent decision to discontinue its B5 Diesel Max fuel (as Z Energy's hibernation of its biodiesel plant discussed previously). Originally, Gull biodiesel was made primarily from used cooking oil and occasionally animal fats (tallow). Because consistent domestic supply was harder to find, over the last six years Gull has been importing biodiesel from a long-established Australian producer. However, in recent years, "even securing regular import supply has become difficult and with the lack of scale, viable options to automate the blending process have been limited" (Gull, 2020).

Bioethanol

In New Zealand, bioethanol has been primarily produced from whey (a dairy industry by-product) at Fonterra's Anchor Ethanol plants. This bioethanol has been blended with petrol, and sold at retail outlets primarily by Gull.

Domestic bioethanol use has been very small – 0.13 PJ in 2019 (MBIE, 2020), or 6 million litres of neat bioethanol. In 2020, Fonterra's output was affected by drought so local production is expected to have been much smaller. Gull has also been importing bioethanol, but has signalled issues with securing supply. As a consequence, although it continues to offer E10, it has discontinued E85 (Gull, 2020b).

Access to global supply of sustainable conventional biofuels is problematic

The main biofuels currently produced on the global scale are ethanol (produced mostly from corn, sugar cane and other crops) and biodiesel (produced from vegetable oils, and fats including used cooking oil). Global production has been increasing since 2010, including for HVO and HEFA production, to reach 4 exajoules in 2019. In 2019, ethanol accounted for 59% of global biofuel production (in energy terms), biodiesel 35%, and HVO/HEFA 6% (REN21, 2020).

United States remains the leading producer of biofuels, with 41% share, followed by Brazil (26%). In these countries, bioethanol production predominates.[47] Europe is the largest producer of biodiesel primarily from rapeseed oil and used cooking oil. Currently, EU accounts for 34% of global biodiesel production (OECD-FAO, 2020). Indonesia, China and Germany account for 4.5%, 2.9% and 2.8% of global biofuel production respectively (REN21, 2020).

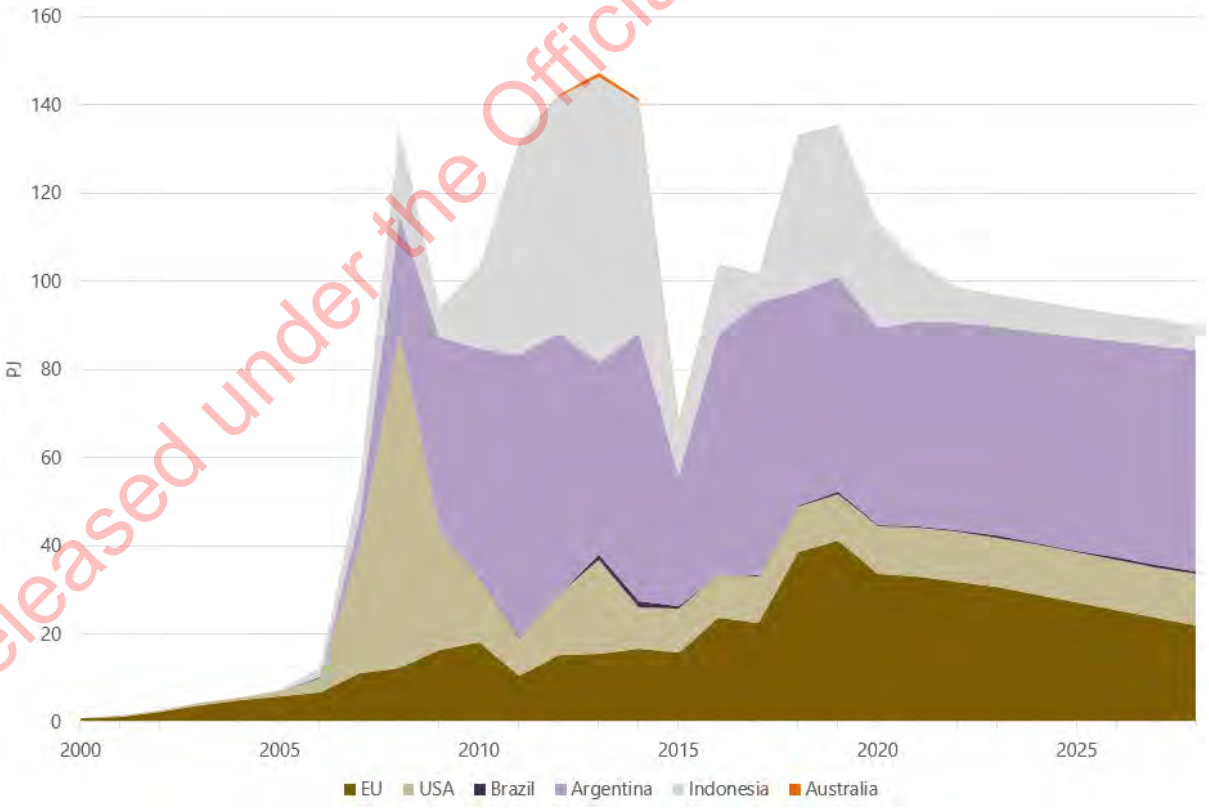
An emerging trend over the next decade is declining biofuels production in both the EU and USA, due to a number of factors. In the US, domestic demand for ethanol declined in 2019 due to the approaching blend limits. In the EU, changes to the Renewable Energy Directive have limited the role of food-based biofuels. Over the longer term, domestic production is expected to decline in OECD countries due to improvements in vehicle fuel efficiency (US EIA, 2019), switch to alternative drivetrains (e.g. electric cars), and the growing role of shared mobility (BNEF, 2020). In Europe

[47] USA and Brazil account for 50% and 33% of global ethanol production respectively.

particularly, consumption of diesel-type fuels is expected to decline as a result of increasing on-road efficiency standards (US EIA, 2019). Biodiesel consumption in the EU is expected to fall below current levels by 2029 (OECD-FAO, 2020).

Although this could in theory result in excess biodiesel capacity that could be used to meet demand signalled from outside EU, the issue of feedstock quality remains. As discussed previously, biofuels from vegetables oils can increase lifecycle emissions, so used cooking oil and animal fats feedstocks are preferred within the lipids pathways. However, the residual supply of this feedstock in EU is uncertain due to the policy boost they have received for domestic consumption. In particular, in an aim to promote the use of advanced biofuels in EU, these feedstocks are allowed to account for twice the energy content to meet Member States biofuel mandates (Flach, et al., 2019). Although over the next decade EU will remain the second largest exporter of biodiesel (Figure 14), its exports are likely to be dominated by biodiesel from rapeseed oil feedstock. To ensure that biodiesel produced from this feedstock does not result in higher lifecycle emissions than fossil fuels, engagement with local producers would be required to determine land-use change effects, such as potential expansion into natural vegetation from rapeseed oil cultivation. A similar engagement would also be required with Argentina (top largest exporter) and USA (third largest exporter), where biodiesel production is dominated by soybean oil. However, the large distances between NZ and these markets could make this engagement impossible. Australia has the advantage of geographical proximity, however OECD projects that biodiesel exports from Australia will be close to zero through to 2029.

Figure 14 – Projections of global exports in biodiesel through to 2029

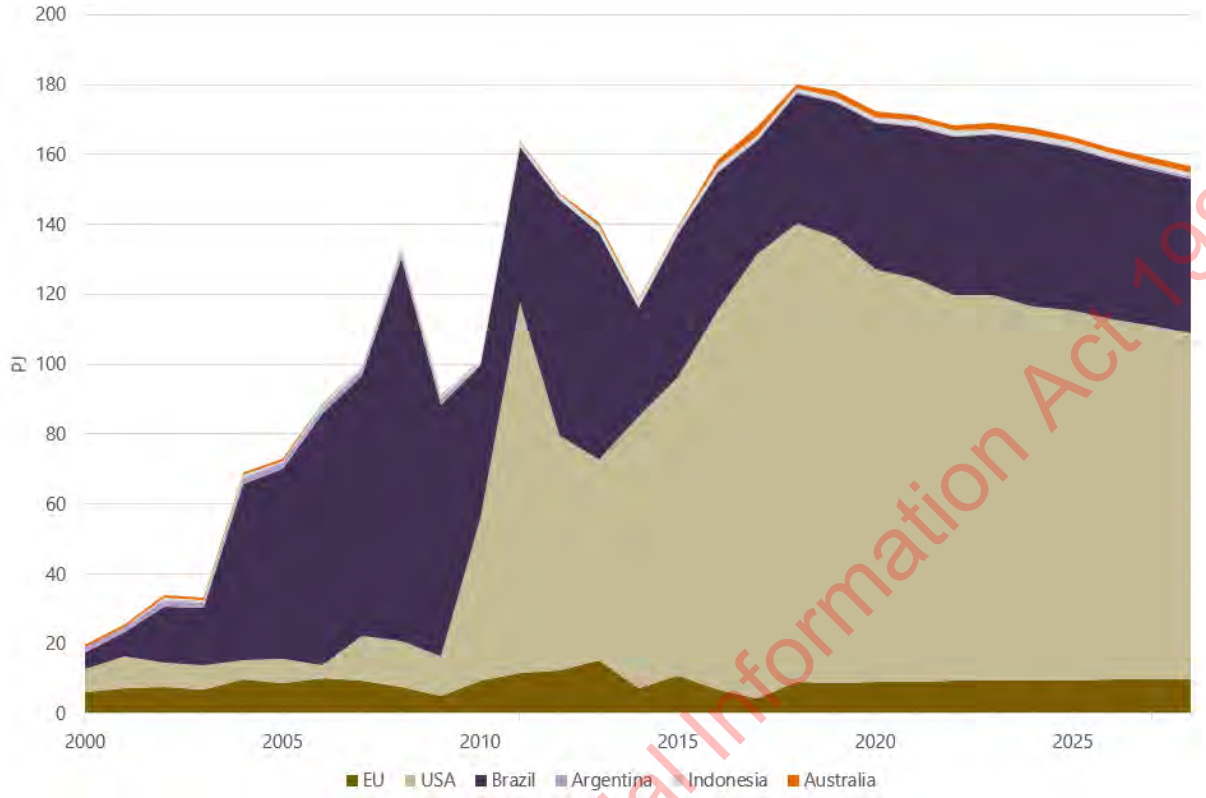


Source: OECD-FAO stats https://stats.oecd.org/

Figure 15 suggests that the top three exports of bioethanol over the next decade will be from USA where it is mainly produced from corn (an average of 107 PJ p.a.) from Brazil where is mainly produced from sugarcane (an average of 47 PJ p.a.) and Europe where it is mainly produced from sugar beat / corn / wheat (an average of 9.5 PJ p.a. The maximum estimated domestic demand for bioethanol for E10 blends is 6 PJ p.a. (in 2030), which is well under available export volumes globally. However, similar to biodiesel, these volumes would need to come from distant markets, from which New Zealand has not imported from before. Australia has been the main exporter of bioethanol for New Zealand use, although still in very small volumes. Proximity brings the benefit of lower shipping costs and the ability to engage with local producers to ensure fuels are produced sustainably. However, over the next decade, ethanol exports from Australia (where it is from starch-containing grains and agricultural residues) are expected to be small - around 1.8 PJ p.a.

Another important point is that projections are inherently uncertain. Once such uncertainty results from the competitive uses of feedstocks that can affect bioethanol production depending on the relative market prices of final products. For example, in 2020 the higher profitability of sweetener meant that the use of recoverable sugars for sugar rather than ethanol was expected to cause Brazilian ethanol output to fall (IEA, 2020). There is also the uncertainty of production yields due to climate change disruptions. In warmer climates, corn yields are expected to decline and become more variable. Because corn production is concentrated in only a few countries, simultaneous production shocks can significantly disrupt global markets (Tigchelaar, et al., 2018). Similarly, climate change can significantly disrupt sugarcane production, particularly in developing countries, due to low adaptive capacity and poor forecasting systems. Although climate change can improve sugarcane water use efficiency and cane yield, high temperatures over extended periods will reduce the amount of water available in soils, making planting increasingly difficult (Zhao & Li, 2015).

Figure 15 – Projections of global exports in bioethanol through to 2029



Source: OECD-FAO stats https://stats.oecd.org/

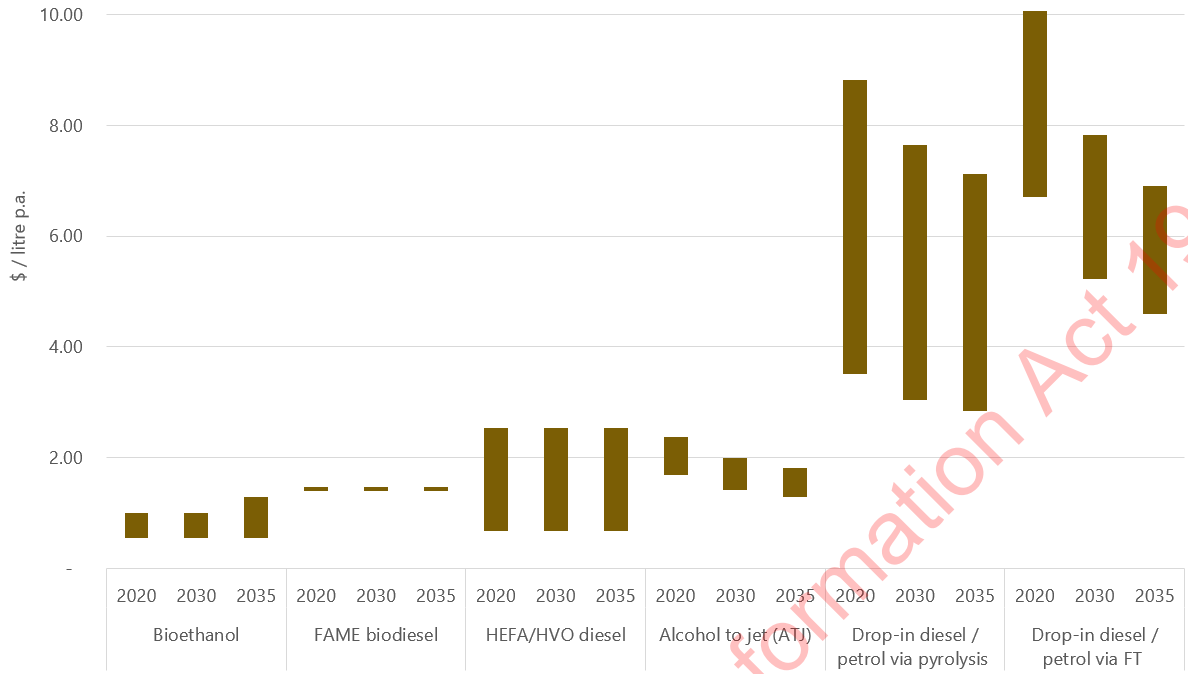
Global production of advanced biofuels is likely to expand from 2025, increasing competition for lignocellulosic feedstock

More advanced technologies based on cellulosic feedstock (e.g. crop residues, energy crops, forestry) do not currently account for a large share of global biofuel production. Over the next decade, most biofuels produced will be based on agricultural feedstock. However, global production of advanced biofuels could start to expand from 2025 (OECD-FAO, 2020), driven by technology improvements and policy incentives increasing demand for these fuels. This policy shift is particularly in response to sustainability concerns over conventional biofuels, as well as due to their limited emissions reduction potential resulting from the relatively low blending walls.

This will be driven by technology improvements and cost reductions

To a large extent, this trend will be due to the technology learning curve that will continue to reduce capital and total production costs. IRENA expects that capital cost reductions for FT synthesis will be around 3% p.a. between 2020 and 2030, and another 2% p.a. through to 2045 (see Figure 16). For pyrolysis oil upgrading, capital cost reductions are expected to be around 1% p.a. through to 2045 (IRENA, 2016). Detailed capex values are provided in Appendix J.

Figure 16 – Specific capital investment for biofuels[48]



Source: learning curves based on (IRENA, 2016). Estimates from the following sources have been adjusted to 2020 NZD - (Z Energy, 2016), (BioPacific Partners, 2020), (Wright, et al., 2010), (Zhao, et al., 2015), (CleanLeap, 2013), (Process Instrumentation, 2007).

Although the specific capital costs advanced biofuels are expected to remain significantly higher than for conventional biodiesel over the next 15 years, production costs between advanced and conventional fuels will continue to converge (Figure 18).[49] This will be due to

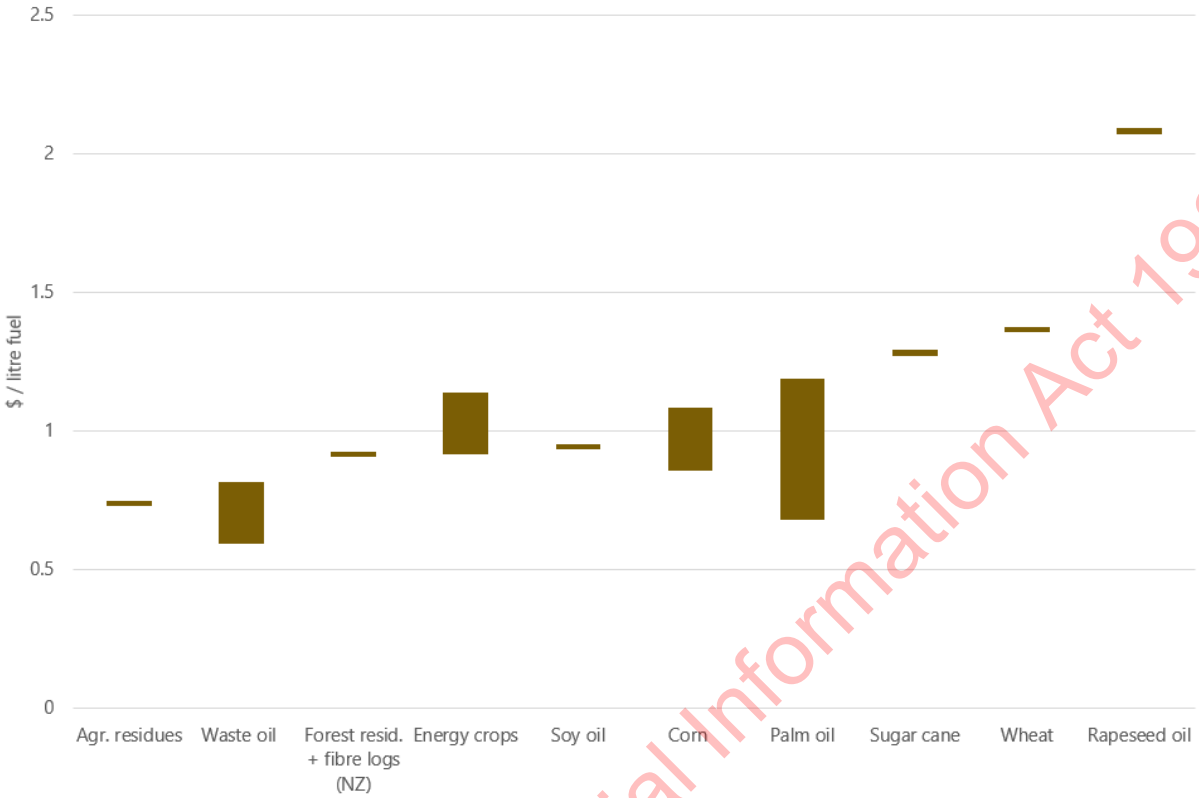
- improvements through learning and scaling up commercial rollout of various advanced pathways, and
- relatively cheaper feedstock for advanced biofuels from waste compared to conventional biofuels (see Figure 17).[50] This is important, because feedstock costs tend to be the greatest contributor to production costs, accounting for 40%-70% of total production costs (Appendix I).

[48] Note these numbers are simply the ratio between investment cost and output. They are not part of a discounted cash flow modelling used to estimate levelised (i.e. production) costs.

[49] (Festel, et al., 2013) find that some advanced biofuels can become competitive even at USD 50/bbl. IRENA however note that the competitiveness threshold is USD 100/bbl, and that under USD 80/bbl advanced biofuels are unlikely to compete with fossil fuels (IRENA, 2016).

[50] The figure shows old projection of costs – it is the relatively of different feedstock costs that is relevant here.

Figure 17 – Relative feedstock costs

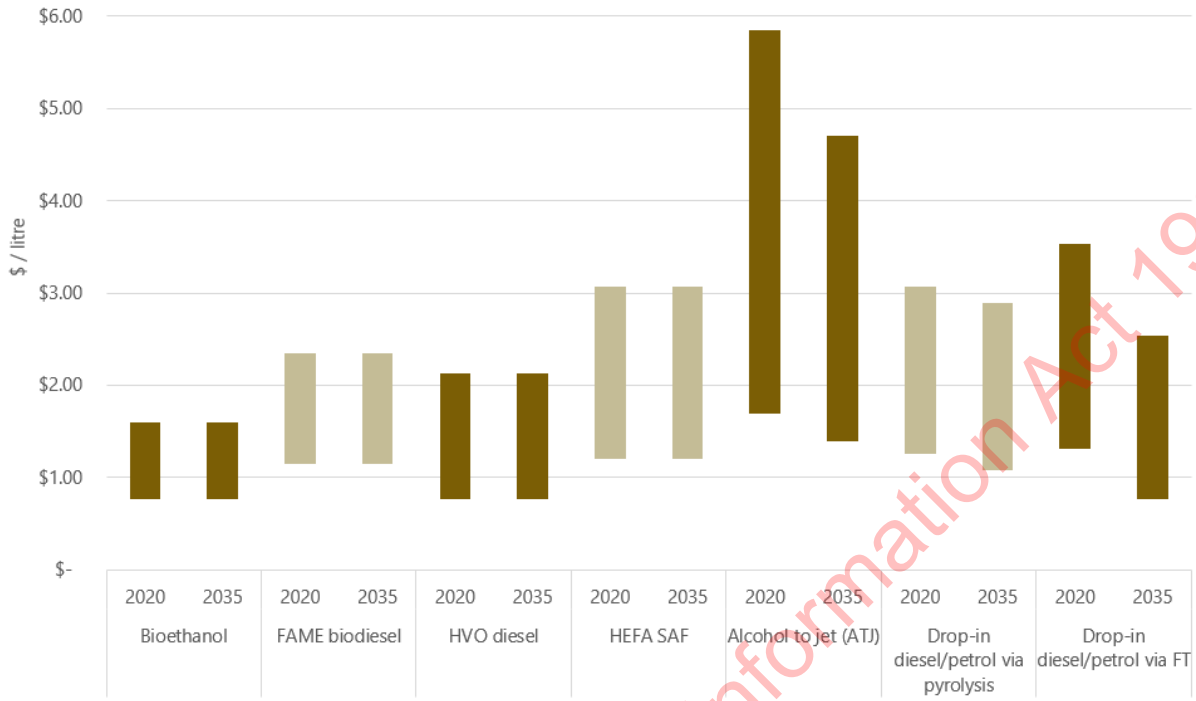


Source: (Festel, et al., 2013), (Pavlenko, et al., 2019), (Suckling, et al., 2018). For some feedstocks, a single datapoint was available.

It is also worth noting that historic price fluctuations have been higher for food feedstocks than for lignocellulosic feedstocks. For example, although soybean oil, sugar and wheat have fluctuated considerably since 2003, the same price for biomass such as hardwood log has been more stable (Appendix G). The supply of renderable animal material is not surprisingly a function of the status of the livestock industry. Consequently, it is subject to the corresponding short term seasonal-fluctuations that can also be observed from historical prices (Appendix G).

As a result of the two factors above, it is expected that the gap between total production costs of advanced and conventional biofuels will continue to narrow through to 2035 (Figure 18).

Figure 18 – Biofuel production costs



Source: (IRENA, 2016), (Pavlenko, et al., 2019), (IEA, 2017), (Maniatis, et al., 2017), (Suckling, et al., 2018)

The EU refining industry also expects a significant scale-up of advanced biofuel production, particularly from 2035, with lignocellulosic-based biofuels having a significant share of total biofuel production, increasing from 4 Mtoe in 2030 to about 75 Mtoe in 2050. The industry expects European HVO production to increase two-fold over the next decade (from 5 Mtoe to 10 Mtoe), but it will be dwarfed by lignocellulosic biofuels over the longer term.

It will also be driven by the imperative to accelerate emissions reductions from transport

IEA's Sustainable Development Scenario (SDS) outlines the major transformations that need to occur across the global energy system to achieve Sustainable Development Goals. The scenario is aligned with the Paris Agreement,[51] and provides a benchmark that can be used to assess current transformations are on track for achieving emissions reduction targets (amongst other sustainable development goals).

IEA's latest assessment is that the global biofuel production is not on track to meet its 2030 SDS target, with current levels need to almost triple over the next decade (IEA, 2020b). As mentioned previously, one of the factors explaining biofuel production shortfall in the EU and US is the blending

[51] The SDS holds the temperature rise to below 1.8 °C above pre-industrial levels, with a 66% probability without reliance on global net-negative CO2 emissions https://www.iea.org/reports/world-energy-model/sustainable-development-scenario

wall for conventional biofuels. Without higher biofuel blend rates or greater use of drop-in fuels, biofuel consumption is set to fall (IEA, 2020b).

Furthermore, current biofuel consumption is minimal in both aviation and international shipping. In 2018, aviation biofuel production of 15 million litres represented less than 0.01% of aviation fuel demand (IEA, 2020b). Under IEA's SDS however, biofuel consumption needs to increase to 7% and 9% of 2030 fuel demand in the aviation and shipping industry respectively.

Although the investment landscape for biofuels is challenging, policy interest remains strong particularly in

- Europe, where the Renewable Energy Directive set a 3.5% target (in terms of total energy consumed) for novel advanced biofuels by 2030. As mentioned previously, demand for advanced biofuels is supported by the double-counting rule where the energy content of these biofuels can count twice towards the member state mandates.
- The United States under the Renewable Fuel Standard and California Low-Carbon Fuel Standard, and
- India, which in 2018 pledged fiscal and investment support for advanced biofuels, with a target to develop 12 commercial-scale plants (IEA, 2020b).

Overall, there is no getting away from the fact that – due to their blend walls (even though they are increasing) – emissions reduction from conventional biofuels are (softly) capped. The EU and US are expected to lead the way in advanced biofuel production to overcome the blend limits that they have reached, which are now limiting the potential for further emissions reduction gains from biofuels.

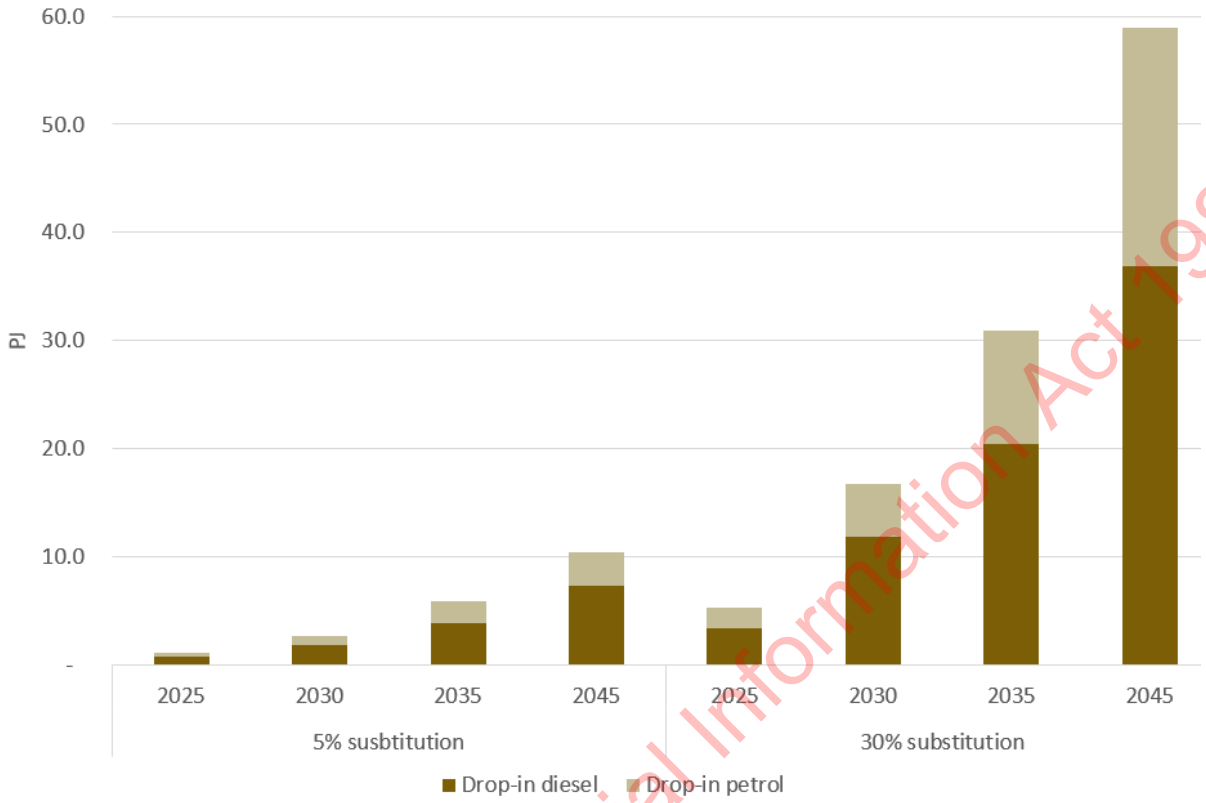
Although it is impossible to predict the rate at which the global advanced biofuel sector will expand in the second half of this decade, there are strong signals that the direction is upwards. This means that competition for advanced biofuel feedstocks will increase.

New Zealand could follow the trend of increased production of advanced biofuels from 2025, but will be exposed to global competition for biomass feedstock

Scion estimates that New Zealand has sufficient feedstock to substitute 30% and even 50% of 2015 transport energy demand (Suckling, et al., 2018) by 2050, with the predominant feedstocks being energy crops (if arable land is used), forest residues and fibre logs. We note that Scion's analysis abstracts from possible net trade impacts on domestically available biomass supply and final biofuel product. However it is possible that, as global competition for biomass feedstock and advanced biofuel increases, some of these could be redirected to export markets.

Figure 19 below shows the potential energy that could be produced from domestic feedstocks. These estimates are solely based on possible feedstock production rates on arable land only, i.e. fibre logs from existing, new and energy forests, as well as forest residues. Two estimates are provided: for 5% and 30% substitution by 2050 of fossil fuels consumed in 2015.

Figure 19 – Potential biofuel energy that could be produced from domestic feedstocks (arable land only)



Source: Sapere analysis based on possible production of biofuel litres as per (Suckling, et al., 2018), using energy conversion assumptions from Appendix E.

The 30% substitution scenario would require considerable output being available by 2025. However, given the technological challenges discussed previously, we think this ramp-up over the next five years is unlikely. A slow start from 2025 is more plausible. Scion's estimates of biomass resources in their 5% substation scenario suggest that there is enough feedstock available to produce around 22.1 million litres of drop-in diesel and 17.1 million of drop-in petrol in 2025.[52] From a technical perspective, this production capacity is plausible. (BioPacific Partners, 2020) note that a number of demonstration projects have already been completed for biocrude and liquid fuel production,[53] and suggest that a production capacity of 75 mlpa[54] and 57 mlpa for biocrude and liquid fuels respectively could be possible over the next 5-10 years. On this basis, we assume that Scion's estimated 2025 output in the 5% substitution scenario is possible.

Starting with 2025, we investigate two scenarios of advanced biofuel production from biomass as described below.

- The **progressive** production scenario assumes (i) an average 15% reduction in drop-in fuel production costs over this period, and (ii) a (low-end) learning curve of 5% for drop-in fuel

[52] Note these values are approximate based on the charts in (Suckling, et al., 2018).
[53] This corresponds to TRL 8 in Figure 3
[54] mlpa = million litres per annum

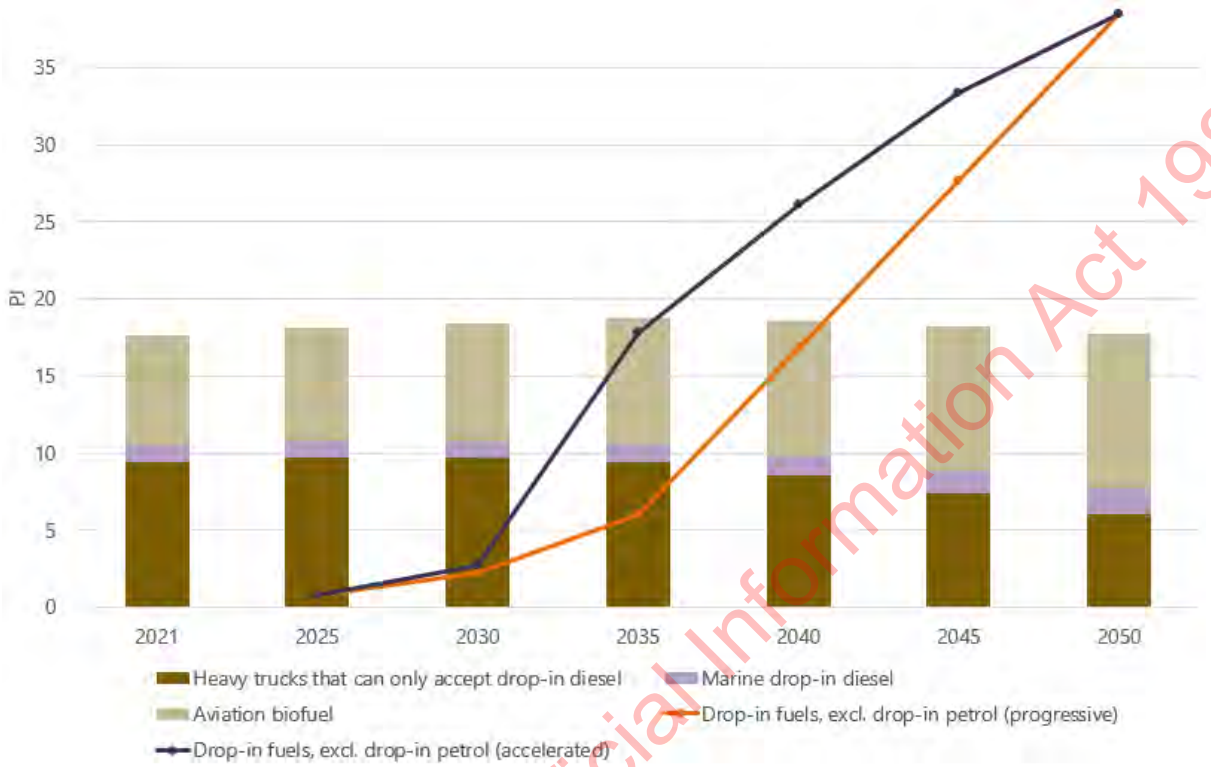
conversion technologies based on (IEA Bioenergy, 2020), where this learning curve measures the production cost reduction at each doubling of cumulative production capacity. Based on the assumptions, between 2025 and 2035 output of advanced biofuels increases by a factor of 8. From 2035, output accelerates (see Figure 20). This is consistent with analysis by (FuelsEurope, 2020), which suggests that significant growth of lignocellulosic-based biofuels is expected beyond 2035 (Appendix K).

- The **accelerated** production scenario assumes that the 2035 volumes in Scion's 30% substitution scenario can be achieved from a technical perspective. These volumes imply that the output between 2025 and 2035 can increase by a factor of 23. Assuming a 5% learning curve as above, this scenario implies a production cost reduction of 21% and a doubling of capacity six times over this period. We think this is very ambitious, particularly given that a number of other factors will also affect the ramp-up, such as feedstock supply availability and lead-time required to add new infrastructure. We include this scenario to gain the following insights: (i) the upper boundary of output and (ii) the time lag between an ambitious and a more realistic scenario.

Figure 20 overlays previous estimates of potential demand for biodiesel and drop-in fuels (excl. drop-in petrol) with potential supply of these fuels in the progressive and accelerated supply scenarios.[55] The figure shows that between 2030 and 2040, assumptions on technology uptake significantly affect the extent to which local production of these drop-in fuels from biomass can satisfy demand, and as a result, the emissions reduction potential from these fuels. In the progressive scenario, it takes approximately five years longer to achieve the same cumulative emissions reductions that are achieved by 2035 in the accelerated scenario.

[55] It is worth noting that the supply on an energy basis was estimated based on Scion results presented in terms of million litres of drop-in petrol and drop-in diesel, and using the energy intensity conversions from Appendix E.

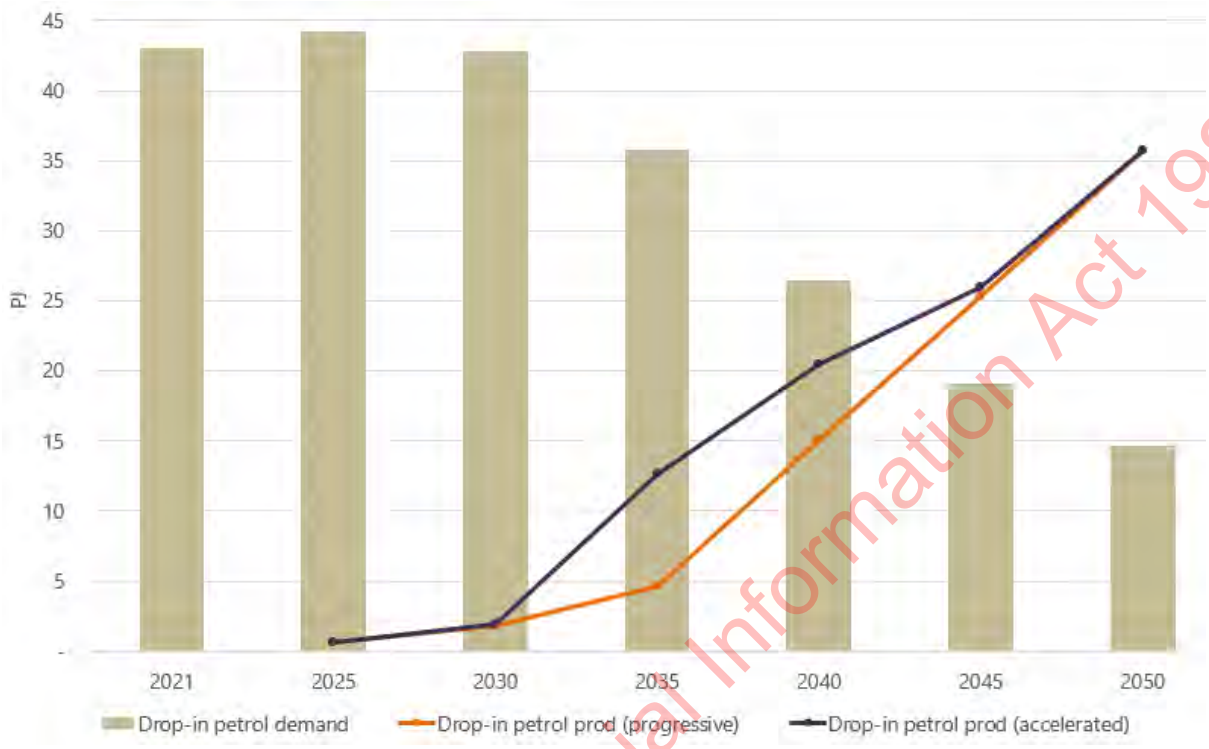
Figure 20 – Comparison of maximum drop-in fuel demand and supply volumes (excl. drop-in petrol), biomass feedstock from non-arable land



Source: Sapere analysis

Drop-in diesel production also results in co-production of drop-in petrol if pyrolysis oil upgrade pathway is used (as per (Suckling, et al., 2018)). The figure below overlays our estimates of potential demand for bioethanol with potential supply of drop-in petrol in the progressive and accelerated scenarios. The figure suggests that over the next decade, potential local production of drop-in petrol would only meet a small fraction of potential demand, with significant variation depending on assumptions on technology maturation.

Figure 21 – Comparison of maximum drop-in petrol demand and supply volumes, biomass feedstock from non-arable land



Source: Sapere analysis

What is a possible emissions reduction scenario for New Zealand?

Summary

This chapter investigates potential biofuel uptake under two scenarios: progressive and accelerated. The uptake estimates represent the intersection of demand and supply described in previous chapters, and reflect assumptions on feedstock availability, fuel compatibility and technology maturity. In reality, many other factors can affect actual uptake, the interaction of which can be complex and is not analysed here. These factors include: trade-offs among alternative fuels that could be used to de-carbonise transport, alternative uses of biofuel feedstock in other local industries, impacts from global competition on local feedstock supply, demand response to higher total ownership costs.

Scenario overview

- 2021-2025: conventional biofuels are primarily used in similar volumes in both scenarios. These comprise imported bioethanol and locally produced biodiesel from tallow. Bioethanol is only used to de-carbonise the light vehicle fleet, and is imported primarily from Australia, where it is produced from starch-containing grains and agricultural residues.
- 2025-2030: HEFA and biomass-based drop-in aviation fuels start to be used in the aviation industry in both scenarios. In the accelerated scenario, some drop-in diesel is also being used by heavy trucks. Drop-in petrol starts being used by light vehicles, but to a lesser extent in the progressive scenario.
- 2030-2035: Use of drop-in fuels gradually ramps up in the progressive scenario and scales exponentially in the accelerated scenario.
- Beyond 2035: drop-in diesel starts being used in shipping from 2035 and from 2040 in the accelerated and progressive uptake scenarios respectively. Drop-in fuel production in the progressive scenario catches up with that in the accelerated scenario beyond 2040.

Volume uptake

- Total biofuel uptake could increase from 0.88 PJ (28.38 million litres) in 2022, to 8-11 PJ (257-335 million litres) by 2030, with a maximum output beyond 2040 of 43 PJ p.a. (approx. 1280 million litres p. a.).
- The share of drop-in fuels (including renewable diesel/aviation fuel) out of total biofuels could increase from zero in 2024 to 65%-73% and 95% in 2030 and 2050 respectively.
- By 2030, drop-in fuel output could reach 167-246 million litres p.a., of which 120 -198 million litres p.a. would be from biomass feedstock.

Lifecycle emissions reductions

- Emissions reductions through to 2024 are small (-0.4% p.a. in either scenario) due to low blending limits and limited supply of conventional biofuels. By 2030, emissions reductions of 3.8%-5.4% p.a. can be achieved through increased drop-in fuel uptake (including renewable diesel/aviation fuel). Emissions savings can increase to 9%-21% p.a. by 2035, and 38% p.a. by 2050.

Capital costs

- To achieve these emissions reductions, significant capital investments would be required. Through to 2025, the average investment cost p.a. would be between $39 and $93 million in either scenario, primarily to scale-up production of biodiesel and renewable aviation fuel (HEFA). Over the 2026-2030 and 2031-2035 periods, additional investment costs of $51-$116 and $115-$254 million p.a. respectively would be required in the progressive scenario. In the accelerated scenario, the additional investments required would be double and four-times higher than the estimates in the progressive scenario over the two periods respectively. Beyond 2036, the relative trend in new capital costs is reversed between the two scenarios, such that more incremental investments are required on average per annum under the progressive scenario, as new production capacity is added.

In this section, we combine the previous analysis on potential demand and supply of biofuels, in order to develop two scenarios of biofuels uptake in NZ transport. In developing the scenario, we make the following assumptions:

- A maximum of 40 million litres (1.34 PPJ) of biodiesel can be produced from local tallow feedstock,[56] and another 500,000 litres of biodiesel is produced from used cooking oil. Biodiesel is used in marine (up to B5) and heavy trucks (B5, B7, B20 and B30).
- Residual tallow feedstock is used to produce HEFA for aviation (, so that a maximum of 80% of total tallow supply is used for biofuel production. It is blended at 50%.
- Most of bioethanol demand is met by imports from 2030 (only 0.13 PJ are produced locally). Imports are from Australia and represent 50% of Australia's exports of 1.8 PJ. Import volumes are gradually scaled up starting with 2022. Bioethanol feedstocks are dominated by corn and agricultural residues. Biofuels from these crops can deliver an average of 44% reduction in emissions for neat fuels on a lifecycle basis, or 4.4% for E10 fuels.
- Biomass drop-in fuels are blended at a 50% limit, and are used in all modes of transport to meet residual demand (i.e. net of demand for conventional biofuels and renewable diesel). On a lifecycle basis, the emissions reduction potential for neat drop-in fuels is 78%, or 39% for the final fuel with a 50% blend.
- As more drop-in diesel is being produced, biodiesel is phased-out as follows:
    - Progressive scenario: complete phase-out takes places in 2035 and 2040 for heavy trucks and shipping respectively.
    - Accelerated scenario: complete phase-out takes place in 2035 for both heavy trucks and shipping.

The resulting uptake volumes are shown in Figure 22 and Figure 23 for the progressive and accelerated scenarios (see Appendix P for data tables). Key findings:

[56] This reflects the capacity at which Z Energy's biodiesel plant could be easily scaled up.

- In the progressive scenario, total biofuel uptake increases from 0.88 PJ (28.38 million litres) p.a. in 2022 to 8.06 (256.5 million litres) p.a. by 2030, reaching a maximum output of 43.14 PJ (1,287.2 million litres) p.a. by 2043. The share of drop-in fuels (including renewable diesel/aviation fuel) out of total biofuels increases from zero in 2024 to 65% and 95% in 2030 and 2050 respectively. In 2030, drop-in fuel output is 166.85 million litres, of which 120 million litres (72%) are from biomass feedstock.
- In the accelerated scenario, total biofuel uptake increases from 0.88 PJ (28.38 million litres) p.a. in 2022 to 10.74 PJ p.a. (335 million litres) p.a. by 2030, reaching a maximum output of 42.54 PJ (1,270 million litres) p.a. by 2040. The share of drop-in fuels (including renewable diesel/aviation fuel) out of total biofuels increases from zero in 2024 to 73% and 96% in 2030 and 2050 respectively, In 2030, drop-in fuel output (including renewable diesel/aviation fuel) is 245.52 million litres, of which 198 million litres (80%) are from biomass feedstock.
- Output reduction beyond 2040 reflects declining demand from road transport due to increased electrification, particular of light vehicles.

Figure 22 – Domestic uptake scenario for biofuels (progressive)

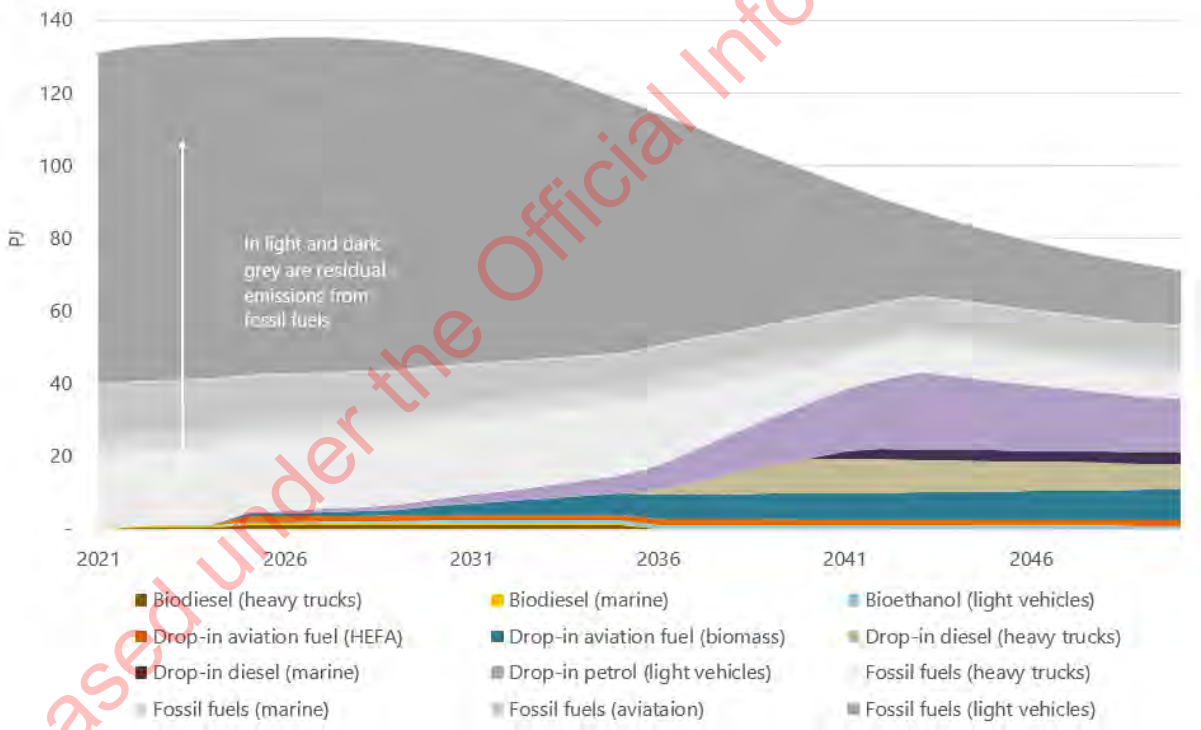
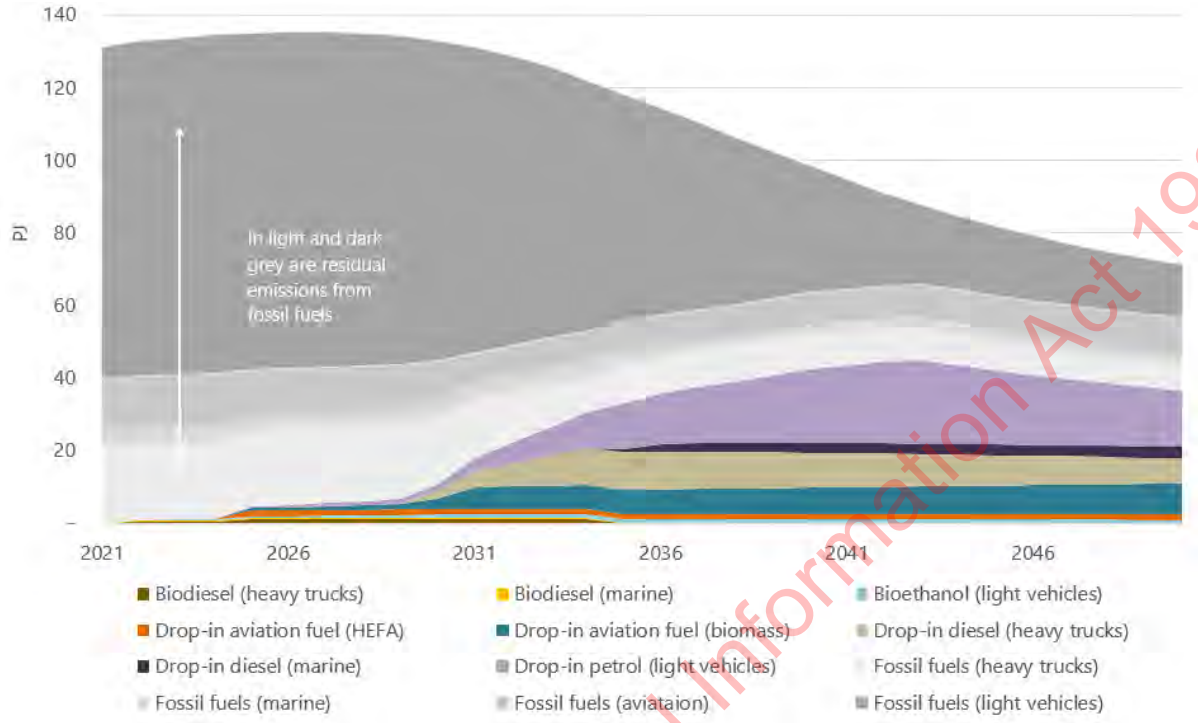


Figure 23 – Domestic uptake scenario for biofuels (accelerated)



Source: Sapere analysis

Figure 24 and Figure 25 illustrate the emissions reduction potential associated with the progressive and accelerated uptake scenarios respectively. Detailed emissions reduction value in ktCO2e are presented in Appendix Q. Figure 26 provides a summary.

We find that the emissions reduction potential over the next five year is small in either scenario: -2% p.a. in 2025 compared to fossil fuel consumption by light vehicles, heavy diesel trucks, domestic navigation and aviation taken all together. This is mainly due to the blending walls applied to conventional biofuels which dominate biofuels uptake through to 2040. By 2030, annual emissions reductions increase to -3.8% and -5.4% p.a. in the progressive and accelerated scenarios respectively. This is due to increased HEFA production for aviation and growing uptake of domestically produced drop-in fuels from biomass. As drop-in fuels uptake continues to grow, annual emissions savings reach 8.6% in 2035 and 26.6% in 2040 in the progressive scenario, and 21% in 2035 and 33% in 2040 in the accelerated scenario. By 2050, annual emissions savings in both scenarios converge to 38%. Most of the emissions reduction is from the use of drop-in petrol for light vehicles, followed by drop-in diesel used for heavy trucks and aviation.

Figure 26 shows that in terms of absolute emissions reductions (in ktCO2e), the progressive uptake scenario lags behind the accelerated uptake scenario by about 5 years. The scenarios start to converge after 2040 for two main reasons (i) convergence of technology maturity in both scenarios, and (ii) lower demand for drop-in petrol from light vehicles due to their increased electrification.

We note that the estimates for emissions reduction from drop-in fuels are based on a concentration limit of 50% for drop-in fuels. However, it is likely that as new engines and fuel standards are

developed, this limit will be increased or lifted for more uses over the next decade. This means that the emissions reduction potential could even greater.

Figure 24 – Annual lifecycle emissions reduction potential in the progressive uptake scenario

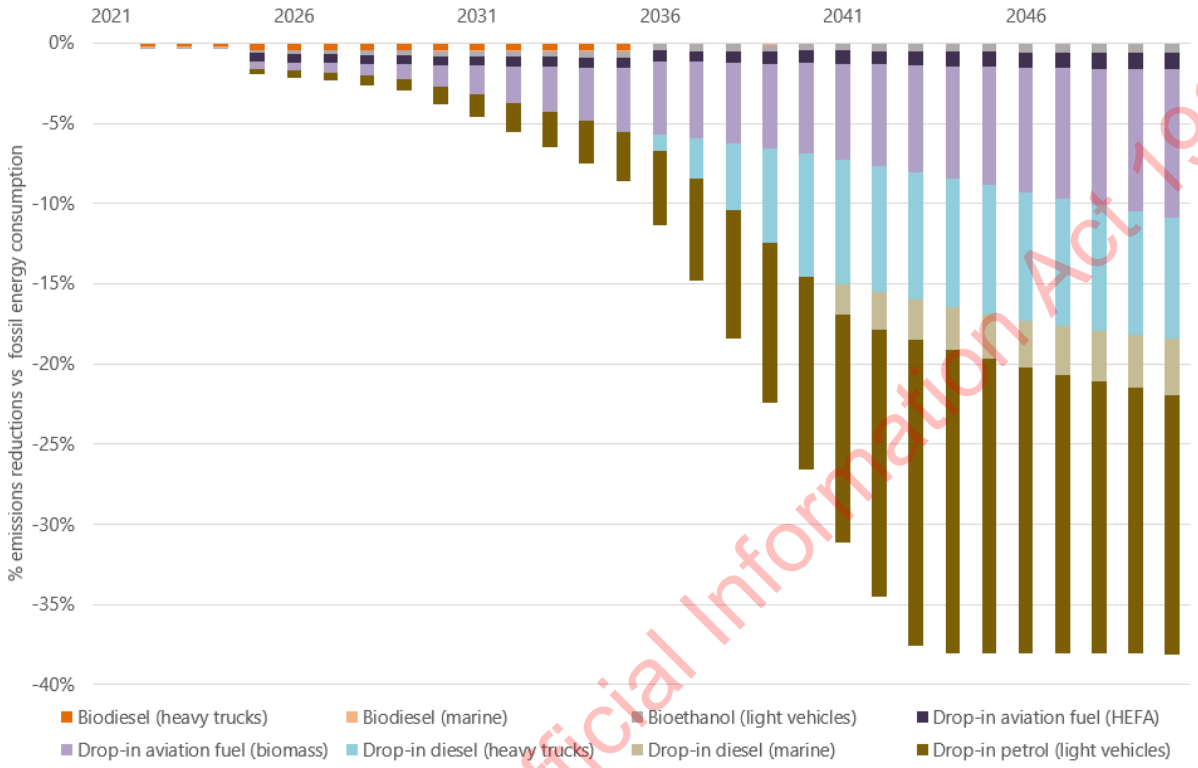
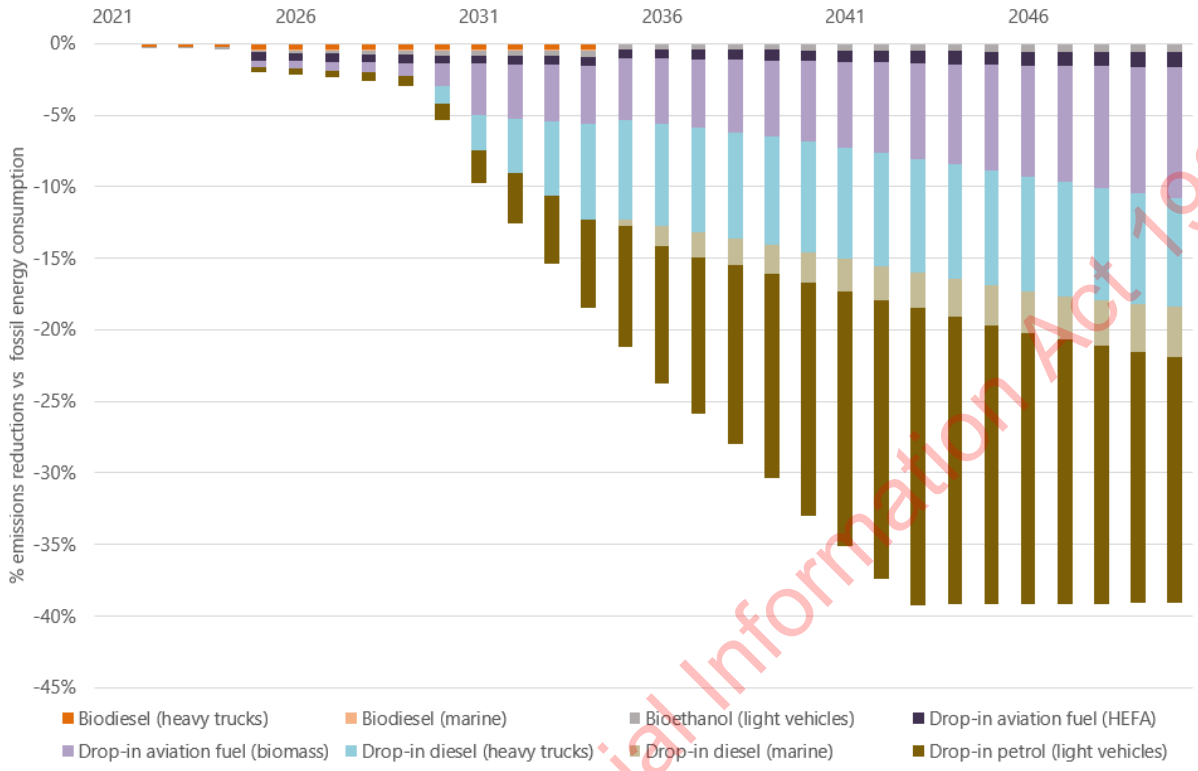
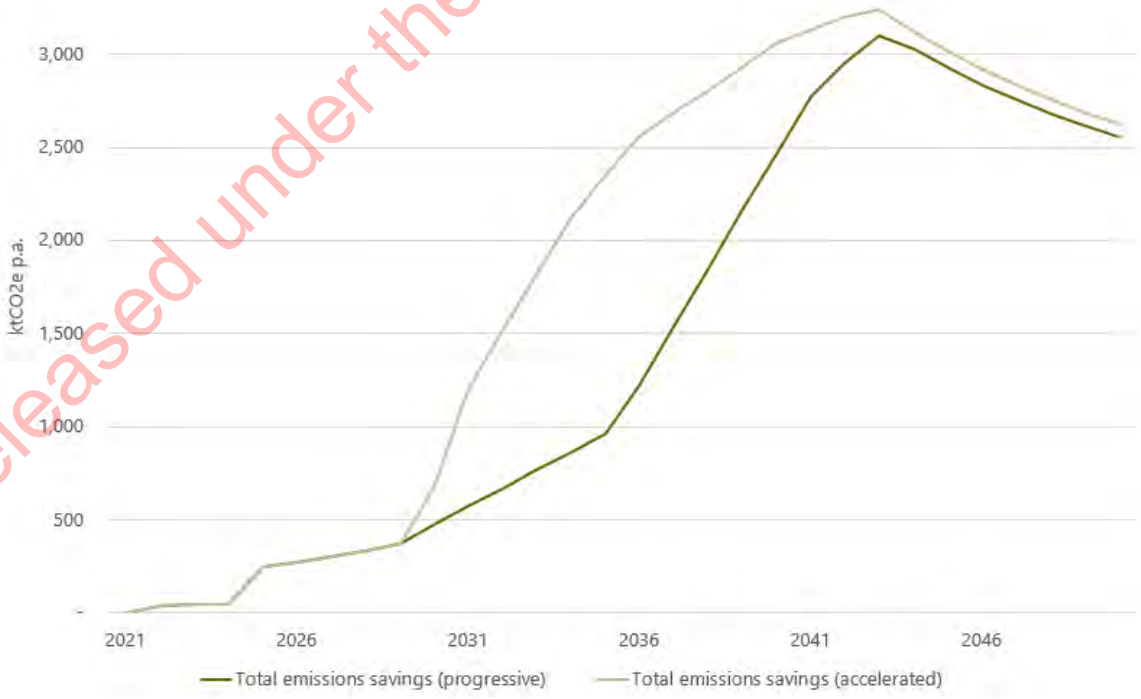


Figure 25 – Annual lifecycle emissions reduction potential in the accelerated uptake scenario



Source: Sapere analysis

Figure 26 – Comparison of annual lifecycle emissions reductions in progressive and accelerated scenarios

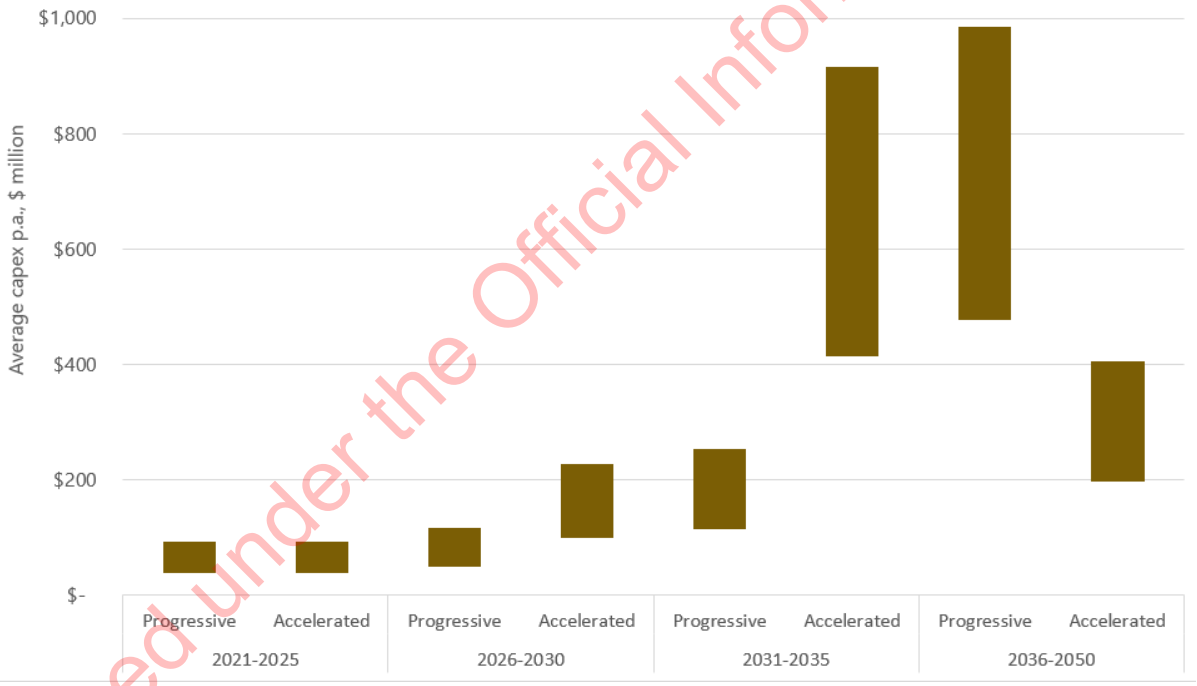


Source: Sapere analysis

To achieve these emissions reductions, significant capital investments would need to be made in either scenario. Table 1 and Table 2 provide the estimates based on minimum and maximum capital cost values observed in the literature, accounting for the technology learning curves for advanced biofuels through to 2035. The detailed capital costs are provided in Appendix J. The table shows that the average investment cost required over the next five years is similar between the two scenarios, between $39-$93 million p.a. primarily to scale-up production of biodiesel and renewable aviation fuel (HEFA).

Between 2026 and 2035, the capital investments that would be required under the accelerated scenario are much higher than those under the progressive uptake scenario, reflecting an accelerated production scale-up. Over the 2026-2030 and 2031-2035 periods, the average annual investments under the accelerated scenario are double and four-times larger than those under the progressive scenario over the respective periods. Beyond 2036, the relative trend in new capital investment reversed, with more incremental capital costs required on average per annum under the progressive scenario, as new production capacity is added.

Figure 27 – Average capex p.a. in the progressive and accelerated uptakes scenarios



Source: Sapere analysis

Table 1 – Capital costs required to achieve the domestic uptake scenario (undiscounted $ million), progressive uptake scenario

Fuel produced		2021-2025		2026-2030		2031-2035		2036-2050	
		Min	Max	Min	Max	Min	Max	Min	max
Biodiesel	Total in period	$31	$34						

Fuel produced		2021-2025		2026-2030		2031-2035		2036-2050	
		Min	Max	Min	Max	Min	Max	Min	max
	Avg. p.a.	$6	$7						
HEFA	Total in period	$32	$120						
	Avg. p.a.	$6	$24						
Drop-in fuels (biomass)	Total in period	$130	$313	$253	$582	$576	$1,269	$2,390	$4,924
	Avg. p.a.	$26	$63	$51	$116	$115	$254	$478	$985
Total fuels	**Total in period**	**$194**	**$467**	**$253**	**$582**	**$576**	**$1,269**	**$2,390**	**$4,924**
	Avg. p.a.	**$39**	**$93**	**$51**	**$116**	**$115**	**$254**	**$478**	**$985**

Table 2 – Capital costs required to achieve the domestic uptake scenario (undiscounted $ million), accelerated uptake scenario

Fuel produced		2021-2025		2026-2030		2031-2035		2036-2050	
		Min	Max	Min	Max	Min	Max	Min	max
Biodiesel	Total in period	$31	$34						
	Avg. p.a.	$6	$7						
HEFA	Total in period	$32	$120						
	Avg. p.a.	$6	$24						
Drop-in fuels (biomass)	Total in period	$130	$313	$496	$1,135	$2,073	$4,577	$982	$2,033
	Avg. p.a.	$26	$63	$99	$227	$415	$915	$196	407
Total fuels	**Total in period**	**$194**	**$467**	**$496**	**$1,135**	**$2,073**	**$4,577**	**$982**	**$2,033**
	Avg. p.a.	**$39**	**$93**	**$99**	**$227**	**$415**	**$915**	**$196**	**$407**

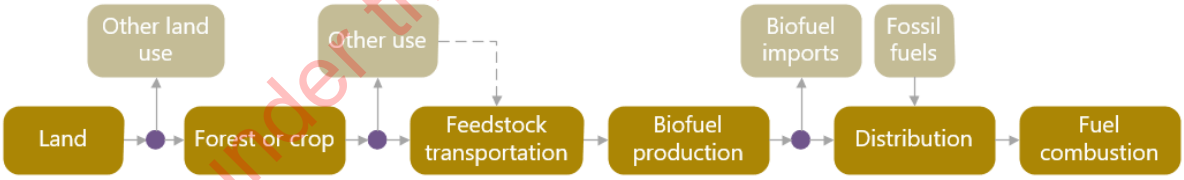
Source: Sapere analysis

What key issues emerge when the full biofuel chain value is considered?

- Biofuel supply chains are complex, and require integration across the agricultural/forestry, biofuel and conventional oil supply chain. The feedstock, conversion process, final fuel specifications, and the engines envisioned for transportation are highly interdependent and must be considered as a system. Furthermore, the different demands of the customers, engine manufacturers and energy companies must be aligned. All of these issues require clear policy direction.
- In New Zealand, there are also opportunities for biofuel production to replace existing uses of land, particularly where farming is economically challenging. However, demand for biomass for transport biofuel production is likely to compete with biomass demand from other sectors, e.g. process heat.
- For advanced biofuels, it could make sense to have a distributed network of processing plants located closer to where the feedstock is grown, with the high-density intermediate being subsequently transported to more centralised plants for conversion into final fuels (Suckling, et al., 2018).
- In terms of fuel distribution, biodiesel and bioethanol need separate infrastructure for blending and transport to retail points. Drop-in fuels could be used with the existing petroleum infrastructure.

Biofuel supply chains can be significantly more complex than those for conventional diesel as they require integration across the agricultural/forestry, biofuel and conventional oil supply chain.

Figure 28 – Biofuel value chain



Source: based on (Suckling, et al., 2018)

Figure 28 shows that other land and other feedstock uses are the first two checkpoints along the biofuel value chain. In New Zealand, opportunities exist for biofuel production to replace existing uses of land, particularly where farming is economically challenging. For example, dry-stock land owners in the relatively inexpensive and flat lands of the East Coast and Northland have been looking for more profitable alternativities to sheep and cattle (Suckling, et al., 2018). However, demand for biomass for transport biofuel production is likely to also compete with biomass demand from other sectors, particularly where such feedstock already has existing uses. For example, the pulp and paper and

panel-board industries could be significantly affected in the near term if fibre logs are diverted away from these industries where it is used as primary energy.[57]

There will also be competition for agricultural and forest residues that could otherwise be used to de-carbonise process heat. Scion estimated that, overall for New Zealand, the energy potential of 18.8 PJ from biomass residues falls short of the total demand for coal used for process heat, which was 24 PJ in 2016 (Hall, 2017). However, the balance between biomass supply and coal demand varies widely across regions. For example, the East Coast has a substantial wood residue resource and almost no coal demand. By contrast, Waikato's coal demand is well in excess of its residual biomass supply. Although there is potential for regional movements to correct for these imbalances, there will be cases where biomass for process heat will be uneconomic due to long transport distances for biomass. Such cases could lend themselves to transport biofuel production.

For advanced biofuels, production plants can be on a much smaller scale, often nearer feedstock supply points. Scion's 2018 biofuels roadmap states that it may make economic sense to do the initial stages of biomass processing (such as drying, pelletising or pyrolysis) at smaller plants located close to where the feedstock is grown. The higher-density intermediate would then be transported to a larger centralised plant for conversion into the final fuel. Of course, the resulting transport cost savings would need to be balanced against the additional processing costs, and the extent to which economies of scale can reduce conversion costs by building larger plants (Suckling, et al., 2018).

Another issue is the production of hydrogen that is required for advanced biofuel pathways. Although hydrogen can be generated from the biomass feedstock itself, the process is inefficient compared to sourcing hydrogen from an external source. The hydrogen requirement represents a large proportion of both capital and operating expenses in a stand-alone facility. (Jones, et al., 2009) estimated that sourcing hydrogen from an oil refinery can reduce the capex and opex of a pyrolysis drop-in fuel by 40% and 15% respectively. Hydrogen is also required for gasification processes to enrich the syngas. Although hydrogen is typically produced from the syngas itself by a process known as the "water-gas shift" reaction, this reaction consumes feedstock carbon, reducing the biomass-to-fuel yields. An alternative option would be to obtain hydrogen from an external source.

As well as potential hydrogen supply, the refinery's role along the biofuel value chain could also include co-processing of biocrudes. However, this has significant technical challenges particularly for high proportions of biocrudes, including due to the high acidity and water content of these products. Another issue is that co-processing would require adapting the catalyst design, which is yet to be commercially proven (Karatzos, et al., 2014). Nevertheless, globally refineries has shown increasing interest in oil upgrading pathways, and the co-processing of biocrude along with fossil-based crude is being actively considered (BioPacific Partners, 2020).

The discussions above clearly indicate that introducing biofuels intro transportation supply chains requires decisions over where and how existing infrastructure and biofuel supply chains can join (e.g. at refinery, marine terminal, inland depot, retail points). The feedstock, conversion process, final fuel

[57] Over the long-term, the nature of primary energy inputs in the industry will reflect the way in which the industry responds to changes in consumer preference, e.g. switch to more bio-degradable options, increased paper recycling etc.

specifications, and the engines envisioned for transportation are highly interdependent and must be considered as a system if an optimal process is to be identified. Accurate feedstock characterization (including both composition and variability) is essential given that this is an upstream boundary condition for the entire subsequent fuel-conversion process (Sandia National Laboratories, 2009).[58]

For bioethanol and biodiesel in particular, integration into existing distribution infrastructure is problematic due to the unfavourable chemical properties of these fuels as discussed previously. They need to be blended through separate distribution channels, and transported via trucks or ships instead of existing pipelines. Before introducing or scaling-up the use of these fuels, existing systems must be checked in terms of construction materials, their interfaces (for corrosion), and glands seals and valves.[59]

Existing fossil fuel distributors already have a substantial distribution infrastructure, so it would make sense to use this for drop-in biodiesel distribution. A potentially attractive way to transport these fuels would be to use existing coastal shipping network and fuel distribution terminals, as well as rail transport in some cases.

A final important checkpoint along the value chain is the intersection of demands by the customer, original equipment manufacturers and fuel suppliers (Table 3).

Table 3 – Requirements and concerns of customers, original equipment manufacturers and fuel suppliers

Customer demands	OEM demands	Fuel supplier demands
Performance Fuel economy Fuel and vehicle cost Reliability Fuel availability Fuel odour Convenience	Competitive, yet profitable Emissions criteria Fuel economy standards Customer satisfaction Service intervals Warrantee issues	Fungibility Feedstock availability End-product stability Transportation and pipeline issues

Source: (Sandia National Laboratories, 2009)

Current vehicles are highly optimised systems, and they need to meet simultaneous requirements. Customers demand performance, fuel economy and affordability. Engine manufacturers must provide for long-service intervals and warranties. Fuel suppliers must deliver fungible fuels that comply with existing standards. Aligning these demands does not happen overnight. They require clear policy direction and regulatory support to influence consumer choices, promote OEM innovation, attract state-of-the-art technology, and allow fuel suppliers to prepare for a shift in the market.

[58] https://www.liquidbiofuels.org.nz/documents/resource/Report-BioFuels7-19V5.pdf

[59] Mild and stainless steel, aluminium, Teflon and fibreglass are all considered acceptable materials of construction for handling biofuels, whereas copper, bronze, tin and zinc may lead to corrosion and sedimentation.

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Appendix A Defining conventional vs advanced biofuels

Transport biofuels typically refer to liquid and gaseous fuels produced from biomass, and are commonly classified as conventional or advanced biofuels. Although there are generally four factors by which biofuels are determined as conventional or advanced, there is no standard definition that covers all these aspects, leading to differences in definitions (IRENA, 2016). These factors are:

- Conversion technologies deployed at commercial scale are referred to as conventional, whereas advanced biofuels are associated with less **mature technologies** that are in the earlier development or deployment stages.
- The focus on the **type of feedstock** is to determine potential competition with food or feed production. Conventional biofuels are those produced from feedstock that could be used for food or feed, whereas advanced biofuels are produced from agricultural and forestry residues, and organic waste, non-food/feed energy crops.

  There is an area of ambiguity for energy crops, used cooking oil (UCO), animal fats, and tall oil feedstocks. Some energy crops can compete with food / feed crops for land and water. Furthermore, animal fats and UCO are widely used with well-established conversion technologies, which means they often don't qualify as feedstocks for advanced biofuels.
- Achieving higher **GHG emissions reduction** is usually associated with advanced biofuels.
- The **product type and quality** can also significantly differ. Advanced biofuels are seen as more similar to fossil diesel, bunker and jet fuels ("drop-in" fuels), and can either blended in high proportions or used neat. Conventional biofuels are chemically different from fossil variants, creating compatibility issues with engines and infrastructures. This restricts them to relatively low blends.

Appendix B Biodiesel engine compatibility issues

Biodiesel (FAME)

The physical and chemical properties of FAME depend on the type of feedstock used, production process, and quality control, which affect the fuel's cold flow, volatility, cetane number and resistance to oxidation. Generally, the advantages of FAME biodiesel are good cetane number,[60] no aromatics and low sulphur. It is also thought to enhance the lubricity of conventional diesel fuel and reduce exhaust gas particulate matter. However, FAME loses its lubricity over a long period of time due to oxidation of unsaturated molecules present in the fuel and increased water from moisture absorption (IEA-AMF, 2020).

Engine manufacturers have been concerned with introducing biodiesel into the markets, especially at high blending rates. This is due to the following FAME biodiesel properties, a lot of which are caused by the high oxygen content imparting polar and hydrophilic:[61]

- It is less stable than conventional diesel fuel, which requires greater precaution to avoid problems linked to the presence of oxidation products in the fuel. There is some evidence that the problem can be exacerbated when the fuel is blended with ultra-low sulphur diesel fuels.
- It requires special care at low temperatures to avoid excessive viscosity and loss of fluidity. To alleviate this problem, additives may be required.
- Deposit formation in the fuel injection system may be higher with biodiesel blends than with conventional diesel fuel, so deposit control additive treatments are advised.
- At low temperatures, FAME can produce precipitated solids above the cloud point, which can cause filterability issues.[62]
- It can negatively affect natural and nitrile rubber seals in fuel systems. Metals such as brass, bronze copper, lead and zinc may oxidise from contact with biodiesel, and create sediments. Switching from conventional diesel to biodiesel may significantly increase tank sediments due to biodiesel's higher polarity, and these sediments can plug fuel filters. Fuel-system parts must therefore be specially chosen for their compatibility with biodiesel.
- Biodiesel fuel that comes into contact with the vehicle's shell may be able to dissolve the paint coatings used to protect external surfaces.

[60] It should be noted that high cetane number is not preferable in marine gasoil/diesel as for road transport (Wood Mackenzie, 2010)

[61] The summary of issues is based on (WWFC, 2019), (Karatzos, et al., 2014), (Wood Mackenzie, 2010), (IEA-AMF, 2020).

[62] Two main temperature measures are cloud point when the first crystals appear in the fuel and the Cold Filter Plugging Point (CFPP) where sufficient crystals have formed to plug a test filer. Different biodiesels have different cloud points and CFPPs with those made from tallow and animal fats generally being higher that those made from vegetable oils (de Pont, 2006).

- FAME's freeze point is well above that allowed for jet fuel and FAME could cause other problems in jet engines. Therefore, these are not suited for aviation.
- Biodiesel esters are high-boiling compounds, which may lead to fuel dilution of the engine oil especially in engines using post-injection for particulate filter regeneration. The high boiling range of FAME results in fuel condensation on the cylinder walls when fuel is injected late in the working cycle. High-boiling components of FAME that do not burn completely can cause engine deposits and increased exhaust emissions, especially at low temperatures.
- Some studies show FAME can increase NOx emissions.

Appendix C Compatibility of bioethanol and biodiesel with existing infrastructure

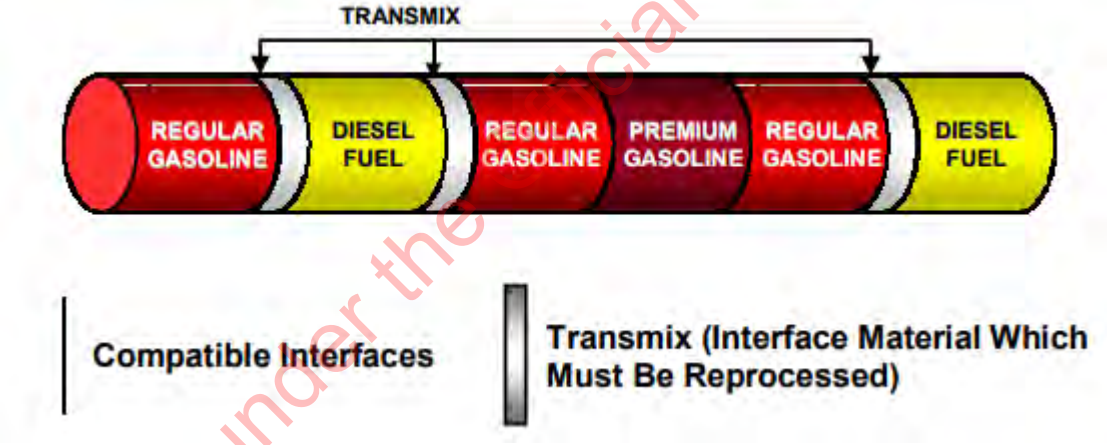
Contamination

Due to its chemical nature, FAME is incompatible with the existing infrastructure including pipelines and storage tanks, so it needs to be blended through separate distribution channels. Instead of using existing pipelines, biodiesel must be transported via trucks, rail or coastal shipping, increasing the carbon footprint of the supply chain.

Typically, pipelines run fossil fuel products in a specific sequence of batches to avoid cross contamination between fuels, as shown in Figure 29. Between batches, a small amount of co-mingled produced is generated. This is known as interface or transmix, and is normally segregated to refractionation to diesel and petrol, or returned to the refinery for processing (Bunting, et al., 2010).

Pipelines are therefore susceptible to contamination, which can carry over from batch to batch.

Figure 29 – Typical sequence of fossil fuel products through pipeline



Source: (Trench, 2001)

FAME is reactive with pipeline metallurgy, and can contaminate subsequent petroleum batches by adhering to the surfaces of pipeline walls. FAME transported through conventional fossil fuel pipelines can mix with the 'water plugs' that are inserted into the pipeline to separate the different fossil fuel liquids when they are transported through the pipeline. It can also stick to the pipeline wall and contaminate jet fuel plugs that follow. Jet fuels are particularly sensitive to biodiesel ester contaminants (Karatzos, et al., 2014).

Ethanol is hydrophilic, which means it picks up water from storage tanks and pipeline, thereby contaminating the fuel. It is also an effective solvent, which means it picks up residues of other materials that have passed through the pipelines, potentially damaging vehicle engines (Childs & Bradley, 2008). Ethanol can also segregate out of an ethanol gasoline mix into a water phase (Bunting, et al., 2010)

Because of its hydrophilic characteristic, ethanol at higher blends is suitable in any situation where you can keep it dry, this being particularly relevant for aviation. Modern cars have plastic sealed fuelled tank, which means they could work fine with high blend ethanol, provided that the ethanol has been kept dry and. The bigger issue is the storage and distribution infrastructure, which can introduce other impurities.

Ethanol cannot generally be transported via existing multi-fuel pipelines because it is a strong solver that can cause corrosion of pipelines and degradation of seals and other pump components. Because it can also dissolve residues left in the pipeline and absorbs water, it can arrive at the terminal outside the range of allowable specifications. This is particularly an issue where ethanol is blended with specifically formulated gasoline to met strict air emissions requirements. For this reason, in the US ethanol is primarily transport by rail, and biorefineries are built along existing rails lines (Rusco, 2012).

Given these characteristics, ethanol is usually transported by truck, train or barge. A greater scale-up of ethanol consumption could require dedicated pipelines to transport significant quantities, as well as storage tanks and distribution infrastructure at gas stations, including either new or extensively cleaned tanks, valves, filters, hoses and nozzles (Childs & Bradley, 2008).

The polarity of ethanol and FAME biodiesel can make the separation of dirt and water more difficult than for fossil fuels. Possible solutions include careful batch sequencing or the use of a separate pipeline to segregate jet fuel from FAME biodiesel (Bunting, et al., 2010).

As mentioned previously, FAME biodiesel also has poor oxidation stability. It contains carbon-to-carbon double bonds that are easily oxidised after production and during the storage and fuel use. Precautions must therefore be taken to deal with such oxidation reactions; these include the use of oxidation stability enhancing additives like butylated hydroxytoluene (BHT) when blending and distributing these fuels (WWFC, 2019).

FAME blends are solvents for a wider range of substances than fossil diesel, and therefore have a cleaning effect on systems using biodiesel, releasing organic residues which can cause blockage of filters. Generally, procedures for handling of biofuel blends require higher standards of cleanliness of systems as compared to fossil diesel. B100 permeates certain plastics such as polyethylene and polypropylene. Fluorinated plastics and nylon are more compatible (Wood Mackenzie, 2010).

Corrosion

Although microbial growth tends to occur anyway in the water phase of diesel storage, addition of FAME increases the availability of microbes. This can increase corrosion risk and may results in blockages in fuel dispenser filters and lines, especially at retail distribution (Wood Mackenzie, 2010). The problem typically occurs where fuels are stored for extended periods and thus is more common in storage tanks than in vehicle fuel tanks (de Pont, 2006).

Most of fossil fuel infrastructure, including pipelines, storage tanks and related equipment is made of low-carbon and low-allow steel, which means it is susceptible to rust and corrosion. Most pipeline networks have engineering features in place to remove contaminating water (Bunting, et al., 2010).

Dissolved water in biofuels can contribute to corrosion and stress corrosion cracking,[63] with the latter issues of particular concern with ethanol (Bunting, et al., 2010).

Ethanol is also extremely corrosive, which can affect the integrity of existing pipeline fittings and aluminium storage tanks. Because it is hydroscopic, it requires special handling to prevent high water content and the consequent risk of corrosion and microbial growth.

[63] The latter is a particular issue for ethanol.

Appendix D Methods used to estimate emissions from co-products

Two main approaches are commonly used with respect to co-product treatment, as well as LUC estimates:

- **Attributional LCA** attributes energy and material inventories for each step in the lifecycle. Allocation can be done on the basis of weight, energy content or market value (economic) of products.
- **Consequential LCA** emphasises interactions among economic indicators, and allows accounting for avoided emissions due to co-products. This is sometimes also referred to as "displacement," "substitution," or "system boundary expansion" approach. This approach is also recommended by the guidelines for LCA issued by the International Organisation for Standardization ISO 14040-14049 guideline series, although is generally more complex (Hoefnagels, et al., 2010).

Both approaches are scientifically sound but are used for different decision-making purposes:[64]

- CO_2e inventories from attributional analyses are intended for LCA practitioners, industry users, and policy-makers interested in average GHG emissions data based on average operations, and are used in micro-economic decision settings.
- CO_2e inventories from consequential analyses are used by practitioners, industry users, and policy-makers interested in marginal impacts from new policies or market changes, and are used in macro-economic decision settings.

In the EU Renewable Energy Directive, the default emissions factors are generally based on the energy-content attributional approach, with the exception of co-product electricity produced from agricultural crop residues (including straw and bagasse), which is not accounted for. These agricultural crops residues also have zero life-cycle GHG emissions until the process of collection.

The LCA approach used for California's Low Carbon Fuel Standard is also generally attributional, with the exception of co-products and ILUC impacts which are estimated using a consequential approach. Emissions from direct and indirect land-use changes are estimated using the Global Trade Analysis Project that was developed for the California Air Resource Board (Dunn, et al., 2017).

[64] Based on (EUCAR, 2020), (Prussi, et al., 2020a)

Appendix E Energy density assumptions for liquid fuels

Table 4 – Energy density assumptions for liquid fuels

	Blend	MJ/litre neat	MJ/litre blend
Bioethanol	10%	21	34.5
Biodiesel	7%	33.5	35.83
Drop-in fuel	50%	34	35
Fossil diesel		37.8	
Fossil petrol		35.4	
Fossil heavy fuel oil		40.9	
Aviation fossil fuel		35.4	

Source: For biofuels, these are average values based on Annex III in EU RED II. For fossil fuels, the values are based on MBIE's oil tables.

Appendix F LCA methodologies used worldwide

There are a number of models available to conduct biofuel LCA. Two prominent US-focused models are:

- GREET (Greenhouse Gases, Regulated Emissions, and Energy use in Transportation) developed by the Argonne National Laboratory. An adapted version of GREET is used by CARB to estimate direct emissions of producing and using transport fuels in the context of the Low Carbon Fuel Standard.
- GHGenius used by Canada Federal Government, Alberta, British Columbia.

In the EU, the BioGrace model was initially developed to provide a harmonised approach to LCA GHG emissions calculations in the EU, and to ensure compliance with the EU Renewable Energy Direct and Fuel Quality Directive. Currently, the EU Joint Research Centre (JRC) is in charge of updating the input data for calculating default emissions factors contained in the EU RED, and publishing a harmonised biomass database of LCA supply chains.[65]

Brazil uses the Virtual Sugarcane Biorefinery (VSB) model, which was initially developed to assess the sugarcane production chain. It has been subsequently expanded to include other feedstocks and conversion pathways for biorefining.

There are also commercial software packages that can be used to conduct biofuel LCA of emissions.

Table 5 summarises the key characteristics of the models above. They key points are:

- Most models have been developed for regulatory use
- Most models do not include LUC changes emissions in their default estimates, except GHGenius which includes default land management emissions in most biomass production systems (e.g. soybean and palm) (Bonomo, et al., 2018). Except VSB, other models allow the user to model LUC as needed.
- GREET and JRC models for CARB and EU RED respectively use the attribution approach, with some caveats and variations.

Table 5 – Key characteristics of international LCA models

	BioGrace	GHGenius	GREET	JRC	VSB
Model version	4d (2015)	5.0a (2018)	2017	2017	2018
Developed for	Yes	No (although used as one)	Yes	Yes	No

[65] https://data.jrc.ec.europa.eu/dataset/jrc-alf-bio-biomass-db-lca-supply-chains-2018-protected

	BioGrace	GHGenius	GREET	JRC	VSB
regulatory use					
Default gases	CO2, CH4, N2O	CO2, CH4, N20, CO, VOC, NOx, fluorinated compounds	CO2, CH4, N2O	CO2, CH4, N2O	CO2, CH4, N2O
Lifecyle data	JRC[66] 2008	Internal	Internal	JRC 2017	Ecoinvent
Unit	MJ	km, MJ	Km, mile, BTU, MJ	MJ	km, MJ
Default allocation	Energy	Mostly substitution[67]	Variable[68]	Energy	Economic
Land use change	C stocks	Internal model	CCLUB/GTAP	C stocks	--
Boundaries	Well-to-wheel	Well-to-wheel	Well-to-wheel	Well-to-wheel	Well-to-wheel

Source: Based on (Bonomo, et al., 2018), (Dunn, et al., 2017)

[66] The Joint Research Center of the European Commission is in charge of defining input values for the calculation of default GHG emissions for biofuels.
[67] For soybean meal, mass allocation is also used.
[68] For FAME and HVO, mainly energy/mass/economic allocations are used, even though the default allocation in GREET is displacement (substitution).

Appendix G Emissions reductions by biofuel pathway

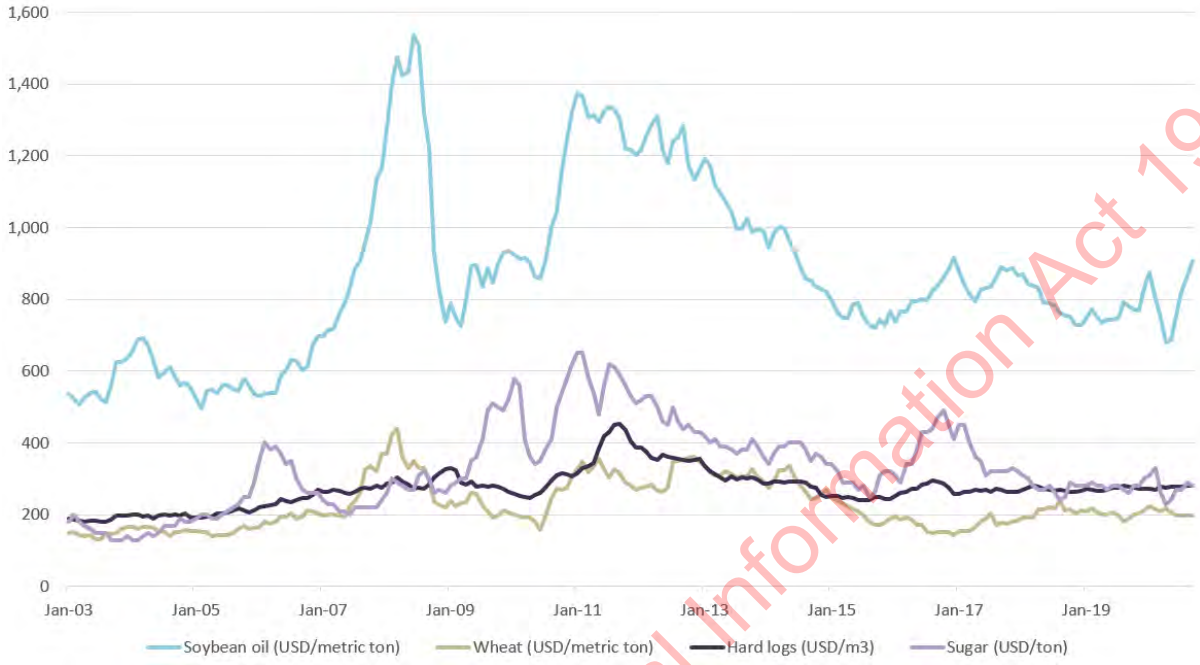
Table 6 – Lifecycle emissions by biofuel pathways

(blend wall in brackets)	**Feedstock**	**Neat % change**	**Blend % change**	**Min gCO2e / MJ**	**Max gCO2e / MJ**
Bioethanol (10%)	Corn	-30%	-3%	40	91
	Wheat	-27%	-3%	45	93
	Wheat straw	-58%	-6%	30	50
	Sugar beat	-56%	-6%	30	53
	Barley	-15%	-1%	69	129
	Sugar cane	-54%	-5%	42	46
FAME (7%)	Rapeseed oil	14%	1%	100	115
	Soybean oil	57%	4%	98	197
	Palm oil	104%	7%	58	326
	Sunflower oil	2%	0%	85	149
	Used cooking oil	-86%	-6%	11	16
	Animal fat	-48%	-3%	37	63
	Short-rotation woody crop	-107%	-8%	-7	-36
HVO (50%)	Rapeseed oil	14%	7%	100	115
	Sunflower oil	5%	3%	91	107
	Soybean oil	57%	28%	98	197
	Palm oil	105%	52%	69	316
	Palm oil mill effluent	-71%	-36%	27	27
	Used cooking oil	-85%	-43%	12	16
	Animal fat	-47%	-23%	37	63
FT diesel (50%)	Forest residue	-78%	-39%	11	20
	Poplar	-91%	-45%	9	-2
	Switchgrass	-91%	-46%	8	8
	Miscanthus	-106%	-53%	-6	-18
	Perennials - avg	-96%	-48%	4	-4
FT petrol (50%)	Forest residue	-80%	-40%	19	19
	Farmed wood	-78%	-39%	21	21
	Forest residue / wood - avg	-79%	-39%	30	30

(blend wall in brackets)	**Feedstock**	**Neat % change**	**Blend % change**	**Min gCO2e / MJ**	**Max gCO2e / MJ**
Pyrolysis (50%)	Pyrolysis oil from waste wood	-69%	-34%	53	53
	Upgraded bio-oil from waste wood	-44%	-22%	0	0

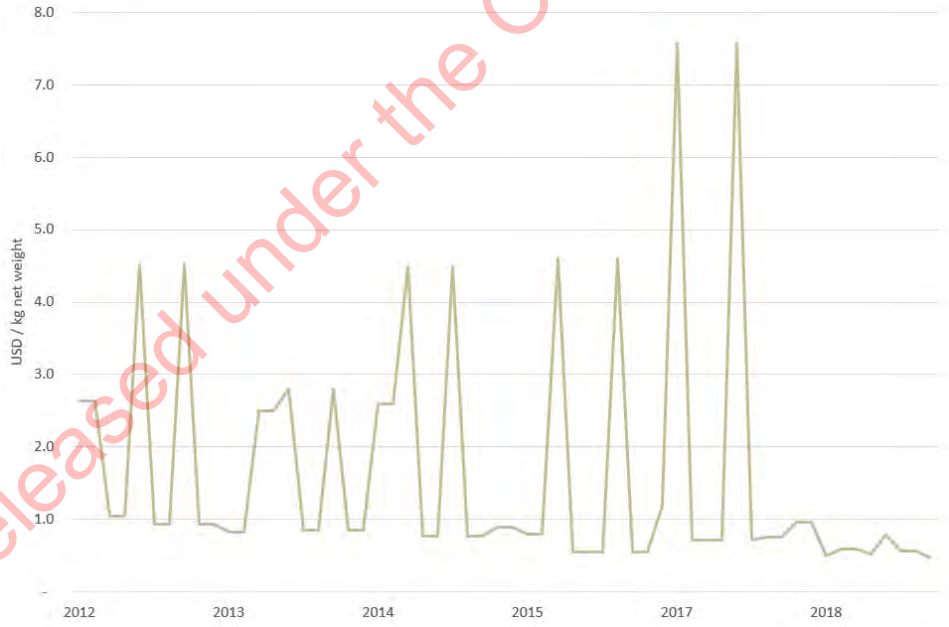
Appendix H Historical feedstock prices

Figure 30 – Commodity prices: soybean oil, wheat, hard logs, sugar



Source: Indexmundi 2021 https://www.indexmundi.com/commodities/

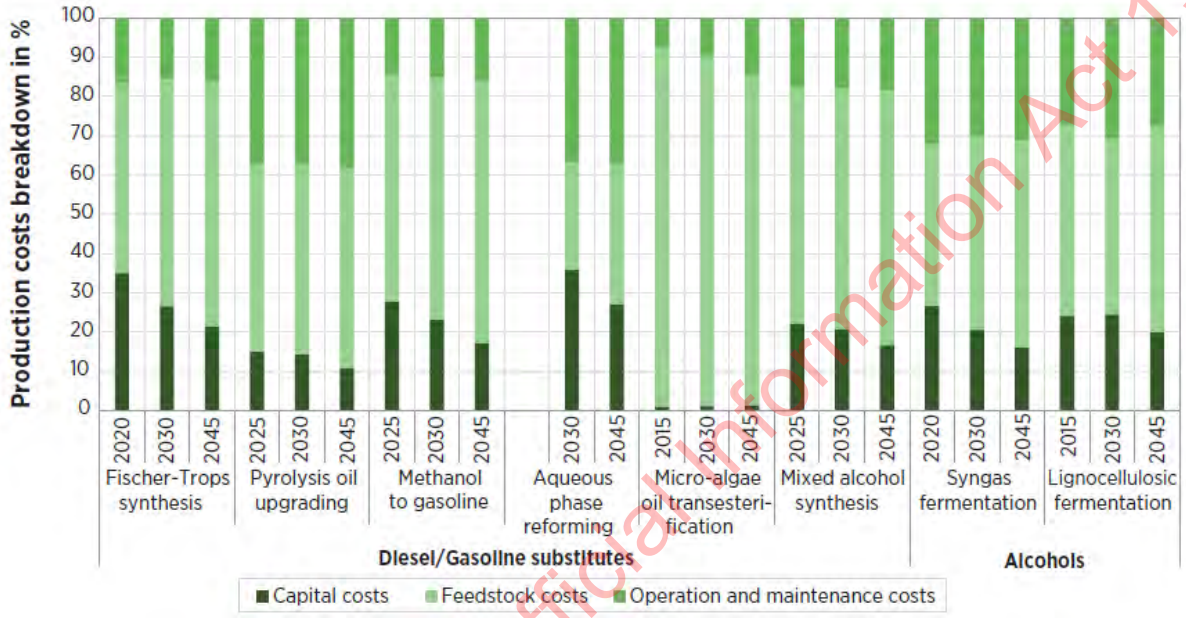
Figure 31 – Commodity prices: tallow



Source: Comtrade data on NZ tallow exports https://comtrade.un.org/data/

Appendix I Feedstock costs as % total production costs for advanced biofuels

Figure 32 – Production cost breakdown



Source: (IRENA, 2016)

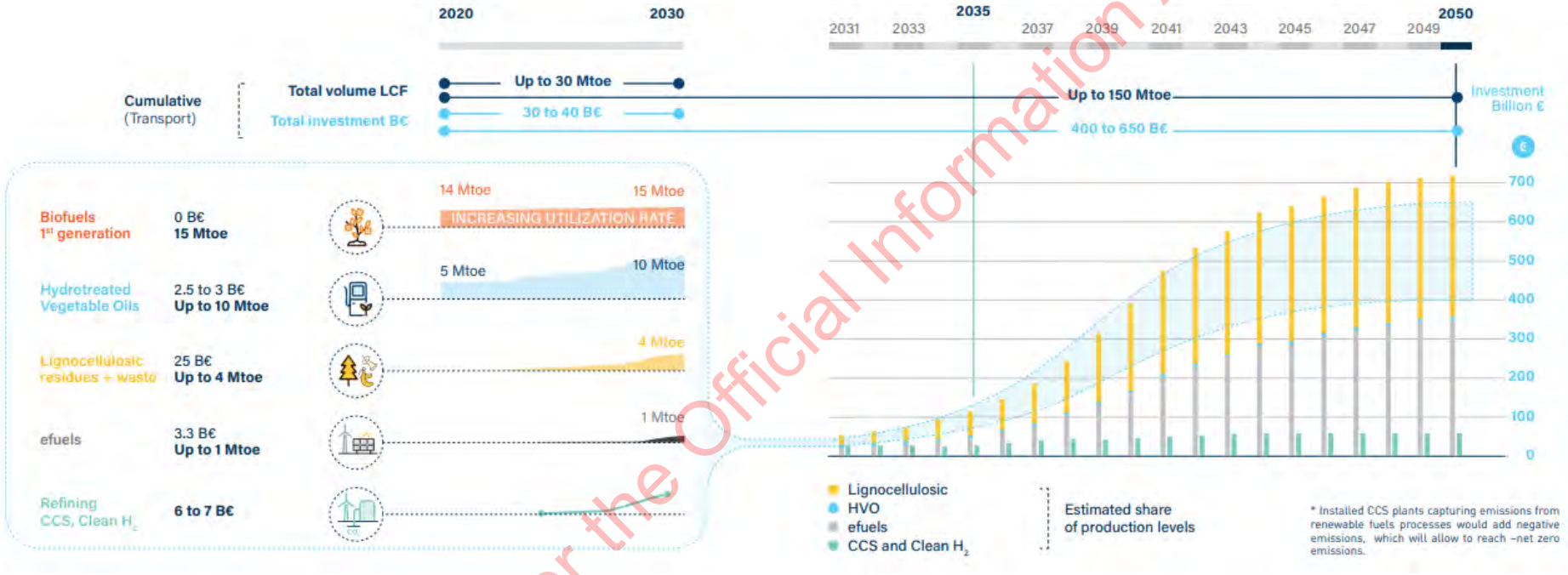
Appendix J Capital costs for biofuel pathways

Table 7 - Capital costs for biofuel pathways

Fuel type	Year	min ($/litre p.a.)	max ($/litre p.a.)
Bioethanol	2020	0.56	1.01
	2025	0.56	1.01
	2030	0.56	1.01
	2035	0.56	1.01
G2 bioethanol	2020	1.69	2.89
	2025	1.55	2.65
	2030	1.42	2.43
	2035	1.30	2.22
FAME biodiesel	2020	1.41	1.47
	2025	1.41	1.47
	2030	1.41	1.47
	2035	1.41	1.47
HEFA/HVO diesel	2020	0.68	2.54
	2025	0.68	2.54
	2030	0.68	2.54
	2035	0.68	2.54
Alcohol to jet (ATJ)	2020	1.69	2.37
	2025	1.55	2.17
	2030	1.42	1.99
	2035	1.30	1.82
Drop-in diesel / petrol via pyrolysis	2020	3.51	8.82
	2025	3.27	8.21
	2030	3.05	7.65
	2035	2.84	7.12
Drop-in diesel / petrol via FT	2020	6.71	10.07
	2025	5.92	8.88
	2030	5.22	7.83
	2035	4.60	6.90

Appendix K EU refining industry 2050 potential scenario

Figure 33 – EU refining industry 2050 potential scenario



Source: (FuelsEurope, 2020)

Appendix L Assumptions for estimating maximum potential demand for biofuels in NZ transport

Table 8 – Average vkt by GVM band

year	GVM band	vkt_billions	vkt millons	vehicles	mean gvm	Avg vkt/vehicle pa
2019	HGSV < 5000	.267	266.7	26599	4385	10,028
2019	HGSV < 7500	.363	363.2	35275	5825	10,296
2019	HGSV < 10000	.215	215.4	18993	8676	11,343
2019	HGSV < 12000	.129	128.7	8576	10669	15,010
2019	HGSV < 15000	.116	115.9	8132	13181	14,252
2019	HGSV < 20000	.150	150.2	8842	16286	16,990
2019	HGSV < 25000	.417	416.5	16928	23324	24,606
2019	HGSV < 30000	.590	589.8	15948	26875	36,983
2019	HGSV > 30000	.844	844.2	13956	32267	60,488

Source: based on Motor Vehicle Register

Table 9 – Fuel economy estimates by RUC type

RUC type	Million tkm	Avg load (t)	Lifetime (years)	Avg litres / 100km
2	1,949	1.8	20	29.5
6	8,302	10.8	20	47.0
14	15,012	14.3	20	57.0
19	67	14.5	20	61.3

Source: based on (Haobo, et al., 2019). Fuel economy is estimated based on the 0.0016*GVM+7.8857 function

Appendix M Engine manufacturer indicated compatibility with heavy vehicles

Engine Manufacturer Indicated Compatibility of Heavy Vehicles - 30 June 2020

Note that the "Max B%" value does not infer across all engines.

Engine Manufacturer Compatibility Statements		Across Range		Max B%	Refers to EFSR 2008	Refers to EN 590	Refers to EN 14214	Refers to ATSM	Specifics
Heavy Vehicles									
DAF		y		5%			y		Provided that the biodiesel complies with the ISO EN14214 standard, up to 5% biodiesel (B5) can be mixed without problems in all DAF Euro 3, Euro 4 and Euro 5 engines.
Fiat	Info not yet available								
Foton	Info not yet available								
Freightliner	www.freightliner.com.au	Cummins - Argosy, Columbia, Coronado	allow	B20	n	n	n	y	All biodiesel fuel blends: ASTM D975 Biodiesel blends between B5 and B20: ASTM D7467 Biodiesel blends up to B7: Cummins Fuel Standards (Table 1 Bulletin 3379001)
Freightliner	www.freightliner.com.au/	Detroit Diesel DD Series - Argosy, Coronado, CST112,	allow	B5	N	Y	Y	D975 D6751	
Freightliner	www.freightliner.com.au/	Detroit Diesel Series 60 - Argosy, Coronado, CST112,	allow	B20	N	N	N	D7467	ONLY POST 2004 Manufacture
Hino	www.hino.co.nz	Y	allow	B5	N	y	y	D6751	Common Rail US04 & euro 5
Hyundai	customerservice@hyundai.co.nz	y	allow	5%		y	y		Must be EN 14214 or equivalent specification
International	comer@intertruck.co.nz	9800 / 9870 / Prostar	Cummins E5	B20					
International	comer@intertruck.co.nz	9800 / 9870	Cummins E5	B20					
Isuzu		Y	allow	5%		Y	Y		
Iveco	Cursor powered on/off road vehicles. Bio diesel from commercial source only	up to E5/EEV only		B30-max		x			can be mixed with EN590 diesel. Biodiesel must meet UNI 10946 and "pren 14214 & DIN 51606" quality. Other restrictions apply-Please refer to an IVECO Dealer
Iveco	Common Rail vehicles	F1A, F1C, 8140, Tector engines	allow	5%		x	x		Biodiesel must comply with EN 14214 and B5 EN590
Kenworth		y	Cummins E5	20%					
Kenworth		y	PACCAR MX	5%					
Mack	konstantin.zharkov@mtd.co.nz	y		30%		y	y		Must be EN 14214
MAN	info@man.co.nz	Y	allow	7%		Y	Y		Fuel must comply with requirements of standard DIN EN 14214. Other conditions apply refer Service Information 180911c
Mercedes-Benz	dave.ballantyne@daimler.com	y	allow	7%		y	y		
FUSO	service@fuso.co.nz	Y		5% max		Y	Y		Must be EN14214
Renault	konstantin.zharkov@mtd.co.nz	y		30%		y	y		Must be EN 14214
Scania	http://www.cableprice.co.nz/contact/	No	Allow	*		Y	Y		* = Variable dependant on vehicle specification, contact manufacturer. Fuel must be EN standard compliant.
UD Trucks	bmusgrave@udtrucks.co.nz	y	allow	5%		y	y		Must be EN 14214
Volvo	jamie.bell@mtd.co.nz	y		30%		y	y		Must be EN 14214
Western Star	info@penskecv.co.nz	Y	allow	*		Y	Y		* = Variable dependant on engine specification. Contact engine manufacturer. Fuel must be EN standard compliant.

Source: (MIA, 2020)

Appendix N Summary of biofuel applications and limits

Fuel family	Conversion technology	Biofuel produced	Blend limits
Road diesel	Trans-esterification of lipds	FAME biodiesel	5% - 7%. Higher blends can be used depending on OEM specifications
	Hydro-treatment of lipids	Hydrogenated renewable diesel	There are no regulatory limits to blending HEFA in diesel. However, it is blended with conventional diesel fuel to meet fuel specifications.
	Gasification / Fischer-Tropsch	Drop-in diesel	EN 15940 does not apply regulatory limits to blending FT diesel
Aviation	Hydro-treatment of lipids	HAFE	Up to 50% HEFA in jet fuel
	Hydro-processing of bio-derived hydrocarbons	HH-SK / HC-HEFA	Up to 10%
	Fischer-Tropsch	Drop-in diesel	FT kerosene is certified for maximum 50% blends with jet fuel
	Cathalytic hydrothermolyosis	Drop-in diesel	Up to 50%
Marine	Trans-esterification of lipds	FAME biodiesel	Technically, up to 7% blends can be used. Standards being developed
	Bio-oil upgrading	Drop-in	Technically, can be used as a direct replacement for fossil marine fuel. Standards being developed
	Mild bio-oil upgrading	Drop-n	Can be used in a marine engine. Standards being developed

Source: (IRENA, 2016), (Maniatis, et al., 2017), (Suckling, et al., 2018)

Appendix O International biofuel standards

Bioethanol for road transport

In Europe, two standards are applicable to bioethanol:

- EN 15376 establishes specification for ethanol to be blended with petrol
- EN 228, the European gasoline fuel specification, is also applicable to ethanol blends up to 10% (DCL, 2014).

At present, most EU members states are using a low 5% blend, although many members states have started moving towards E10 (Horizon Magazine, 2020). In some countries, e.g. France, E10 has been widely used for some time now (DCL, 2014).

FAME biodiesel for road transport

Within the European Union, there are three two sets of standards that define the specifications of low FAME blend fuels. These specifications define a range of properties of the fuel, some of which are related to the intrinsic chemistry of the molecules, e.g. cetane number, viscosity and iodine number, and some of which are more related to the processing method, e.g. residual glycerides, water content, sterol glucosides, alkali metals and free acids (Wood Mackenzie, 2010).

- EN 590 (European Diesel Fuel Specification) sets a maximum limit of 7% for FAME blends in fossil diesel, regardless of the type of feedstock. This is higher than the 5% limit allowed under ASTM D975, which is used in the US.
- Similarly, EN 16734 set a limit of 10% for FAME blends at the EU level. However, Member State legislation can set additional requirements, or even prohibit the marketing and delivery of these fuels.
- EN 14214 (Fatty Acid Methyl Ester (FAME) Fuel Specification) sets the specifications for neat FAME (B100). It establishes specifications for biodiesel use as either (i) a final fuel in engines designed or adapted for biodiesel use, or (ii) a blendstock for conventional diesel fuel. Under ASTM, neat biodiesel is governed by the ASTM D6751 standard, however this contains specifications for neat biodiesel as a blending component, and not as a final fuel (WWFC, 2019).

For higher blends, the viscosity of fuels is an issue. The EU Fuel Quality Directive (Annex II) sets a maximum limit for the density at (15 °C) of fuels that are sold, at 845 kg/m3. This limits the potential for high FAME blends. Because B20 / B30 do not meet this requirement, they can only be used in dedicated fleets, so long as they meet the EN16709 standard for B20/B30 blends.

HVO and synthetic fuels for road transport

There are no regulatory limits to blending HVOs and synthetic fuels. However, they are blended with conventional diesel fuel to meet fuel specifications.

The fuel standard EN 15940 covers hydrotreated paraffinic renewable diesel fuel and synthetic Fischer-Tropsch products in the EU. It was approved in 2016, opening up the possibility for drop-in biodiesel

in current and future diesel vehicles up to 100% (Maniatis, et al., 2017). The standard does not explicitly regulate the origin of the feedstock, as that part of the fuel supply chain is covered by the Fuel Quality Directive and Renewable Energy Directive.

When used in a blend, the neat paraffinic diesel fuel does not necessarily need to meet EN 15940, as long as the final fuel meets the diesel fuel blend requirements defined in other standards, such as EN 590 for B7 FAME, and EN 16734 for B10 FAME (Neste, 2020).

This standard can be used as guidance for the production of synthetic fuels and HVO when used as blending components. However, additional engine validation may be needed to ensure that the fuel works well with the existing vehicle and engine. Subject to validation and care using additives, these fuels can be used in any diesel engine either in pure form or blended with fossil diesel as long as the finished fuels meets the required standard (WWFC, 2019).

Sustainable aviation fuel

For aviation fuel, international standards have been adopted due to the fact that the same aircraft can be fuelled in different countries. The standard regulating the technical certification of SAF is ASTM D7566, which evaluates the technologies can be used for producing neat SAF. Once blended, the final fuel must meet ASTM D1655 standard, which determines if the fuel is fit-for-purpose based on various parameters, such as composition, volatility, corrosion, thermal stability, energy content, freeze point, combustion characteristics, lubricity, material compatibility etc.

The figure below shows the seven technology pathways that can currently produce drop-in SAFs, and the ASTM certification status.

Table 10 - Approval status for sustainable aviation fuels

Conversion technology	Feedstocks	Maximum blend (%)	ASTM status
Fischer-Tropsch (FT) and FT containing aromatics (FT-SKA)	Wastes (MWS, etc.), coal, gas, sawdust	50%	Included in ASTM D7566 in 2009 and 2015 respectively (Annex 1 and 4)
Hydro-processed esters and fatty acids (HEFA/HVO)	Vegetable oils: palm, camelina, jatropha, used cooking oil	50%	Included in ASTM D7566 in 2011 (Annex 2)
Direct sugars to hydrocarbons producing synthetic iso-paraffins (SIP)	Sugarcane, sugar beet	10%	Included in ASTM D7566 in 2014 (Annex 3)
Alcohol-to-jet (ATJ, isobutanol or ethanol)	Sugarcane, sugar beet, sawdust, lignocellulosic residues (straw)	50%	Included in ASTM D7566 in 2016

Conversion technology	Feedstocks	Maximum blend (%)	ASTM status
Hydroprocessed hydrocarbons (HH-SPK or HC-HEFA)	Oil produced from (botryococcus braunii) algae	10%	Included in ASTM D7566 in 2020 (Annex 7)
Cathalytic hydrothermolyosis (CHJ)	Triglycerides such as soybean oil, jatropha oil, camelina oil, carinata oil, and tung oil	50%	Included in ASTM D7566 in 2020 (Annex 6)

Source: based on (IATA, 2020), (ICAO, 2020)

Marine fuels

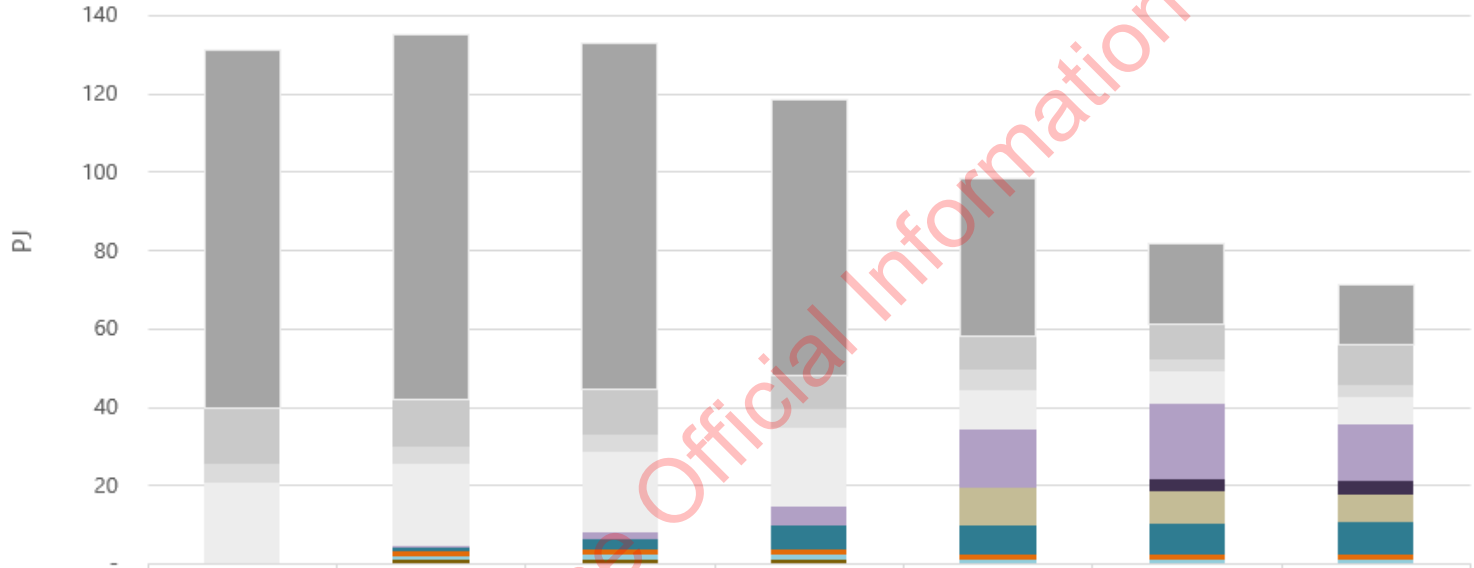
ISO standards on bio-derived fuels for the shipping sector are still work-in progress. Key issues that need addressing are fuel stability towards oxidation, minimal water content to inhibit microbial growth, and low-temperature flow properties of biofuels. Currently, regulations do not allow biodiesel blending with marine distillate or residual fuels, as they are seen as contaminants. FAME content in marine fuels cannot exceed 0.1% volume in distillate fuels, due to lack of data concerning storage, handling, and treatment in a marine environment (IEA Bioenergy, 2017).

Nevertheless, the International Marine Organisation's limits on sulphur emissions from 2020 is encouraging for biofuel use in shipping. Larger vessels that use marine heavy fuel, either diesel or diesel-electric, will be able to use biocrude-based blends from sustainable feedstocks with limited upgrading (Bioenergy Association, 2019). HVOs are also a technically good replacement of heavy fuel oils and is compatible with current engines and supply chain. Newer fuels like DME (dimethyl ether), bioLNG, bioethanol, and (bio)methanol are compatible with modern marine diesel engines, though their widespread acceptance in shipping is limited by availability (IEA Bioenergy, 2017).

The IEA Bioenergy Task 39 are working on development of a suitable marine standard for biofuels (Bioenergy Association, 2019).

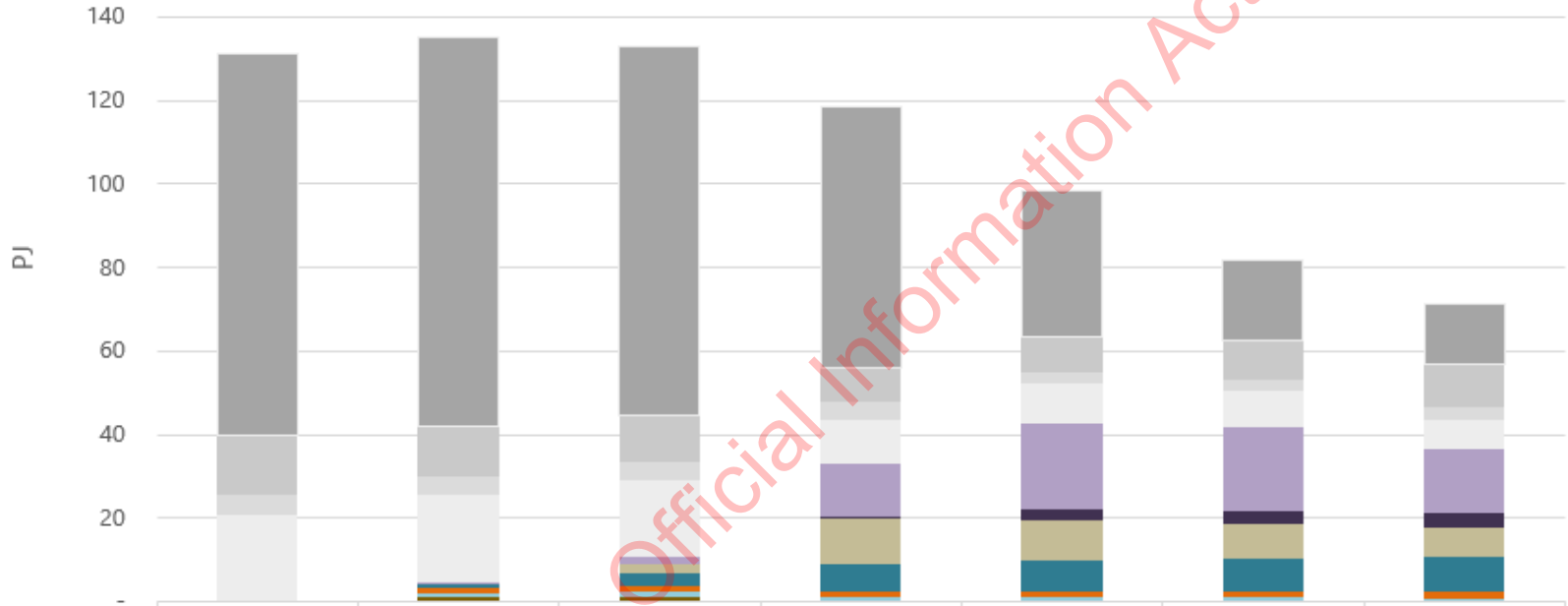
Appendix P Domestic uptake scenario for biofuels

Figure 34 – Biofuel uptake volumes in progressive uptake scenario



	2021	2025	2030	2035	2040	2045	2050
Fossil fuels (light vehicles)	91.45	93.04	88.31	70.29	40.23	20.42	15.50
Fossil fuels (aviataion)	14.31	12.31	11.47	8.69	8.73	9.36	10.04
Fossil fuels (marine)	4.50	4.32	4.32	4.65	5.30	2.90	3.18
Fossil fuels (heavy trucks)	21.03	20.79	20.73	20.11	9.76	8.42	6.93
Drop-in petrol (light vehicles)	-	0.58	1.81	4.66	15.01	19.05	14.61
Drop-in diesel (marine)	-	-	-	-	-	2.90	3.18
Drop-in diesel (heavy trucks)	-	-	-	-	9.70	8.42	6.93
Drop-in aviation fuel (biomass)	-	0.75	2.26	6.01	7.12	7.75	8.43
Drop-in aviation fuel (HEFA)	-	1.61	1.61	1.61	1.61	1.61	1.61
Bioethanol (light vehicles)		0.46	1.030	1.03	1.03	1.03	0.95
Biodiesel (marine)		0.18	0.18	0.19	-	-	-
Biodiesel (heavy trucks)		1.18	1.18	1.17			

Figure 35 – Biofuel uptake volumes in accelerated uptake scenario



	2021	2025	2030	2035	2040	2045	2050
Fossil fuels (light vehicles)	91.45	93.04	88.22	62.32	34.84	19.22	14.63
Fossil fuels (aviataion)	14.31	12.31	11.01	8.16	8.73	9.36	10.04
Fossil fuels (marine)	4.50	4.32	4.32	4.24	2.65	2.90	3.18
Fossil fuels (heavy trucks)	21.03	20.79	18.60	10.64	9.73	8.42	6.93
Drop-in petrol (light vehicles)	-	0.58	1.90	12.63	20.40	20.25	15.53
Drop-in diesel (marine)	-	-	-	0.60	2.65	2.90	3.18
Drop-in diesel (heavy trucks)	-	-	2.13	10.64	9.73	8.42	6.93
Drop-in aviation fuel (biomass)	-	0.75	2.71	6.55	7.12	7.75	8.43
Drop-in aviation fuel (HEFA)	-	1.61	1.61	1.61	1.61	1.61	1.61
Bioethanol (light vehicles)		0.46	1.030	1.03	1.03	1.03	0.90
Biodiesel (marine)		0.18	0.18	-	-	-	-
Biodiesel (heavy trucks)		1.18	1.18				

Appendix Q Absolute emissions reductions in the two scenarios

Table 11 - Possible LCA emissions reductions from biofuels in New Zealand transport (ktCO2e) – progressive uptake

	2021 - 2025	2026 - 2030	2031 - 2035	2036 - 2040	2041 - 2045	2046 - 2050
Biodiesel for heavy trucks	129	260	258	0	0	0
Biodiesel for marine	33	41	42	34	0	0
Bioethanol for light vehicles	47	166	213	213	213	205
HEFA	71	355	355	355	355	355
Drop-in aviation fuel (biomass)	55	513	1,654	2,524	2,748	2,989
Drop-in diesel for heavy trucks	0	0	0	2,058	3,287	2,764
Drop-in diesel for marine	0	0	0	0	994	1,125
Drop-in petrol for light vehicles	43	417	1,307	4,036	7,186	6,006
Total	**335**	**1,751**	**3,830**	**9,221**	**14,784**	**13,444**

Table 12 – Possible LCA emissions reductions from biofuels in New Zealand transport (ktCO2e) – accelerated uptake

	2021 - 2025	2026 - 2030	2031 - 2035	2036 - 2040	2041 - 2045	2046 - 2050
Biodiesel for heavy trucks	129	260	207	0	0	0
Biodiesel for marine	33	41	33	0	0	0
Bioethanol for light vehicles	47	166	213	213	213	209
HEFA	71	355	355	355	355	355
Drop-in aviation fuel (biomass)	55	546	2,313	2,524	2,748	2,989
Drop-in diesel for heavy trucks	0	156	2,942	3,717	3,287	2,764
Drop-in diesel for marine	0	0	44	907	1,027	1,125
Drop-in petrol for light vehicles	43	424	2,913	6,310	8,073	6,385
Total	**379**	**1,947**	**9,020**	**14,027**	**15,704**	**13,820**

Source: Sapere analysis

About Sapere

Sapere is one of the largest expert consulting firms in Australasia, and a leader in the provision of independent economic, forensic accounting and public policy services. We provide independent expert testimony, strategic advisory services, data analytics and other advice to Australasia's private sector corporate clients, major law firms, government agencies, and regulatory bodies.

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Biofuel

EECA recently commissioned research regarding liquid biofuels, which covers demand and supply constraints, technology readiness for drop-in biofuels and life-cycle emissions analysis by feedstock.

We have attached this report to this submission as it informs EECA's view on the liquid biofuels opportunity for New Zealand.

Recommendation A - Set a target and introduce polices so that at least 140 million litres of low carbon liquid fuels are sold in Aotearoa by 31 December 2035

From discussion with the Commission, we understand this target was calculated based on liquid biofuels (but is currently worded to also cover other low carbon liquid fuels). Due to the variance in lifecycle emissions of different biofuel types and feedstocks, we suggest that a volumetric target (i.e. in litres) may not be the best approach to achieve emissions reductions. We would support instead an emissions reduction target (i.e. in CO2-e) for low carbon fuels.

The 140ML target appears to be based on production estimates from available wood feedstock rather than on a wider analysis including technical feasibility, demand-supply dynamics or maximising emissions reductions. This raises several points:

- The life-cycle emissions vary a lot from one biofuel to another (mainly depending on feedstock and associated land use change). Therefore, emissions reduction should be the main driver of any biofuel policy (especially incentives) in order to prevent the use of biofuels with poor emissions benefits (or even increased emissions compared to fossil fuels).
- There might be more valuable (such as chemicals) or efficient (such as direct combustion for process heat) uses of wood than the production of liquid biofuels. A national discussion is needed on what are the priority uses of this limited resource. The Commission's recommendation for the development of a national plan for the bioeconomy (Necessary Action 6) would be an appropriate and valuable opportunity for this discussion to take place.
- So as not to delay action while developing a bioeconomy plan, interventions such as a biofuel mandate or low carbon fuel standards should still be implemented (which consider the emissions and sustainability of the biofuel but not the source of the biofuel).
- The blending limits for biodiesel and bioethanol suggest that the potential demand for these fuels on an energy basis could be 6% of current demand for diesel fuels by heavy trucks and marine, and 6% of current demand for petrol fuels by light vehicles respectively (biodiesel is not suitable for aviation). This potential could be realised immediately with the import of biofuels, rather than waiting to set up a domestic production industry to provide 3% of demand (as seems to be suggested in the Commission's draft advice). It would be useful if the Commission could be more explicit about if it sees a role for biofuel importation.
- The potential incremental demand for drop-in diesel is much higher assuming a 50% concentration limit, i.e. around 44% of total energy required by diesel heavy trucks, marine and aviation, and 47% of total energy required by light petrol vehicles.
- Our research suggests that, due to technological readiness, production of drop-in biofuel from wood biomass is unlikely to be at scale before 2035.
- Our research includes a progressive scenario where liquid biofuel uptake increases from 0.88 PJ (28.38 million litres) p.a. in 2022 to 8.06 (256.5 million litres) p.a. by 2030, reaching a maximum output of 43.14 PJ (1,287.2 million litres) p.a. by 2043.

Recommendation C - Introduce incentives to establish low emissions fuel plants, such as biofuel sustainable aviation fuel, and make those fuels more competitive with traditional fossil fuels

This recommendation seems to cover incentivising production of biofuels, as well as incentivising demand for biofuels (reducing the cost premium of the fuel).

Demand and production are two different aspects and we feel should be treated separately in the Commission's advice.

The experience with Marsden Point shows that ensuring availability for the domestic market is more complex than building a local production capacity: securing feedstock is a starting point, and ensuring demand is key.

The challenge is that feedstocks are globally tradable commodities, as are biofuels. This can create a complete disconnect between local production and local availability.

We agree that there may be a role for incentives for increasing demand in the short term. However, we are cautious about the proposal to provide incentives for domestic production. The opportunity cost to subsidise domestic production is unlikely to be justified by domestic emissions reduction only, and there is a need to factor in other considerations such as security of supply, economic impact, competing usages for the feedstock and factors that would result in a competitive advantage for production in New Zealand.

The capital cost alone for producing 100 million litres by 2030 would be in the range of $300-$760 million, depending on the conversion technology.[1] Such projects will not take place if investors have low confidence in capital cost recovery and prospects to scale production to reduce costs per unit of energy.

We suggest that the potential for incentives for biofuel production or demand should be considered as part of the wider bioeconomy plan recommended in Necessary Action 6. This would need to consider the risks of government support for biofuel production, including:

- New Zealand subsidising production of biofuels which are then exported to other countries.
- New Zealand building production capacity put in global competition for feedstock.
- New Zealand taking technology development risks in isolation - the scale of investments call for global effort.

[1] For FT catalysis and hydro-cracking, the estimate assumes a current capex of $9.12/litre fuel as per (BioPacific Partners, 2020), and a 3% p.a. learning curve to 2030. For pyrolysis oil upgrade, the estimate assumes a capex value of $3.03-$7.6/litre fuel depending on whether the hydrogen is produced or purchased. This cost range is derived from capex estimates by (Wright, et al., 2010) for the n-th plant and a pioneer plant. The pioneer plant is assumed to be built in 2035, and the n-th plant in 2025.

Off-road diesel

We would like to draw the Commission's attention to an opportunity not mentioned in the advice and that might have been overlooked: Off-road diesel. This umbrella term refers to the following (non-road) uses of diesel:

Sector	**Application examples**
Aviation	Airport ground service equipment
Rail	Rail maintenance equipment
Marine	Recreational boating, personal watercraft, fishing
Agriculture	All-terrain farm vehicles, farm motorcycles, tractors
Construction	Off-road trucks and tractors, generators, machinery
Industrial	Forklifts, generators, other industrial equipment
Mining	Mining equipment, off-road mining trucks
Forestry	Forestry equipment, off-road logging trucks
Residential	Residential lawn and garden equipment
Commercial	Commercial lawn and garden equipment, heating, forklifts
Government	Defence, lawn and garden equipment
Recreational	Motorsport, off-road motorbikes

There was about 36PJ of non-transport diesel use in 2019[2] (including an unknown portion for heating). This is equivalent to 2.6 Mt CO2e/year, so the opportunity for emission reduction is likely to be within the range of 1 to 2 Mt CO2e/year.

EECA has commissioned research to increase the understanding of this opportunity, for which solutions such as hybrid and biofuels could be relevant. We will share these insights with the Commission when they are available in mid-2021.

In the meantime, the Commission could mention the opportunity of off-road diesel in the list of potential targets for low-carbon fuels in its advice.

[2] MBIE Energy Balance Tables

Board Report

TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY
EECA

Meeting Date	**2/03/2021**
Subject	EECA's submission on the Climate Change Commission's draft advice
Purpose	This paper seeks the Boards comments on EECA's draft submission on the Climate Change Commission's draft advice
Prepared by	Marcos Pelenur, Group Manager Strategy, Insights and Regulation

Context

1. On 31 January 2021, the Climate Change Commission (**the Commission**) has released its draft advice for public consultation. The purpose of the Commission's advice is to advise the Government on:
   a. The level of the first three five-yearly emissions budgets that will put New Zealand on track to meeting its domestic 2030 and 2050 emissions targets, and
   b. The direction of policy that should be included in the Government's first emissions reduction plan.
2. EECA will make a submission on the Commission's draft advice. Submissions are due by 14 March 2021.
3. The high level key message from the Commission's advice is that current Government policies do not put New Zealand on track to meet our recommended emissions budgets and the 2050 targets. Meeting the emissions budgets is possible with existing technology – but transformational and lasting change across society and the economy will be needed.
4. There is a lot of material included in the Commission's advice, covering all sectors of the economy. The areas of most relevance for EECA are the 'Heat, Industry and Power', 'Transport' and 'Multisector Strategy' sections.

Development of EECA's submission

5. An early draft of EECA's submission is attached as Appendix 1. It includes three main elements:
   a. A short summary of the main points included in the submission
   b. A table providing 'EECA's response at a glance' which sets out the Commission's recommendations we are responding to and whether we favour, do not favour or recommend change
   c. Our detailed response to the Commissions consultation documents, responding to all of the Commission's consultation questions and recommendations that are of relevance to EECA.
6. Due to the amount of material included in the 'detailed response' section of our submission, we suggest that the Board focuses on the summary and EECA's response at a glance table, as well as any specific recommendations that are of particular interest.

Our submission will continue to be developed and refined after the Board meeting

7. On 10 and 23 February, the Commission released information about the data and modelling that underpins its advice. We are still testing the Commission's modelling and assumptions, including comparing to TIMES-NZ. For this reason our current draft submission does not yet include commentary on the Commission's modelling and targets.
8. EECA staff are meeting with the Commission on 1 March to ask questions about the Commission's advice and seek clarification on some points. This may lead to some changes to our submission.
9. We have discussed and intend to share an early draft of our submission with MBIE, the Ministry for the Environment and the Ministry of Transport. While these agencies are not making a formal submission, it appears that the comments included in our submission are broadly consistent with their views.

Process for finalising EECA's submission

10. Following the Board meeting on 2 March, we will continue developing the submission, incorporating any comments from the Board. We propose that the Chair be authorised to sign out the final submission on behalf of the Board. If any material changes are made following the Board meeting, the Chair may raise these with the Board.
11. We will provide our submission to the Minister, for her information, shortly before submitting to the Commission.

Recommendations

12. It is recommended that the Board
    a. **Consider and discuss** our draft submission on the Climate Change Commission's draft advice (attached).
    b. **Authorise** the Board Chair to sign out EECA's final submission, noting that any major changes will be raised with the Board.

Marcos Pelenur
GROUP MANAGER STRATEGY, INSIGHTS and REGULATION

Andrew Caseley
CHIEF EXECUTIVE

Appendix

- Appendix 1 - EECA's draft submission on the Climate Change Commission's draft advice

Cover page

EECA's submission to the Climate Change Commission's 2021 draft advice for consultation

1-page letter from the Chair

About EECA

The Energy Efficiency and Conservation Authority (EECA) is the Crown entity established under the Energy Efficiency and Conservation Act 2000 to encourage, promote, and support the uptake of energy efficiency, energy conservation, and the use of renewable sources of energy in New Zealand. This mandate provides us with the authorising environment to work with a wide range of stakeholders and customers, as we transition to a low carbon and sustainable economy.

Get Alan to insert updated figure.

Summary of key points of EECA's submission

EECA generally supports the Commission's advice and recommendations

EECA welcomes and supports the Commission's overarching finding that we can meet our 2050 targets with existing technology, noting that significant change and action is required. EECA strongly advocates that interventions such as supporting energy efficiency and the uptake of electric vehicles can make a significant contribution to our decarbonisation goals.

We recognise that there are many new low emission technologies being developed in most sectors of the economy, and these have the potential to unlock significant emission reduction options or provide for lower cost decarbonisation pathways. However, the long timeframes required to scale up new technologies and the urgency of our need to decarbonise mean that we cannot wait.

We recognise that the Commission hasn't been tasked with identifying specific policies, this is the role of the Government. As a result, there are a number of the Commission's recommendations that we support in principle, but there will need to be further work to determine if there is a viable policy solution.

EECA has a key role in implementing the policies that would flow from the Commission's advice

EECA's function under the Energy Efficiency and Conservation Act 2000 is to encourage, promote, and support energy efficiency, energy conservation, and the use of renewable sources of energy. Given that a significant portion of New Zealand's emissions are from energy, emission reduction has become an increasing focus of our strategic and operational activity. The goals of efficient use of energy and emission reduction are inseparable.

EECA works in an interesting space, we are a Crown Agent, but have close relationships with both Government and industry. This gives us a unique ability to provide the Government with an 'ear to the ground' to understand the impact of policies on industry and improve the evidence base of policy development.

We utilise our three levers, motivation (information and public engagement), co-investment and regulation to carry out our functions and we are one of the few government agencies capable of directly investing in emission abatement through co-investment in low emission technologies.

Given our experience with direct emission mitigation projects, we welcome the opportunity to make a submission to the Commission on the draft Budgets and share our insights.

There are a few key areas of focus for EECA

There is a lot of interdependence between the areas covered by the Commission's advice. We have focussed our submission on the main areas of relevance to EECA's activities. This is primarily transport, heat, industry and power and the multi-sector strategy.

Given the wide range of subject matter and recommendations covered by the Commission's advice, it is essential that there is coherence as an overall package. For this reason we strongly support the recommendations that relate to developing overarching strategies, such as the National Energy Strategy or bioeconomy plan, to provide clear and coherent direction. Targets such as those

proposed by the Commission should be developed as part of those strategies, to ensure consistency and that the targets are based on strong evidence.

Transport

- EECA generally agrees with the Commission's advice relating to reducing travel by private vehicles and shifting to low emission modes.
- We strongly support the Commission highlighting accelerating light electric vehicle uptake as a time-critical necessary action and the recommendations to achieve this.
- Comment on EV supply – awaiting research by Tim Denne.
- The recommendation to develop a national charging infrastructure plan is of particular relevance to EECA and we are working with government departments to progress this.
- We agree that low carbon fuels such as biofuel and hydrogen will play an important role in decarbonising hard to electrify transport applications.
- EECA supports the development of 'green' hydrogen (produced from renewable electricity) that is economic and can cost-effectively reduce emissions. However, deployment of hydrogen in New Zealand still remains in the demonstration phase.
- We urge caution with the Commission's proposal to set a volumetric target for biofuel uptake, based on the potential for domestic production using woody biomass.
- We suggest that an emission reduction target for low carbon fuels would be more appropriate, based on wider analysis of fuels and feedstocks, including technical feasibility, demand-supply dynamics or maximising emissions reductions.
- EECA recently commissioned research regarding liquid biofuels which we will provide to the Commission. The research covers demand and supply constraints, technology readiness for drop-in biofuels and life-cycle emissions analysis by feedstock. This will help to better understand the viable biofuel sources with greatest emission reduction potential, whether imported or domestically produced.
- The Commission's recommendation for the development of a national plan for the bioeconomy (Necessary Action 6) would be an appropriate and valuable opportunity to discuss the priority uses of our bio-resources, including the place for biofuel.

Heat, industry and power

- Generally agree with the Commission's recommendations, our detailed submission includes some qualifying statements and issues for further consideration.
- EECA agrees process heat, along with transport, is one of New Zealand's best emissions reduction opportunities. However, in EECA's experience, achieving this potential will require government to work alongside industry to overcome the key financial and non-financial barriers to implementing the rapid transitioning from fossil fuels to renewables.
- EECA highlights the Government Investment for Decarbonising Industry (GIDI) fund as an example of a mechanism to realise the technical potential to accelerate emissions reduction in process heat.
- EECA supports renewing the national energy strategy and agrees there is good rationale for expanding New Zealand's policy focus beyond the electricity generation mix to encompass renewable energy use more broadly. However, we feel that the proposed 60% target needs to be tested as the treatment of geothermal electricity generation makes it appear that the amount of renewable energy that New Zealand currently uses is much higher than it is in practical reality.
- Optimising electricity demand through efficiency improvements will be a critical enabler to transport and process heat electrification. The Commission's advice includes a range of

recommendations but the impact of these on achieving emissions reduction will not be equal. We suggest that the Commission indicates the expected impact of these, and therefore the prioritization.

- EECA agrees there is a need for long-term planning on bio-resources, including prioritisation of use (particularly between liquid biofuels for transport and biomass for process heat).
- EECA supports measures to increase the energy efficiency of buildings, and also notes the significant co-benefits of improved buildings in terms of health and wellbeing.

Multi-sector strategy

- We strongly support the proposal that behaviour change at organisational and business level, as well as an individual one, is critical to achieving net zero. EECA has promoted behaviour change through the "Gen Less" public engagement platform since 2019.
- We support measures to support coordinated action on behaviour change and suggest several steps to support this through concrete deliverables and dedicated funding.
- EECA strongly agrees with the recommendations related to aligning investment with climate outcomes (as well as it being a time critical necessary action) and we offer some comment and questions that may assist the commission in clarifying its advice for maximum impact.
- EECA agrees with the recommendations for general strengthening of ETS settings and the intent behind these, but the specific wording in the advice could potentially be enhanced and clarified.

EECA's response at a glance

Key: 🟢 We favour | 🟡 Recommend change | 🔴 We do not favour

Transport

Necessary action 2 - Develop an integrated national transport network to reduce travel by private vehicles and increase walking, cycling, low emissions public and shared transport		
		We recommend that, in the first budget period the Government progress the following steps to meet emissions budgets:
a	🟢	Deliver specific and timebound targets to increase low emissions public and shared transport and walking and cycling, and supporting infrastructure through strengthening the direction of the Government Policy Statement on Land Transport.
b	🟢	Significantly increase the share of central government funding available for these types of transport investment, and link funding with achieving our emissions budgets.
c	🟢	Improve mobility outcomes through measures including supporting public transport uptake nationally and locally by reducing fares for targeted groups (such as for those under 25 years of age), and improving the quality and integration of services.
d	🟢	Encourage Councils to implement first and last kilometre travel solutions in their transport networks, such as increased on-demand and shared vehicle and bike services, secure park and ride solutions at public transport, and encouraging micro-mobility options.
e	🟢	Further government encouragement for working from home arrangements.
Time-critical necessary action 2 - Accelerate light electric vehicle uptake		
	🟢	Light electric vehicle uptake needs to be accelerated as fast as possible. To meet our proposed emissions budgets and be on track for 2050, at least 50% of all light vehicle (cars, SUVs, vans and utes) and motorbike imports should be electric by 2027 (both battery EV and plug-in hybrid EV). To achieve this, we recommend in the first budget period the Government:
a	🟢	Place a time limit on light vehicles with internal combustion engines entering, being manufactured, or assembled in Aotearoa, other than in specified exceptional circumstances. The limit should be no later than 2035 and, if possible, as early as 2030.
b	🟢	Introduce a package of measures to ensure there are enough EVs entering Aotearoa, and to reduce the upfront cost of purchasing light electric vehicles until such time as they are cost competitive with the equivalent ICE vehicle.
c	🟢	Improve the efficiency of the light vehicle fleet and stop Aotearoa receiving inefficient vehicles by introducing an emissions target for light vehicles new to Aotearoa of 105 grams CO2 per kilometre by 2028.
d	🟢	Develop a charging infrastructure plan for the rapid uptake of EVs to ensure greater coverage, multiple points of access and rapid charging, and continue to support the practical roll out of charging infrastructure.
Progress indicators		
a	🟢	Government to have consulted, no later than 30 June 2022, on preferred policy options for accelerating EV uptake (including a date for placing a time limit on the import of ICEs).
b	🟢	Cabinet decisions on preferred policy options to be made, as soon as possible but no later than 31 December 2022, on accelerating EV uptake.
c	🟢	Government to have implemented regulations on improving the fuel efficiency by 30 June 2022.
Necessary action 3 - Accelerate light electric vehicle uptake		

		We recommend that, in the first budget period the Government make progress on the following:
a	🟢	As part of a policy package introduce a fiscal incentive, such as a feebate or subsidy, to reduce the upfront cost of EVs until such time as there is price parity with ICEs.
b	🟢	As part of an equitable transition, evaluate and support interventions such as leasing, hire and sharing schemes to remove barriers and address some of the upfront capital costs of EVs.
c	🟢	Investigate ways to bulk procure and ensure the supply of EVs into Aotearoa and work with the private sector to do so.
d	🟢	Evaluate how to use the tax system to incentivise EV uptake and discourage the purchase and continued operation of ICE vehicles.
e	🟢	Work with the private sector to roll out EV battery refurbishment, collection and recycling systems to support sustainable electrification of light vehicle fleet.
f	🟢	Evaluate the role of other pricing mechanisms beyond the NZ ETS, such as road pricing, can play in supporting the change to a low emissions and equitable transport system.
g	🟢	In setting these policies the Government needs to mitigate impacts for low-income households and people with disabilities, regional and remote access, and with limited access to electricity.

Necessary action 4 - Increase the use of low carbon fuels for trains, ships, heavy trucks and planes

		We recommend that, in the first budget period the Government take the following steps to support the use of low carbon fuels for heavy vehicles such as trucks, planes, ships, and off-road vehicles to meet emissions budgets:
a	🟡	Set a target and introduce polices so that at least 140 million litres of low carbon liquid fuels are sold in Aotearoa by 31 December 2035.
b	🟢	Introduce low carbon fuel standards or mandates to increase demand for low carbon fuels, with specific consideration given to aviation.
c	🟡	Introduce incentives to establish low emissions fuel plants, such as biofuel sustainable aviation fuel, and make those fuels more competitive with traditional fossil fuels.
d	🟢	Place further emphasis on decarbonising the rail system, and establish an investment strategy and clear targets to increase the share of rail and coastal shipping.

Heat, Industry & Power

Time-critical necessary action 3 - Target 60% renewable energy no later than 2035

		Setting a target for renewable energy enables the Government to signal the required emissions reductions across the full energy system. Within that context, the 100% renewable electricity target should be treated as aspirational and considered in the broader context of the energy system that includes electricity, process and building heat and transport. We recommend the Government:
a	🟢	Develop a long-term national energy strategy that provides clear objectives and a predictable pathway away from fossil fuels and towards low emissions fuels, and the infrastructure to support delivery.
b	🟡	Under the framework of the national energy strategy, set a renewable energy target to increase renewable energy to at least 60% by 31 December 2035.

Progress indicator

	🟡	The Government to have, by 30 June 2023, set a renewable energy target of at least 60% by 31 December 2035, set milestones for 2025 and 2030, and released an energy strategy to deliver this target.

Necessary action 5 - Maximise the use of electricity as a low emissions fuel

		We recommend that, in the first budget period the Government take steps to ensure a low emissions, reliable and affordable electricity system to support electrifying transport and industry through progress on the following:
a	🟡	Under the framework of a national energy strategy, set a date by which coal electricity generation assets must be retired.
b	🟢	Under the framework of a national energy strategy, decide how to progress solutions to the dry year problem, when this should happen, and at what cost.
c	🟡	Introduce measures, such as a disclosure regime, to reduce wholesale electricity market uncertainty over Emissions Budgets 1 and 2, to encourage investment in new renewable generation.
d	🟢	Assess whether electricity distributors are equipped, resourced and incentivised to innovate and support the adoption on their networks of new technologies, platforms and business models, including the successful integration of EVs.
e	🟢	Enable more independent generation and distributed generation, especially for remote rural and Māori communities, and ensure access to capital for this purpose.
f	🟢	Monitor and review to ensure electricity remains affordable and accessible, and measures are in place to keep system costs down, such as demand response management.
Necessary action 6 - Scale up provision of low emissions energy sources		
		We recommend that, in the first budget period the Government make progress in scaling up the provision of new low emissions fuels by:
a	🟢	Developing a plan for the bioeconomy alongside the new national energy strategy, across transport, buildings, energy, waste, land use and industry.
b	🟢	Assessing the place that hydrogen has in the new national energy strategy.
Necessary action 7 - Reduce emissions from process heat		
		We recommend that, in the first budget period the Government take steps to reduce carbon emissions from fossil fuelled boilers by:
a	🟢	Urgently introducing regulation to ensure no new coal boilers are installed.
b	🟡	Introducing measures to help reduce process heat emissions from boilers by 1.4 Mt CO2e over 2018 levels by 2030 and by 2 Mt CO2e by 2035.
c	🟢	Increasing support for identifying and reporting on emissions reduction opportunities in industry, including energy efficiency, process optimisation, and fuel switching.
d	🟢	Helping people to access capital to reduce barriers to the uptake of technology or infrastructure upgrades such as boiler conversions, energy efficiency technologies, and electricity network upgrades.
Necessary action 8 - Support innovation to reduce emissions from industrial processes		
		We recommend that, in the first budget period the Government take steps to support innovation in hard-to-abate industrial processes, including by:
a	🟢	Developing a long-term strategy for the future of hard-to-abate industries, including iron, steel making, cement and lime production and petrochemical production. This strategy should be developed alongside the national energy strategy, future Economic Plans and strategies for an equitable transition (see time-critical necessary actions 1 and 3).
b	🟢	Based on the outcome of the strategy, investigating whether bespoke solutions requiring research and development specific to Aotearoa will be required.

Buildings

Necessary action 9 - Increase energy efficiency in buildings

We recommend that, in the first budget period the Government introduce measures to transform, transition and reduce energy use in buildings. Measures should include:

a	●	Continuing to improve energy efficiency standards for all buildings, new and existing stock, through measures like improving insulation requirements. Expand assistance which targets low-income households.
b	●	Introducing mandatory measures to improve the operational energy performance of commercial and public buildings.
c	●	Setting a date by when no new natural gas connections are permitted, and where feasible, all new or replacement heating systems installed are electric or bioenergy. This should be no later than 2025 and earlier if possible.

Multisector

Necessary action 16 - Support behaviour change

● We recommend that, in the first budget period the Government embed behaviour change as a desired outcome in its climate change policies and programmes in order to enable New Zealanders to make choices that support low emissions outcomes.

Time-critical necessary action 6 - Align investments for climate outcomes

To meet emissions budgets and achieve the 2050 target, it is important that policy decisions and investments made now do not lock Aotearoa into a high emissions development pathway. Safeguards and signals will be needed to prevent this, including a specific focus on ensuring long-lived assets such as infrastructure are net-zero compatible. To achieve this, we recommend in the first budget period the Government:

a	●	Immediately start to factor target-consistent long-term abatement cost values into policy and investment analysis in central government. These values should be informed by the Commission's analysis which suggests values of at least $140 per tonne by 2030 and $250 by 2050 in real prices.
b	●	Encourage local government and the private sector to also use these values in policy and investment analysis.
c	●	Ensure that economic stimulus to support post-COVID-19 recovery helps to bring forward the transformational investment that needs to happen anyway to reach our joint climate and economic goals.
d	●	Investigate and develop a plan for potential incentives for businesses to retire emissions intensive assets early.
e	●	Require the Infrastructure Commission to include climate change as part of its decision- and investment-making framework, including embedded emissions and climate resilience
f	●	Investigate and develop plans to mobilise private sector finance for low emissions and climate-resilient investments.

Progress indicators

a	●	Government to start, as soon as possible and by no later than 31 March 2022, factoring target-consistent long-term abatement cost values into policy and investment analysis.
b	●	Government to publish, as soon as possible and by no later than 31 March 2022, how the COVID-19 economic stimulus is helping to accelerate the climate transition.

Time-critical necessary action 7 - Driving low emissions choices through the NZ ETS

		The Emissions Trading Scheme (NZ ETS) needs to drive low emissions choices consistent with emissions reduction targets in Aotearoa, including a focus on gross emissions reductions. In the first budget period the Government should:
a		In the next annual update to NZ ETS settings:
i	🟢	Align unit volumes with emissions budgets, taking into account the need to reduce the NZU stockpile.
ii	🟢	Increase the cost containment reserve trigger price to $70 as soon as practical and then every year by at least 10% plus inflation.
iii	🟢	To maintain continuity with recent prices, immediately increase the auction reserve trigger price to $30 as soon as practical, followed by annual increases of 5% plus inflation per year.
b	🟢	Amend the NZ ETS so that it contributes, as part of a package of policies (see time-critical necessary action 5), to delivering the amount of afforestation aligned with our advice on the proportion of emissions reductions and removals, consistent with budget recommendation 2.
c	🟢	Establish a sound market governance regime for the NZ ETS as soon as possible to mitigate risks to market function, as some of these risks are potentially catastrophic for the scheme's effectiveness. This work should be advanced through an interagency team including MBIE for its financial markets expertise.
Progress indicators		
a	🟢	Government ensure that, in the next annual update to the NZ ETS settings, unit volumes are aligned with emissions budgets and price control settings are increased.
b	🟢	Government to develop proposals as soon as possible to establish a sound market governance regime for the NZ ETS, and to have legislated to address the most significant risks by no later than 30 June 2023.
Necessary action 19 - Continued ETS improvements		
		We recommend that, in the first budget period the Government make progress on:
a	🟢	Developing options and implementing a plan for recycling some or all of the proceeds from NZ ETS unit auctions into emissions reductions, adaptation, equitable transitions and meeting international climate change obligations.
b	🟢	Undertaking a first principles review of industrial allocation policy.
c	🟢	Continuing to phase out industrial allocation.
d	🟢	Exploring alternative policy instruments that could address the risk of emissions leakage.
e	🟢	Providing more information to reduce uncertainty about adjustments to NZ ETS settings, particularly how it intends to manage unit volumes in light of the split-gas 2050 target.
f	🟢	Clarifying the role and avenues for voluntary mitigation in Aotearoa.
Budget recommendation 5 The rules for measuring progress towards emissions budgets and the 2050 target		
d	🟡	From 2021, if the Government allows voluntary offsetting for carbon neutral claims to take place in Aotearoa through cancelling NZUs, adjustments corresponding to the amount of NZUs cancelled must be made to the relevant emissions budget, or to the inventory, to avoid the emissions reductions claimed from being negated by increases to the NZ ETS cap.

Detailed response to the CCC's consultation documents

Consultation question 4: Limit on offshore mitigation for emissions budgets and circumstances justifying its use (p. 38)

Do you support budget recommendation 4? Is there anything we should change, and why?

EECA supports the recommendation to limit offshore mitigation for the first emissions budgets. EECA's work has identified there is a significant pool of emissions reductions opportunities that could be unlocked domestically at a cost for government below the cost of offshore mitigation. Energy efficiency also has a number of well-documented co-benefits[1], which can be realised within New Zealand if we pursue domestic mitigation.

[1] Capturing the Multiple Benefits of Energy Efficiency – Analysis - IEA 2015

Consultation question 9: Establish processes for incorporating the views of all New Zealanders (p. 44)

Do you support enabling recommendation 5? Is there anything we should change, and why?

EECA supports the intent to make New Zealanders' views front and centre of the discussions that need to happen to balance the fairness of the transition. We would also highlight the current work in this space, and the opportunity to use EECA's existing *Gen Less* platform to further these objectives.

Through EECA's own research into perceptions about climate change and energy emissions, done in the context of our Gen Less campaigns, we already know a fair bit about public views on climate change. We know that New Zealanders understand the need to take climate action, but are seeking direction on how this should occur and what role they need to play

With the right level of effort and investment we can achieve this type of climate empowerment through public education, awareness and communication. Research shows that while the public has a high understanding of and is generally receptive to arguments in favour of addressing climate change, most people do not know how to make a meaningful contribution.

Research shows people are seeking leadership, particularly looking for government and business to take the lead.

A majority of New Zealanders want others to do more to reduce our climate change impact. EECA research (January 2019) found that 88% of people want companies to do more, 76% want government to do more and 76% want other people to do more.

If government intends to step proactively into engaging with the public on climate change it will be important to identify shared objectives across relevant agencies, which can guide coordinated action on public awareness, communication and education. Four potential core cross-government objectives, with increasing level of engagement with the public include:

- ensure the public are **well-informed** and understand government plans and policies
- **engage** people in effective consultation on plans and policies to help ensure the best decisions are made for New Zealand and New Zealanders as we transition to a low emissions economy
- **co-develop and support the shared vision** being led by government
- motivate people to **take action** in their own lives to reduce emissions and make **long-term decisions** that will help them and New Zealand transition well.

In doing so, it will be important to identify and build upon what is already in place and working within government and in different sectors of society. In particular, EECA's public GenLess platform, which aims to increasing willingness of public and businesses to engage with climate change, offers a well-suited and increasingly well-recognised platform to host a public engagement programme.

Consultation questions 13: An equitable, inclusive and well-planned climate transition (p. 103)

Do you support the package of recommendations and actions we have proposed to increase the likelihood of an equitable, inclusive and well-planned climate transition? Is there anything we should change, and why?

EECA supports the emphasis placed on ensuring that the climate transition is equitable and inclusive.

Of particular relevance for EECA, the Commission's Necessary Action 1 (d) recommends there is a need to "Assess the Government's current standards and funding programmes for insulation and efficient heating to determine whether they are delivering at an appropriate pace and scale, and how they could impact housing and energy affordability. The Government should give particular consideration to potential flow through costs to tenants, and to government owned housing stock".

EECA's current low-income home retrofit programme *Warmer Kiwi Homes* is one of government's key interventions in alleviating energy hardship in New Zealand. It is the latest iteration of a low-income home retrofit subsidy programme that has been running in various forms since 2009. Since the start of the current programme in July 2018, 53,177 insulation and heating retrofits (39,491 insulation retrofits and 13,686 heating retrofits, respectively) have been completed. EECA is regularly reviewing the design and targeting of this programme to ensure that it delivers maximum benefit to low-income households at maximum cost-effectiveness for public money. A recent cost-benefit analysis returned a benefit to cost ratio of 4.7:1.

EECA is just beginning a scheduled outcome evaluation of the WKH programme, involving empirical research, which will provide valuable new information about the extent to which the programme is delivering warm, dry homes and how the heating element of the programme and behavioural and social factors are contributing to improving occupant comfort and wellbeing.

Findings of the evaluation are expected by February 2022 and will provide an important source of information for the consideration of the impact and effectiveness of these types of insulation and heating programmes on housing and energy affordability and wider benefits.

Consultation question 14: Transport (p. 110)

Do you support the package of recommendations and actions for the transport sector? Is there anything we should change, and why?

Necessary action 2 - Develop an integrated national transport network to reduce travel by private vehicles and increase walking, cycling, low emissions public and shared transport

EECA supports action to increase the use of low emission transport modes, such as walking, cycling and public and shared transport, as well as optimising or reducing travel.

EECA's research shows that only 4 in 10 New Zealanders understand that transport is their single largest contributor to carbon emissions. Behaviour change will be a key enabler to help shift people to choose other low emission transport modes such as walking, cycling and public transport and alternate choices such as working from home. EECA's Gen Less campaign has been getting the message out to the public to help people understand the impact of their transport choices on carbon emissions.

Nearly a third of car trips in NZ are under 2km[2] - and there is opportunity for these "first and last kilometre" trips to be provided by other low emission transport modes and services. EECA agrees that a key challenge to address will be the provision of safe, affordable, convenient and accessible frequent public or shared transport choices. Provision of infrastructure and the design of cities and regions will allow the shift away from private fossil fuel vehicle use and EECA will support the role of government agencies in this important work.

EECA has also supported the demonstration of several electric bus and car share projects through the Low Emission Vehicle Contestable Fund. These technologies and services are now being rolled out in cities around New Zealand, however, there is a need to accelerate their adoption.

Time-critical necessary action 2 - Accelerate light electric vehicle uptake

EECA supports the Commission highlighting the transition of the light vehicle fleet as a time critical necessary action. New Zealand's emissions breakdown makes it clear that the light vehicle fleet provides the greatest opportunity for reducing transport emissions, particularly as there are low emission alternatives already available in the form of battery and plug in hybrid electric vehicles.

[Note that we are testing several of the CCC's assumptions against TIMES-NZ, such as 50% of light vehicle imports electric by 2027, 40% of fleet electric by 2035]

Below are EECA's comments on the Commission's recommended package of measures for accelerating light electric vehicle uptake:

Recommendation A - Place a time limit on light vehicles with internal combustion engines entering, being manufactured, or assembled in Aotearoa, other than in specified exceptional circumstances. The limit should be no later than 2035 and, if possible, as early as 2030

EECA agrees that it will be necessary for New Zealand to set a date from which the importation/manufacture/assembly of light internal combustion engine vehicles will not be allowed. With the target year of the Clean Car Import Standard being 2025, and many of our trading partners adopting similar policies, it seems appropriate to set this date some time between 2030 and 2035, as suggested by the Commission.

[2] Ministry of Transport NZ Household Travel Survey Data 2015-2017.

Recommendation B - Introduce a package of measures to ensure there are enough EVs entering Aotearoa, and to reduce the upfront cost of purchasing light electric vehicles until such time as they are cost competitive with the equivalent ICE vehicle

Constraints to the access of electric vehicles from overseas markets could result in a scarcity of vehicle volume and choice. These restrictions on supply could increase the comparative cost of electric vehicles and therefore slow the progress of transitioning the domestic fleet. EECA has commissioned research on EV supply constraints – to be completed in late February/early March [placeholder for research findings to be inserted here].

[If the EV supply constraints research notes that EV supply is not encouraging, we may need to note that there may be a need to support the uptake of efficient ICE vehicles (such as 'soft' hybrids) in the short term. However, we note that, given New Zealand households hold on to vehicles until they are about 20 years old, this risks delaying the electrification of the vehicle fleet and will require emissions reductions in other non-transport sectors to offset.]

While the upfront cost of electric vehicles is currently acting as a barrier to EV uptake, we note that the lower total cost of ownership compared to fossil-fuelled vehicles improves the competitiveness of electric vehicles.

[Note we are testing TIMES-NZ results of assumed price parity – CCC assumes 2024]

Recommendation C - Improve the efficiency of the light vehicle fleet and stop Aotearoa receiving inefficient vehicles by introducing an emissions target for light vehicles new to Aotearoa of 105 grams CO2 per kilometre by 2028

EECA supports the introduction of a vehicle fuel economy standard and welcomes the Government's announcement that the target year for the Clean Car Import Standard will be 2025.

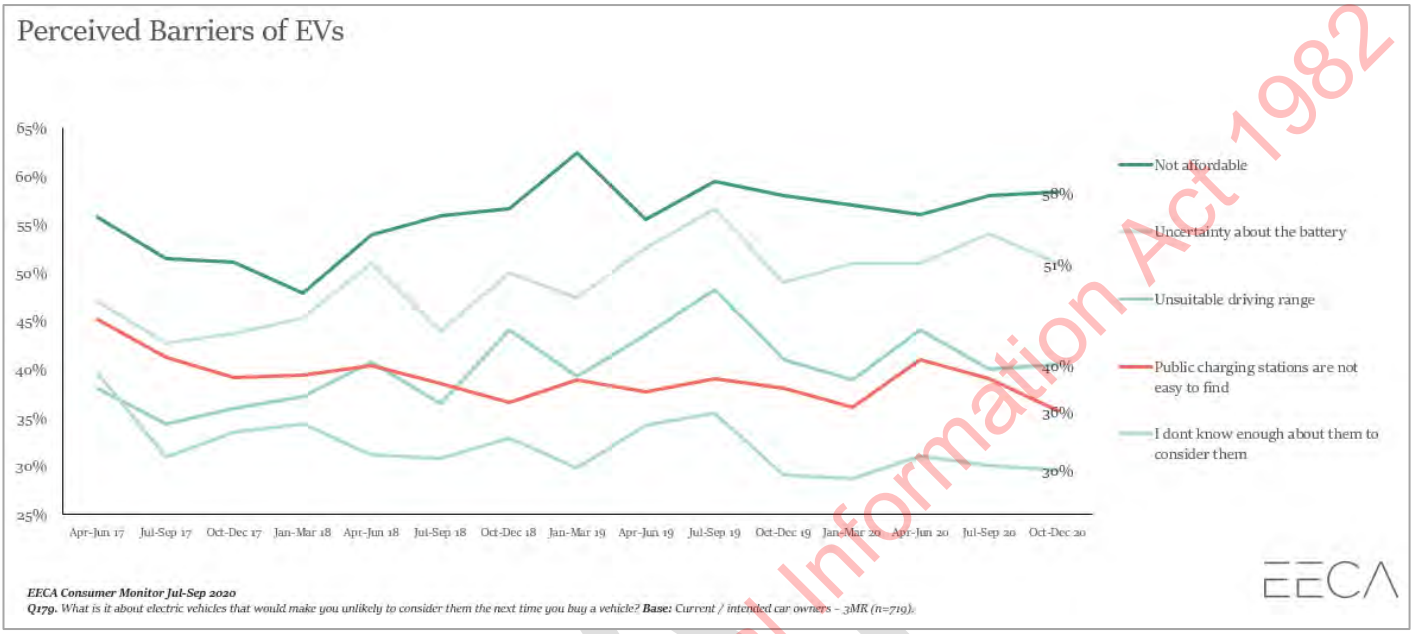
Recommendation D - Develop a charging infrastructure plan for the rapid uptake of EVs to ensure greater coverage, multiple points of access and rapid charging, and continue to support the practical roll out of charging infrastructure

EECA has had an important role in the rollout of New Zealand's electric vehicle charging network. The Low Emission Vehicle Contestable Fund has provided co-funding to over 1,000 EV charging projects (over 600 for public EV chargers). So far, the rollout of New Zealand's EV charging network has started from a low base and is led by a few charging service providers. This has been an appropriate approach up to this point as the number of electric vehicles on the network has been low. However, with the introduction of policies to significantly increase the uptake of EV's, a more coordinated plan for future EV charging infrastructure and investment is required.

EECA supports the recommendation of a national EV charging infrastructure plan and is working with other government departments to advance this work. Any charging plan should go beyond simply setting out the proposed location of public EV charging infrastructure. The plan should also factor in and be able to respond to the future EV uptake scenarios that influence charging requirements, wider electrification policies and strategies, current government programmes for co-investment and feed into consideration of electricity distribution network upgrades. The plan should also consider issues such as lack of competition from charging providers, rural gaps, low and middle-income communities, workplace and commercial buildings and residential charging.

Necessary action 3 - Accelerate light electric vehicle uptake

EECA also supports the recommended actions for accelerating light electric vehicle uptake under Necessary Action 3. There are a range of actions needed to reduce the cost and increase the supply of EVs in New Zealand. EECA's consumer monitoring shows that the upfront cost premium of electric vehicles is the primary barrier to EV uptake in New Zealand.



Necessary action 4 - Increase the use of low carbon fuels for trains, ships, heavy trucks and planes

EECA agrees that a range of low carbon fuels, such as biofuel and hydrogen will be needed for New Zealand to decarbonise hard to electrify applications such as planes and ships. It is not clear at the stage whether applications in heavy duty road freight will be better suited for electrification or use of low carbon liquid or gaseous fuels.

Hydrogen

In 2019, EECA commissioned Concept Consulting to undertake research on the cost effectiveness of hydrogen technologies for decarbonising the New Zealand economy relative to alternatives and we recently supported Are Ake in their initial study of the economics of using green hydrogen to decarbonise long-distance heavy freight in New Zealand. Through the delivery of our funding programmes, we have also had insight into hydrogen technology and applications.

EECA supports the development of 'green' hydrogen (produced from renewable electricity) that is economic and can cost-effectively reduce emissions. Growing policy commitment and global investment have the potential to make hydrogen a commercially viable low-carbon alternative to some fossil fuel applications in the future (as New Zealand is a technology taker).

At present, there are significant challenges for the commercial scale deployment of green hydrogen in New Zealand relative to its carbon abatement impact. EECA agrees that there are significant barriers and challenges on both the supply and demand side for hydrogen to become an economically viable alternative.

Deployment of hydrogen in New Zealand still remains in the demonstration phase. Pilot and demonstration projects have the potential to de-risk the technology for first adopters and reduce safety, regulatory and technical barriers.

Biofuel

EECA recently commissioned research regarding liquid biofuels, which covers demand and supply constraints, technology readiness for drop-in biofuels and life-cycle emissions analysis by feedstock.

We have attached this report to this submission as it informs EECA's view on the liquid biofuels opportunity for New Zealand.

[Note that we are testing the CCC's low carbon fuel target (140ML by 2035) against TIMES-NZ]

Recommendation A - Set a target and introduce polices so that at least 140 million litres of low carbon liquid fuels are sold in Aotearoa by 31 December 2035

From discussion with the Commission, we understand this target relates to liquid biofuels. Due to the variance in lifecycle emissions of different biofuel types and feedstocks, we suggest that a volumetric target (i.e. in litres) may not be the best approach to achieve emissions reductions. We would support instead an emissions reduction target for low carbon fuels.

The 140ML target appears to be based on production estimates from available wood feedstock rather than on a wider analysis including technical feasibility, demand-supply dynamics or maximising emissions reductions. This raises several points:

- The life-cycle emissions vary a lot from one biofuel to another (mainly depending on feedstock and associated land use change). Therefore, emissions reduction should be the main driver of any biofuel policy (especially incentives) in order to prevent the use of biofuels with poor emissions benefits (or even increased emissions compared to fossil fuels).
- There might be more valuable (such as chemicals) or efficient (such as direct combustion for process heat) uses of wood than the production of liquid biofuels. A national discussion is needed on what are the priority uses of this limited resource. The Commission's recommendation for the development of a national plan for the bioeconomy (Necessary Action 6) would be an appropriate and valuable opportunity for this discussion to take place.
- The blending limits for biodiesel and bioethanol suggest that the potential demand for these fuels on an energy basis could be 6% of current demand for diesel fuels by heavy trucks and marine, and 6% of current demand for petrol fuels by light vehicles respectively (biodiesel is not suitable for aviation).
  This potential could be realised immediately with the import of biofuels, rather than waiting to set up a domestic production industry to provide 3% of demand (as seems to be suggested in the Commission's draft advice).
- The potential incremental demand for drop-in diesel is much higher assuming a 50% concentration limit, i.e. around 44% of total energy required by diesel heavy trucks, marine and aviation, and 47% of total energy required by light petrol vehicles.
- Our research suggests that, due to technology readiness level, production of drop-in biofuel from wood biomass is unlikely to be at scale before 2035.
- Our research includes a possible ambitious scenario where liquid biofuel uptake increases from 0.88 PJ (28.38 million litres) p.a. in 2022 to 11.57 PJ p.a. (359.8 million litres) by 2030, reaching a maximum output of 48.4 PJ (1,443 million litres) p.a. by 2040.

Recommendation B - Introduce low carbon fuel standards or mandates to increase demand for low carbon fuels, with specific consideration given to aviation

[We will test with the Commission on 1 March what is meant by "specific considerations for aviation".]

Regarding use of SAF biofuels for aviation, we would like to highlight that even with a very low-carbon biofuel, the radiative effects related to the release of combustion particles in high atmosphere would still result in aviation having a significant impact on climate[3]. Even a very low carbon biofuel would solve only a third of the problem, and therefore does not appear as a solution compatible with a net zero objective.

Recommendation C - *Introduce incentives to establish low emissions fuel plants, such as biofuel sustainable aviation fuel, and make those fuels more competitive with traditional fossil fuels*

This recommendation seems to cover incentivising production of biofuels, as well as incentivising demand for biofuels (reducing the cost premium of the fuel).

Demand and production are two different aspects and we feel should be treated separately in the Commission's advice.

The experience with Marsden Point shows that ensuring availability for the domestic market is more complex than building a local production capacity: securing feedstock is a starting point, and ensuring demand is key.

The challenge is that feedstocks are globally tradable commodities, as are biofuels. This can create a complete disconnect between local production and local availability.

We agree that there may be a role for incentives for increasing demand in the short term. However, we are cautious about the proposal to provide incentives for domestic production. The opportunity cost to subsidise domestic production is unlikely to be justified by domestic emissions reduction only, and there is a need to factor in other considerations such as security of supply, economic impact, competing usages for the feedstock and factors that would result in a competitive advantage for production in New Zealand.

The capital cost alone for producing 100 million litres by 2030 would be in the range of $300-$760 million, depending on the conversion technology.[4] Such projects will not take place if investors have low confidence in capital cost recovery and prospects to scale production to reduce costs per unit of energy.

We suggest that the potential for incentives for biofuel production or demand should be considered as part of the wider bioeconomy plan recommended in Necessary Action 6.

[3] https://www.sciencedirect.com/science/article/pii/S1352231020305689?via%3Dihub#!
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5940853/
https://archive.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-6-2.html
https://acp.copernicus.org/articles/19/8163/2019/#&gid=1&pid=1

[4] For FT catalysis and hydro-cracking, the estimate assumes a current capex of $9.12/litre fuel as per (BioPacific Partners, 2020), and a 3% p.a. learning curve to 2030. For pyrolysis oil upgrade, the estimate assumes a capex value of $3.03-$7.6/litre fuel depending on whether the hydrogen is produced or purchased. This cost range is derived from capex estimates by (Wright, et al., 2010) for the n-th plant and a pioneer plant. The pioneer plant is assumed to be built in 2035, and the n-th plant in 2025.

Off-road diesel

We would like to draw the Commission's attention to an opportunity not mentioned in the advice and that might have been overlooked: Off-road diesel. This umbrella term refers to the following (non-road) uses of diesel:

Sector	**Application examples**
Aviation	Airport ground service equipment
Rail	Rail maintenance equipment
Marine	Recreational boating, personal watercraft, fishing
Agriculture	All-terrain farm vehicles, farm motorcycles, tractors
Construction	Off-road trucks and tractors, generators, machinery
Industrial	Forklifts, generators, other industrial equipment
Mining	Mining equipment, off-road mining trucks
Forestry	Forestry equipment, off-road logging trucks
Residential	Residential lawn and garden equipment
Commercial	Commercial lawn and garden equipment, heating, forklifts
Government	Defence, lawn and garden equipment
Recreational	Motorsport, off-road motorbikes

There was about 36PJ of non-transport diesel use in 2019[5] (including an unknown portion for heating). This is equivalent of 2.6 Mt CO2e/year, so the opportunity for emission reduction is likely to be within the range of 1 to 2 Mt CO2e/year.

EECA has commissioned research to increase the understanding of this opportunity, for which solutions such as hybrid and biofuels could be relevant. We will share these insights with the Commission when they are available in mid-2021.

In the meantime, the Commission could mention the opportunity of off-road diesel in the list of potential targets for low-carbon fuels in its advice.

[5] MBIE Energy Balance Tables

Consultation question 15: Heat, industry and power sectors (p. 118, p. 111)

Do you support the package of recommendations and actions for the heat, industry and power sectors? Is there anything we should change, and why?

Time-critical necessary action 3: Target 60% renewable energy no later than 2035

Recommendation A - Develop a long-term national energy strategy that provides clear objectives and a predictable pathway away from fossil fuels and towards low emissions fuels, and the infrastructure to support delivery

EECA supports the development and implementation of a long-term national energy strategy to transition away from fossil fuels to renewable fuels. Any energy strategy should be complementary to and aligned with the NZEECS 2017-2022.

We note we are in the final year of the existing New Zealand Energy Strategy 2011-2021.

Recommendation B - Under the framework of the national energy strategy, set a renewable energy target to increase renewable energy to at least 60% by 31 December 2035

Under section 21 (1) of the Energy Efficiency and Conservation Act 2000, EECA's function is to encourage, promote, and support energy efficiency, energy conservation, and the use of renewable sources of energy. EECA agrees there is technical and economic potential for New Zealand to significantly increase its use of renewable energy, and that doing so will be critical to achieving New Zealand's climate change goals.

Under the New Zealand Energy Efficiency and Conservation Strategy (NZEECS) 2017-2022, New Zealand has an existing target of 90 per cent of electricity generation from renewable sources by 2025. EECA agrees there is good rationale for expanding New Zealand's policy focus beyond the electricity generation mix to encompass renewable energy use more broadly. An appropriate energy target should be developed as part of any long-term energy strategy, with emissions reduction prioritised as the outcome.

The development of a target should be based on an accurate evidence base of where the greatest opportunity exists. Currently, New Zealand's amount of renewable energy is about 40% of Total Primary Energy Supply (TPES) calculated using the International Energy Agency (IEA) rules. We support using international standards to ensure consistent reporting and allow for meaningful comparisons. However, the IEA treats geothermal electricity generation differently to hydro, solar or wind electricity generation. In essence, all the energy extracted from geothermal fluid is added to our TPES rather than the net electricity generation. As the thermodynamic potential of relatively low temperature heat is low, only about 15% of this extracted geothermal heat becomes electricity. If geothermal electricity generation was accounted for the same way as hydro generation, i.e. electricity exported from the power station, then New Zealand's renewables percentage falls to 26% rather than the 40% currently reported.

Of this 26%, about 76% of it (or 20% of our total consumer energy) relates to electricity, including that from geothermal. Virtually all of the non-electricity renewable energy is the energy, ultimately from trees, which the wood processing industry uses. In other words, outside of the electricity and wood processing sectors virtually all (>95%) of New Zealand's energy needs are currently met by fossil fuels.

Necessary Action 5: Maximise the use of electricity as a low-emission fuel

EECA agrees electrification will be critical to achieving New Zealand's climate change objectives. Optimising electricity demand through efficiency improvements will be a critical enabler to transport and process heat electrification. EECA's 2019 'Energy Efficiency First' report found potential for cost-effective efficiency measures that collectively comprise an estimated 10-12% of electricity demand. At costs between $15-$50/MWh, this efficiency potential is significantly cheaper than even the lowest-cost new renewable generation currently available.[6]

EECA has a range of existing policies that contribute to this, including energy product regulations under the trans-Tasman Equipment Energy Efficiency (E3) Programme. The 86 million products sold under the programme since 2002 have saved 59.55 PJ of electricity, equating to $1.45 billion of national benefit, and 2.33 Mt of CO2-e. It will also be critical to ensure market / regulatory settings enable and encourage the integration of new innovative technologies, such as demand response / flexibility and battery storage, to improve power system flexibility and security as the percentage of electricity supplied by intermittent renewables increases.

Generally, it will be critical to ensure policies to encourage demand-side electrification (in transport and process heat) are consistent with and mutually reinforce policies to increase renewable generation, and that electricity prices are optimised to support decarbonisation.

The Commission provides a number of recommendations under this action covering a wide range of areas. It would be useful if these recommendations could more explicitly provide a sense of priority, to assist consideration of where resource is best focussed.

Recommendation A - Under the framework of a national energy strategy, set a date by which coal electricity generation assets must be retired

Any regulation to mandate the phase-out of coal or other fossil fuel electricity generation assets should be considered carefully under the framework of a national energy strategy and balance the energy trilemma of cost, sustainability, security.

Whether mandating the phase-out of coal electricity generation is necessary to achieve a highly renewable electricity system that enables electrification while balancing the trilemma will need to be carefully considered in the context of New Zealand's climate goals and existing market and policy settings. Mandating the retirement of plant is just one option among other options that could be explored, for example –

- setting a mean-year coal generation target of zero;
- setting grid emissions factor targets/pathways;
- requiring thermal generation usage to be tied to new renewable build.

Recommendation B - Under the framework of a national energy strategy, decide how to progress solutions to the dry year problem, when this should happen, and at what cost

As noted above, efficiency measures to optimise demand will be critical to integrating a higher percentage of intermittent renewable generation while mitigating against dry year risk.

[6] https://www.eeca.govt.nz/our-work/research/research-papers-and-guides/energy-efficiency-first/

This recommendation could be strengthened to require dry year solutions to be optimised for cost and carbon reduction impact. The current recommendation relies on a national energy strategy putting these in place, however this cannot be guaranteed with more direct guidance.

Recommendation C - Introduce measures, such as a disclosure regime, to reduce wholesale electricity market uncertainty over Emissions Budgets 1 and 2, to encourage investment in new renewable generation

Encouraging investment in new renewable generation is desirable and necessary. It is not clear whether a disclosure regime can sufficiently address the prevailing uncertainties. A liquid and long term wholesale contracts market or some other minimum price mechanism may be necessary.

Recommendation D - Assess whether electricity distributors are equipped, resourced and incentivised to innovate and support the adoption on their networks of new technologies, platforms and business models, including the successful integration of EVs

Agree (see above).

This is important, however the Commission should perhaps go further in terms of what needs to happen if the assessment finds distributors are insufficiently equipped to facilitate the transition.

Recommendation E - Enable more independent generation and distributed generation, especially for remote rural and Māori communities, and ensure access to capital for this purpose

Community, independent and distributed generation has a role to play in the electricity system where they support the energy trilemma (affordability, security, sustainability). It is important to be clear on what problems the different technologies and interventions are trying to solve (e.g. energy affordability, poverty, emission reduction, cold damp housing etc). At a time when very large volumes of capital investment are needed, care needs to be taken to ensure that this capital delivers on the desired outcomes.

Another key consideration is that any rules introduced should be set so that independent generation is not unnecessarily impeded.

It is also important that distributed generation is provided in a coordinated manner under a Demand Flexibility framework that ties together the different elements in the system (solar photovoltaics, Home Energy Management Systems, storage, electric vehicles and appliances.

Recommendation F - Monitor and review to ensure electricity remains affordable and accessible, and measures are in place to keep system costs down, such as demand response management

This recommendation could be interpreted as suggesting price controls. It is important not to conflate system efficiency with affordability. Both are important for the transition, however mechanisms to achieve them are different, and potentially operate in conflict with one another. Preventing electricity from becoming uncompetitive when priced against fossil alternatives is a key element of the transition, and an efficient system will be needed to enable this. However, an efficient system also relies on cost-reflective pricing and effective cost recovery. Where measures are needed to address affordability issues related to poverty, these should be implemented by the appropriate social agencies.

As noted above, energy efficiency, and demand response / flexibility will be critical to enabling a highly renewable electricity system that supports decarbonisation through electrification.

Necessary Action 6: Scale up the provision of low-emission energy sources

Recommendation A - Developing a plan for the bioeconomy alongside the new national energy strategy, across transport, buildings, energy, waste, land use and industry

EECA agrees there is a need for long-term planning on bio-resources, including prioritisation of use. This is required to optimise the balance between value added and energy security. It is an important aspect of an orderly transition avoiding unnecessary costs. Hence, any plan will need to address trade-offs for using limited bio-resources, particularly between liquid biofuels for transport and biomass for process heat.

The barriers to developing bio-resource supply-chains are unlikely to be uniform across sectors. For example, process heat sites are diffused across multiple sites through the country, while any biofuel production site will likely be concentrated in one region. These dynamics have important implications for supply-chains and distribution of costs.

As noted by the Commission, there are significant opportunities to replace fossil fuels for process heat with biomass. However, many process heat users face significant financial and non-financial barriers to implementing these opportunities, and policy to help overcome these barriers can catalyse deepening/broadening of bio-resource supply-chains. The Government Investment to Decarbonise Industry (GIDI) has funding available for projects to convert process heat boilers to biomass.

[If forestry planting across the country is managed and planned by the government (like an urbanisation plan), then it can be a way to address biomass availability in some regions.]

Recommendation B - Assessing the place that hydrogen has in the new national energy strategy

EECA agrees the role of hydrogen should be considered as part of any new national energy strategy.

While the role of hydrogen is still being discovered EECA notes that [hydrogen is not a primary source of energy and therefore can't participate to energy security as is mentioned in page 90 of the advice report.]

Necessary Action 7: Reduce emissions from process heat

Recommendation A - Urgently introducing regulation to ensure no new coal boilers are installed

EECA agrees there is a need for regulation to ensure no new coal boilers are installed, and that such regulatory action is consistent with New Zealand's climate change objectives. EECA also supports investigating regulatory options to accelerate the phase-out of existing coal and other fossil fuelled boilers. Regulations can provide an effective mechanism for reducing 'avoidable' emissions, that is, emissions from fossil fuel usage that could be cost-effectively reduced through efficiency and/or replaced by renewables using existing technologies.

Regulations can complement the ETS and complementary measures, such as the GIDI Fund.

Recommendation B - Introducing measures to help reduce process heat emissions from boilers by 1.4 Mt CO2e over 2018 levels by 2030 and by 2 Mt CO2e by 2035

EECA agrees process heat, along with transport, is one of New Zealand's best emissions reduction opportunities. However, in EECA's experience achieving this potential will require government to

work alongside industry to overcome the key financial and non-financial barriers to implementing the rapid transitioning from fossil fuels to renewables.

The proposed quantum of process heat emissions reductions is technically feasible and, according to the Ministry for the Environment's marginal abatement cost analysis, can be achieved at costs that are within the Commission's assumed shadow price pathway. To the extent that process heat abatement opportunities can be achieved at marginal abatement costs lower than the Commission's expected shadow carbon price pathway (and in some cases below current ETS prices or at negative abatement costs), these abatement opportunities can be considered 'no regrets' and should therefore be prioritised within the next emissions budget period. EECA's experience from the first funding round of the Government Investment to Decarbonise Industry reinforces this point.

As noted by the Commission, achieving these targets will require process heat users to rapidly begin replacing existing fossil fuel assets with renewables, starting in year one of the first emissions budget period and then continuing throughout the second and third budget periods. Implementing these changes will be expensive for businesses, with financial barriers compounded by technical and other non-financial barriers. Achieving the Commission's recommended process heat emissions reductions within the recommended timeframes will therefore require government to support industry to overcome the barriers to accelerating their transition from fossil fuels to renewables, alongside a combination of higher emissions prices and/or regulations.

The new $70 million Government Investment to Decarbonise Industry (GIDI) Fund, administered by EECA, provides businesses with access to capital co-funding that, alongside EECA's suite of other energy service programmes (including the Energy Transition Accelerator), are supporting businesses to start transitioning away from fossil fuels to renewables.

It would be useful if the Commission's advice relating to recommendations A and B could be a bit clearer and consistent with the optimal pathway outlined in the advice:

- In table 3.1, the "process heat" line states "Replace coal with biomass and electricity" during the first two budgets (with the third budget focussing on replacement of gas by biomass and electricity).
- In Part 3.8.5 Industry and Heat, figure 3.15 (page 64), the graph shows that almost all coal use disappears by 2035 and just a third of it remains in 2030.
- On page 76, it is stated that "Deep cuts in coal use between 2020 and 2030 (by about ~75% from 2010 levels)" are required to be consistent with a 1.5C trajectory.

It is important to be clear with this messaging, in light of discussions about the changes to the RMA.

Recommendation C - Increasing support for identifying and reporting on emissions reduction opportunities in industry, including energy efficiency, process optimisation, and fuel switching

Agree, and we note MBIE's 2019 discussion document 'Accelerating Renewable Energy and Energy Efficiency' included options under section 1 to address information failures, including requiring large energy users to publish Corporate Energy Transition Plans (including reporting emissions annually) and conduct energy audits every four years.

Businesses face a range of information barriers with the result that many existing cost-effective opportunities to improve energy efficiency and reduce emissions (including at or below current ETS prices) remain unrealised. Moreover, requiring businesses to report on emissions reduction

opportunities will improve transparency and data inputs to guide policy and long-term transition planning.

EECA has been increasingly active in this space in the past few years, with the roll out of our Energy Transition Accelerator programme, which offers bespoke technical support to large emitters to develop long-term transition plans. EECA also offers a range of support to help large energy users and other businesses overcome information barriers to improving energy efficiency and identifying fuel switching opportunities, including energy audits, feasibility studies, support for energy graduates, and technology demonstration funding.

We would like to highlight that support is only one part of the equation, and not necessarily the main barrier to wider and faster uptake. Other barriers that need to be addressed include:

- EECA's mandate is limited to energy related emissions, while businesses logically want to assess their emissions as a whole. An alignment of EECA's mandate with a consistent approach of the low-carbon transition would facilitate uptake and reduce costs for businesses.
- While some businesses are thinking about the transition and are willing to work with and be supported by EECA, others lack the incentives to address this long-term challenge. Triggering a review of existing consents and mandating transition plans would create the required incentive.

Recommendation D - Helping people to access capital to reduce barriers to the uptake of technology or infrastructure upgrades such as boiler conversions, energy efficiency technologies, and electricity network upgrades.

Agree, and as noted above there is technical potential to accelerate emissions reduction consistent with the Commission's draft process heat emissions reduction targets. EECA's GIDI Fund is an existing mechanism for achieving this.

Any increased government funding should be complementary the ETS, and carefully considered alongside both regulatory and non-regulatory options.

EECA is experienced in working with industry to address barriers to uptake of technology, energy efficiency and renewable energy.

While some can struggle to access capital (because they are over-indebted for example), it is not our experience that access to capital is the main issue.

Overall, in a context of low regulation incentives, the challenge is mostly about improving the return on investment of the transition projects so they can be attractive enough for decision makers and become a priority for their organisation.

Necessary Action 8: Support innovation to reduce emissions from industrial processes

Recommendation A - Developing a long-term strategy for the future of hard-to-abate industries, including iron, steel making, cement and lime production and petrochemical production. This strategy should be developed alongside the national energy strategy, future Economic Plans and strategies for an equitable transition (see time-critical necessary actions 1 and 3).

Recommendation B - Based on the outcome of the strategy, investigating whether bespoke solutions requiring research and development specific to Aotearoa will be required.

While EECA does support the intent to support innovation to reduce emissions from industrial processes, it is not necessarily the case for hard-to-abate industrial processes.

In New Zealand, hard-to-abate industrial processes consist of "one-plant sectors". Most innovation in these globalised sectors are likely to come from abroad, especially to reduce emissions, which involves significant rethinking of these processes (hence the name "hard-to-abate").

Therefore, the required investments would be very expensive for a small country alone.

In addition, these plants are controlled by international owners, which can decide to move their plant at will. So there is a real risk at investing significant amount of taxpayer money in these assets.

However, there is a need to support a wider adoption of innovations reducing emissions in a wide range of sectors of New Zealand economy.

EECA published an international technology scan[7] listing some of the innovation which wider use would help the transition, with a range of co-benefits.

Necessary Action 9: Increase energy efficiency in buildings

EECA supports measures to increase the energy efficiency of buildings, and also notes the significant co-benefits of improved buildings in terms of health and wellbeing.

The Commission's *Evidence Report Chapter 9: Which path could we take?* includes some assumed levels of energy efficiency and energy intensity improvement. EECA's view on these assumptions is included below:

- **Residential / existing:** The Commission assumes that existing homes' energy intensity improves by 6% by 2035. We feel that this level of improvement is eminently achievable, particularly if you consider that this level of improvement would be achieved with a conversion to heat pump water heating alone.
- **Residential / new build:** The Commission assumes that by 2035, new builds are 35% more energy efficient compared to today's performance. While it is unclear if the Commission is comparing to today's new builds or today's average house, either way it should be achievable. This seems to align with the timeline of the "final step" of MBIE's Building for Climate Change programme in terms of timeline and probably energy use, which we support.
- **Commercial:** The Commission assumes a 30% improvement in commercial and public buildings' energy intensity is possible by 2035 compared to today's performance. Based on

[7] https://genless.govt.nz/assets/Business-Resources/International-technology-scan.pdf

experience with the NABERSNZ building energy efficiency rating system, we feel that this level of improvement is also achievable.

Recommendation A - Continuing to improve energy efficiency standards for all buildings, new and existing stock, through measures like improving insulation requirements. Expand assistance which targets low-income households

The Warmer Kiwi Homes programme, administered by EECA and targeting low-income households, supports insulation and clean, efficient heating to improve the energy efficiency of homes. Support for this programme should continue until all target homes have received retrofits.

EECA is also strongly supportive of the Building for Climate Change programme, administered by MBIE, which will initially focus on improved standards for new builds.

Recommendation B - Introducing mandatory measures to improve the operational energy performance of commercial and public buildings

EECA continues to support the use of the NABERSNZ tool, a system for rating the energy efficiency of office buildings. There are already a number of public and private sector organisation that use NABERSNZ as a straightforward means of helping to make their building more efficient.

The use of this tool could be expanded as a means of delivering on the Commission's budget of a 30% improvement in commercial and public buildings' energy intensity by 2035. For example, the tool could be used to drive energy efficiency improvements in apartment buildings, shopping centres, data centres, hotels and public hospitals.

Recommendation C - Setting a date by when no new natural gas connections are permitted, and where feasible, all new or replacement heating systems installed are electric or bioenergy. This should be no later than 2025 and earlier if possible

EECA strongly endorse a strategic view being taken of New Zealand's future energy systems. Given available technologies and international trends, this is likely to identify 'all-electric' homes and commercial buildings as an efficient solution for the majority of NZ, in which case a roadmap should be developed to avoid stranded assets.

Consultation question 19: Multisector strategy (p. 134)

Do you support the package of recommendations and actions to create a multisector strategy? Is there anything we should change, and why?

General comments on the multi-sector approach

A combination of policies and market interventions will be necessary the meet the emissions targets. Although the introduction to chapter 6 accurately describes the types of measures needed to reach these targets, the multisector section is quite limited in what it considers. Although the introduction refers to "emissions pricing and other market incentives to influence choices" the advice relies heavily on the Emissions Trading Scheme (ETS) being the primary driver of emissions reduction and underplays the potential in areas such as behaviour change.

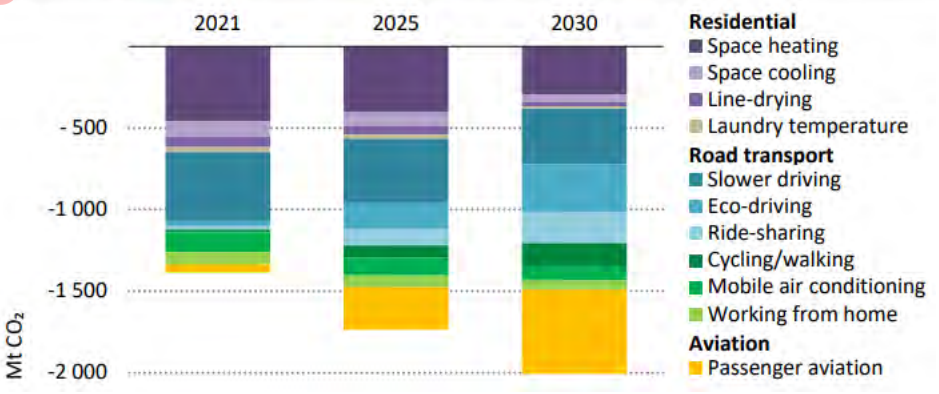
The ETS, whilst theoretically presenting the most efficient path to the reduction of GHG emissions, remains a work in progress with limited authenticated impact on energy emissions to date. The multisector strategy appears to omit a number of areas that have been identified by other agencies (including the government's emissions reduction plan work programme). We are interested to understand if these differences are based on a different perception of priority or need. In particular, areas such as innovation, research, and training, all seem to be critical aspects of delivering the emissions budgets, but are not apparent in the Commission's multisector strategy.

Necessary action 16 - Support behaviour change

EECA agrees that behaviour change is a key component of any plan to escape carbon lock-in. We strongly support the proposal that behaviour change at organisational and business level, as well as an individual level, is critical to achieving net zero. EECA advises caution, however, against limiting the discussion to specific, small-scale changes. Ad-hoc behaviour change efforts risk creating only short-lived impact – we must pursue deep and long-term systemic change to lock-in behaviour change at the scale required.

IEA modelling in the World Energy Outlook 2020 shows that "behavioural changes are essential to achieve the scale and speed of emissions reductions required." The IEA examined 11 individual measures related to behaviour, which in total would reduce CO_2 emissions by 2 Gt in 2030 (see the figure below). While these illustrative measures would not necessarily be the right mix for New Zealand, they highlight the critical role of behaviour change in reaching New Zealand's net-zero target, and the scale of the behaviour change activity that is needed.

Figure 4.15 ▷ Impact of behaviour changes on CO_2 emissions in the NZE2050



Source: IEA, World Energy Outlook 2020

A better understanding of behavioural sciences has the potential to turn previously invisible influences into explicit choices, and to guide the public towards making choices with long-term benefit in both private and collective terms. Behavioural insights and behavioural interventions can be used to support the deployment of traditional policy tools such as regulation, information and market-based policies. They can play a key role in enhancing the impact of a package of measures to trigger systemic change among New Zealanders on the scale required to reach net zero by 2050.

EECA has an active work programme on behaviour change, and has been promoting behaviour change through its *Gen Less* public engagement platform since 2019.

EECA has a strategic process underway to develop better ways of influencing values and addressing the value-action gap through effective communications and behaviour change – our *Hearts & Minds* strategy. By combining bottom up individual behaviour change with top down systemic influencing actions, the Hearts and Minds strategy aims to create fertile ground for systemic change.

Some of the barriers to behaviour change (e.g. removing the fringe benefit tax driving utes sales by businesses) will be out of EECA's mandate so EECA intends to work with other agencies to dovetail behavioural campaigns with measures to remove regulatory barriers in a coordinated and planned manner.

EECA also intends to measure the gap between what people and businesses will need to do in a net-zero world, and what they are doing today. This will inform our progress towards our objectives and the evolution from year to year.

Gen Less is aimed at influencing energy-related purchasing and other behavioural choices at the individual level. *Gen Less* has been informed by ongoing market research and monitoring of individuals' and businesses' values and actions related to climate change. Noting the importance of building upon what is already in place, we would reiterate the opportunity to harness the Gen Less platform as a channel for increased behaviour change efforts by government (see our comments on consultation question 9 above).

While we agree with the pressing need for further behavioural research in an Aotearoa-specific context, the recommendations underplay the existing evidence and experience available to support behaviourally informed interventions in the short term.

At one end of the spectrum, well-tested behavioural insights can be used to inform policy interventions relatively easily, for example by integrating key principles into development of communications and messaging to ensure it is easy, attractive, social and timely (EAST).

At the other end of the spectrum, specifically designed behavioural interventions might seek to encourage low-carbon behaviours using approaches such as rewards programmes or gamification of carbon reduction commitments and achievements. There is potential for every policy or programme to benefit from behaviourally informed framing, at a minimum, to ensure that unduly complex and convoluted procedural requirements or messaging do not stifle potential behaviour change.

EECA is in the early stages of an empirical research project which will explore the impacts of the *Warmer Kiwi Homes* programme, with a particular focus on understanding the behavioural factors which influence heating and other energy-using practices in response to the intervention. The results, expected early 2022, should provide a strong basis for improved, behaviourally informed future iterations of the programme. These insights will be reinforced by other research projects in this space, such as HEEP2 being developed by BRANZ with strong behavioural learning objectives.

We agree that meaningful behaviour change action will require a collaborative, focused and multiagency approach, but suggest a dedicated team with a strong, clear mandate should be tasked to lead this.

Discussion between government agencies with relevant activities around public engagement (and behaviour change) on climate change has already begun in the context of the Government's Emissions Reduction Plan.

Given coordination groups already exist, next steps need to move current activities from simple information sharing to meaningful coordinated action. We believe this is best achieved through establishing a dedicated team with mandated objectives, delivery commitments, accountability and dedicated funding, to support development of concrete coordinated projects. We believe this is best achieved by establishing a dedicated behavioural insights team within government, as has been recommended by the OECD.

This team would support across government agencies to scope, research and design sustainable and audience focused behaviour change initiatives as proposed by the Commission and track progress in behaviour and value change.

There is precedent for creating a distinct government agency focused on behaviour change. Internationally, similar agencies have been established at the highest level, as with Australia's Behavioural Economics Team, or nested within a ministry or regulatory agency, such as in Ireland, Japan, the Netherlands and the UK.

This could be reinforced with a requirement for all policies and programmes to include behavioural diagnostics, intervention elements and a communications plan - activities that a Behavioural Insights team could support agencies with.

This team could also provide a coordination function across agencies' communications programmes, to ensure intervention and communications are aligned in their individual messaging (link to rec 5).

It is worth noting that EECA currently occupies analogous role to that of NZTA, performing its role as the operations arm of the energy system, implementing MBIE's energy policy function. With additional resourcing, EECA may be well placed to lead delivery of future cross government coordinated behaviour change activities in climate change.

We agree that piloting, testing and evaluation of impacts of interventions on behaviour and development of New Zealand-specific insights will be a key activity.

Continuous monitoring can shed light on the long-term impacts of behavioural interventions, however agencies generally lack resource to monitor these effects over long-enough time periods.

Monitoring and evaluation remains the responsibility of each individual agency, but a stronger direction from central government requiring rigorous and systematic policy and programme evaluation is needed to support this in practice.

There is an opportunity to support the continuous improvement of climate change related interventions through improved coordination and knowledge sharing among groups conducting research and evaluation. This function could be delivered by the proposed behavioural insights body or by another centralised monitoring and evaluation promotion team.

Time-critical necessary action 6 - Align investments with climate outcomes

EECA strongly agrees with this recommendation and the priority given to it.

We would like to offer some comment and questions that may assist the commission in clarifying its advice for maximum impact.

Recommendation A - Immediately start to factor target-consistent long-term abatement cost values into policy and investment analysis in central government. These values should be informed by the Commission's analysis which suggests values of at least $140 per tonne by 2030 and $250 by 2050 in real prices

EECA notes that Treasury has recently published shadow-pricing guidance for use in government investment decision-making. Establishing appropriate shadow carbon prices is a complex task with a wide range of uncertainty. It would be helpful if the Commission could clarify the recommendation in terms of the process it recommends be used to establish 'target-consistent prices' (a term which will be a key component of implementing this recommendation). We agree that the Commission's own modelling will be a useful resource, however there are other potential sources that may give different or more nuanced results.

Recommendation B - Encourage local government and the private sector to also use these values in policy and investment analysis

This recommendation is sensible. However, it would be helpful if the Commission could provide more clarity on what sorts of mechanism they envisage being used to deliver on this. Government agencies are required (or at least very strongly encouraged) to follow Treasury processes for investment and spending, but local government and the private sector have no such requirement.

Recommendation C - Ensure that economic stimulus to support post-COVID-19 recovery helps to bring forward the transformational investment that needs to happen anyway to reach our joint climate and economic goals

EECA agrees with this recommendation and has made resources available to help out with this where appropriate. This recommendation may benefit from slightly more precise wording, in that logically it will refer to un-committed post-COVID recovery stimulus, as money which has already been spent cannot be influenced.

Recommendation D - Investigate and develop a plan for potential incentives for businesses to retire emissions intensive assets early

EECA agrees that some additional incentives may need to be made available to businesses if some assets are to be retired within the required timeframe. However, we would urge caution in developing a specific plan for this component. Any scheme will have the risk of being manipulated and the asset retirement barrier will need to be addressed in the wider context of barriers. One role for voluntary carbon markets could be to bring forward replacement of high emissions assets, thus addressing the 'time gap' problem.

Recommendation E - Require the Infrastructure Commission to include climate change as part of its decision- and investment-making framework, including embedded emissions and climate resilience

EECA expects that the Infrastructure Commission (InfraComm) would already be subject to Treasury shadow-pricing guidance. As such it would be helpful if the Commission could clarify what additional measures should apply to InfraComm. It would be useful if the Commission advised how it envisages

embedded emissions and climate resilience should be accounted for, and why this approach would be limited to InfraComm and not extended to all Government investment.

Recommendation F - Investigate and develop plans to mobilise private sector finance for low emissions and climate-resilient investments

There is a growing demand for ways to demonstrate climate action and address climate related risk by businesses. This is mainly coming from new participants driven by risk management rather than pure marketing.

We support this action and we would like to highlight the potential of the voluntary carbon market (VCM) as a vehicle for private sector finance investments. Today, the existing VCM is niche and could be scaled up significantly.

EECA has been working with Motu and a wide range of stakeholders to address this challenge using the voluntary carbon market opportunity arising from the beginning of the Paris Agreement period.

We have attached the report we have developed with Motu to this submission as it outlines the problems, the opportunities and the current thinking in term of solutions. This report also addresses the waterbed effects with the ETS.

Voluntary mitigation can help to bridge current gaps in mitigation ambition, financing, and speed that could undermine the long-term goals of the Paris Agreement.

Through our work, EECA identified a convergence of trends, barriers and opportunities and concluded that the VCM has the potential to be a vehicle for private finance to help unlock emissions reduction by funding domestic energy transition.

There are domestic emission reduction opportunities in New Zealand that are cost effective compared to alternatives such as forestry or offshore credits. These opportunities (energy efficiency and renewable energy projects) are not responsive to energy (and therefore carbon) prices because they face non-price barriers or the price signal is not yet sufficient to trigger investments.

As demonstrated with the GIDI fund, an injection of capital could unlock some of these opportunities by improving the return on investment of the projects. The VCM could be a source of private funding for these projects.

Additionally, there is an incentive mismatch between businesses with cost-effective opportunities but low incentives/willingness to act and businesses with willingness to transition but few opportunities (overly expensive or not technically mature). Enabling these businesses to split the value and the claims for these projects would enable a shift from the zero-sum game status quo to a collaborative environment.

Shortcomings of the Kyoto period offsetting and carbon neutral approach have resulted in relatively low uptake and low trust in this market. Fixing the accounting issue by increasing transparency is key to increase trust and fix the behaviour issues related to current offsetting practices.

Allowing the VCM to fund domestic projects could also improve trust by bringing the outcomes of the spending closer to New Zealanders.

Time Critical necessary action 7 - Driving low emissions choices through the NZ ETS

Recommendation A - In the next annual update to NZ ETS settings:

(i) Align unit volumes with emissions budgets, taking into account the need to reduce the NZU stockpile

(ii) Increase the cost containment reserve trigger price to $70 as soon as practical and then every year by at least 10% plus inflation

EECA agrees with the general strengthening of ETS settings and the intent behind these.

The specific wording in the advice could potentially be enhanced and clarified.

Specifically:

Recommendation A(i) - This recommendation could be more specific about the expected change in unit auction volumes. The current recommendation specifies a principle for adjustment (i.e. alignment with budgets) but stops short of identifying the quantum of adjustment the Commission expects to see. This means that if government adjusts the auction volumes at all, this could be claimed to be complying with this recommendation, when actually it is not a sufficient adjustment. A specific range of auction volumes "i.e. Commission analysis suggests that the appropriate range of auction volumes is X to Y million units per year" would be a more effective recommendation.

Recommendation A (i) and (ii) - A fundamental principle of the ETS is that it makes use of a market mechanism to determine the price. While having well signalled price corridors is a useful feature of the ETS, as it provided a degree of confidence about price levels, care should be taken that the ETS is not over-constrained.

The recommendations are set at specific prices, with specific escalation rates. Given the timeframe, the starting price is unlikely to be problematic, however the escalation rates may need to be revisited over time. A more useful approach would be to reference the price setting to ETS market outcomes from a preceding period. For example, "The auction reserve trigger price will be set at the average of the previous 3 months published ETS price".

The justifying comment "these changes are needed because maintaining current settings will lead to failure to meet emissions budgets" should be rephrased for clarity and accuracy. At present it implies a direct link between the ETS settings and New Zealand's emissions. While the ETS is a key tool in managing emissions, it is neither fully effective, nor the only measure being applied to the emissions problem.

Recommendation B - Amend the NZ ETS so that it contributes, as part of a package of policies (see time-critical necessary action 5), to delivering the amount of afforestation aligned with our advice on the proportion of emissions reductions and removals, consistent with budget recommendation 2

This recommendation would benefit from improved clarity and further explanation. It implies some sort of differentiation between forest types, but it is not easy to determine how this would work in practice. While the detail will be developed in consultation with affected parties, a more tangible strawperson example would provide affected parties with a better basis for discussion.

Recommendation C - Establish a sound market governance regime for the NZ ETS as soon as possible to mitigate risks to market function, as some of these risks are potentially catastrophic for the scheme's effectiveness. This work should be advanced through an interagency team including MBIE for its financial markets expertise

Our understanding is that the intent of this recommendation is for the Government to speed up implementation of the market governance work programme already identified. The progress indicator refers to 'the most significant risks' however it is not clear from the advice what the Commission believes these to be.

Necessary action 19 - Continued ETS improvements

Recommendation A - Developing options and implementing a plan for recycling some or all of the proceeds from NZ ETS unit auctions into emissions reductions, adaptation, equitable transitions and meeting international climate change obligations

Recycling of ETS revenue would be a valid means of increasing Government funding for the transition, however direct hypothecation is the not the only means of achieving this. Some additional discussion around the range of possible options would be helpful (i.e. revenue recycling could be done via Treasury investment policy instead). Additionally, the target areas for recycling revenue into are quite broad. Can the Commission offer additional guidance on prioritisation or hierarchy of competing uses?

Recommendation B - Undertaking a first principles review of industrial allocation policy

Industrial allocation policy merits a first principles review. However, due to the potential wealth transfers involved, any review has the potential to become a pitched battle between opposing viewpoints. An independent party may be better placed to undertake this review, perhaps the Commission themselves could undertake this task if directed.

Recommendation C - Continuing to phase out industrial allocation

The Government has put in place a policy to phase out industrial allocation slowly and over a long timeframe. It would be useful to understand if the Commission recommends maintaining this policy or accelerating the phase-out of industrial allocation to be consistent with targets and budgets and ensuring a fair and equitable burden of action across the economy.

Recommendation D - Exploring alternative policy instruments that could address the risk of emissions leakage

Emissions leakage can occur from all sectors of the economy. It would be useful if the Commission can clarify whether this recommendation relates to industrial allocation to EITE sectors, or more broadly (i.e. including agriculture). If the recommendation does not include primary production then perhaps the Commission could consider merging recommendation b, c, and d into a single recommendation that says "Adjust the industrial allocation regime and related policies to be consistent with targets and budgets while managing risks of carbon leakage".

Recommendation E - Providing more information to reduce uncertainty about adjustments to NZ ETS settings, particularly how it intends to manage unit volumes in light of the split-gas 2050 target

Reducing uncertainty in the ETS settings is important for encouraging long-term investment activity in emissions reduction. However, the need to reduce uncertainty is somewhat inconsistent with discussions in the advice about managing 'the waterbed effect' (Evidence report Chapter 16, page 8), which suggests fluidly adjusting auction volumes to account for actual emissions reductions both inside and outside the ETS. It would be helpful if the Commission could clarify how these competing objectives would best be managed.

Recommendation F - Clarifying the role and avenues for voluntary mitigation in Aotearoa

We do not share the Commission's view that, providing an adjustment, when a NZU is cancelled, it is equivalent to removing a tonne of emissions from the atmosphere. This theoretical reasoning does not seem to take into account the significant amount of NZUs stockpiled by some businesses, most of which were received for free as a result of over allocation.

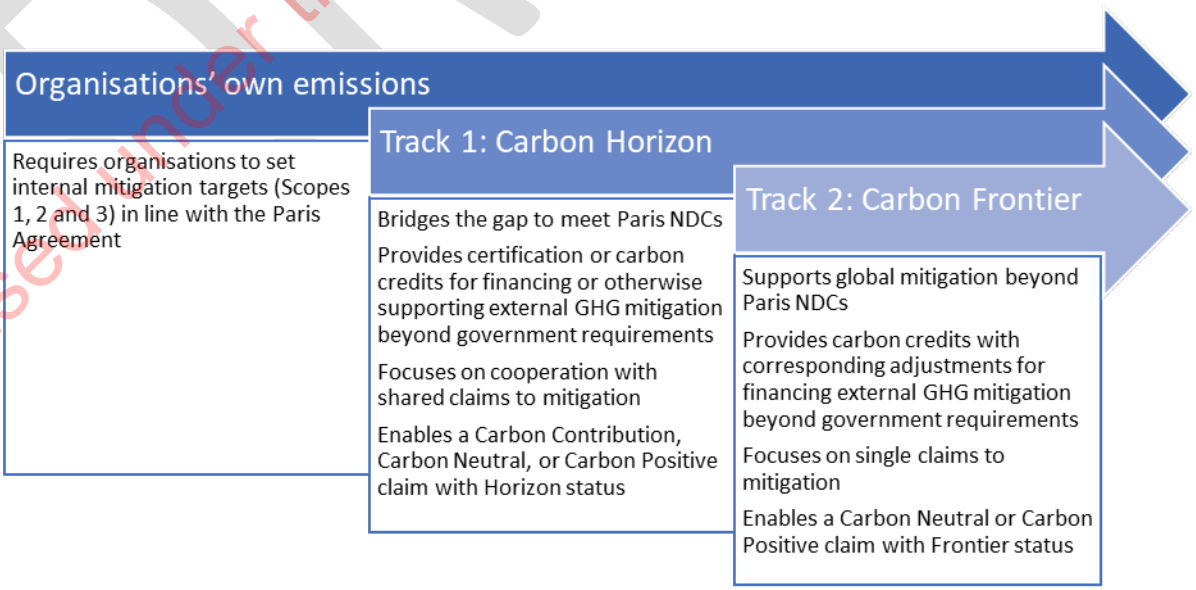
However, we do support the general recommendation, although it would be helpful if the Commission could provide a clearer position. This could be used as a starting point for inter-agencies discussion on the matter.

As mentioned in Recommendation F of Time Critical Necessary Action 7, EECA has been working on this topic with Motu and a wide range of stakeholders.

We think that the voluntary carbon market (VCM) has a key role to play to unlock domestic transition projects facing non-price barriers, or for which the price signal is not yet sufficient to trigger investments when the opportunity arise (e.g. asset replacement).

From the joint work with Motu and the workshops participants, we suggest potential solutions, including:

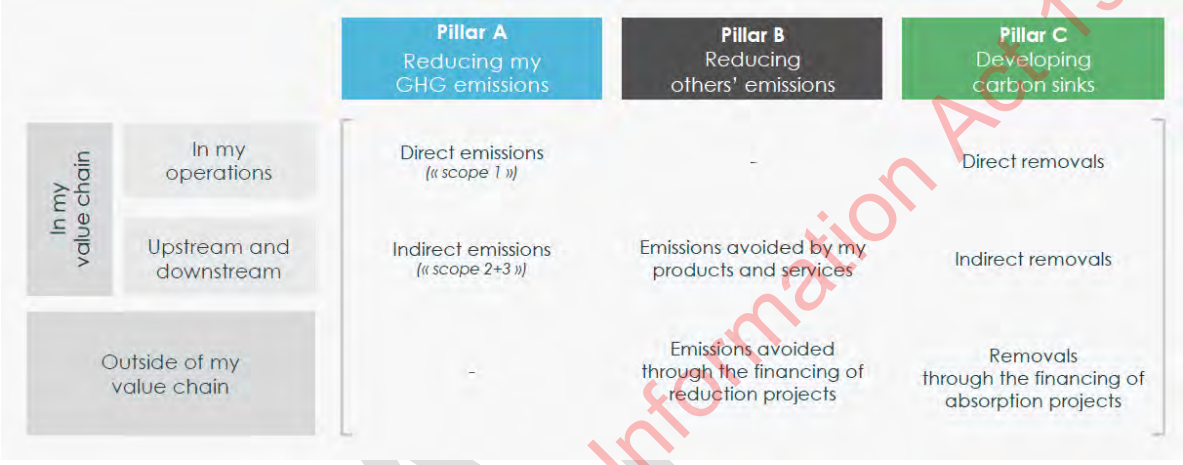
a) A straw proposal for a two-track system intended to boost voluntary mitigation at scale with benefits for both organisations and government.



In the past, voluntary mitigation typically focused on generating and trading VCCs eligible for carbon-neutral offsetting claims. While retaining that option with new features to make it Paris-compatible, this proposal expands the scope of eligible voluntary mitigation to include

recognition for more diverse forms of cooperation with shared gains and greater valuation of environmental, social, cultural, and economic co-benefits. It is scalable for the global transition toward net-zero emissions.

b) An alternative, "dashboard" approach to carbon accountability for organisations, increasing transparency and allowing shared claims to favour collaboration.
With this approach, an organisation's performance would be distinct from helping others, and the gross emissions would be distinct from removals. It would result in a clearer risk exposure for investors and shareholders.
An example of such approach has been developed by the Net Zero Initiative:



Adoption of such reporting would unlock better outcomes such as:

- Allowing increase of gross emissions from a company producing goods or services that unlock greater emissions reductions for their customers (such as energy providers).
- For the state sector, it would highlight investments in domestic reduction projects as a valid option compared to purchasing offshore credits to cancel.

Cover page

EECA's submission to the Climate Change Commission's 2021 draft advice for consultation

Letter from the Chair

To the Climate Change Commission,

On behalf of the Energy Efficiency and Conservation Authority (EECA), I would like to congratulate the Commission on the release of its draft advice. This represents the first major release from the Commission and the product you have delivered reflects the amount of work that has gone into its development.

It is essential for New Zealand to have clear, evidence-based, independent advice on how we can progressively meet our 2050 net zero emission ~~reduction~~ targets. The Commission's draft advice provides a clear message that the emissions budgets and proposed policy direction are 'ambitious but achievable'.

EECA has ~~been proud to provide~~ prioritised its resources to provide input to the Commission's work, based on our experience working with the public and private sectors to encourage, promote, and support the uptake of energy efficiency, energy conservation, and the use of renewable sources of energy in New Zealand.

EECA's purpose and statutory functions mean we have an important role in the implementation of the government's response to several key areas covered by the Commission's advice. We look forward to continue working with the Commission, wider government, industry and the public on our transition~~essential shift~~ to a low emission economy.

Kind regards

Elena Trout
Chair, EECA Board

About EECA

The Energy Efficiency and Conservation Authority (EECA) is ~~a~~the Crown entity established under the Energy Efficiency and Conservation Act 2000 to encourage, promote, and support the uptake of energy efficiency, energy conservation, and the use of renewable sources of energy in New Zealand. This mandate provides us with the authorising environment to work with a wide range of stakeholders and customers, as we transition to a low carbon and sustainable economy.

Key points of EECA's submission

EECA generally supports the Commission's advice and recommendations

EECA welcomes and supports the Commission's overarching finding that we can meet our 2050 targets with existing technology, noting that significant change and action is required as well as the need to overcome some of the cost barriers associated with the existing technology. EECA strongly advocates that interventions such as supporting energy efficiency and the uptake of electric vehicles, and the move to renewable energy sources for our process heat ~~can~~needs can make a significant contribution to our decarbonisation goals.

We recognise ~~that~~ there are many new low emission technologies being developed in most sectors of the economy, and these have the potential to unlock significant emission reduction options with the increasing potential ~~or provide~~ for lower cost decarbonisation pathways. However, the long timeframes normally required to scale up new technologies and the urgency of our need to decarbonise mean the existing barriers need to be overcome.

~~that we cannot wait.~~

We appreciate ~~that~~ the Commission has not been tasked with identifying specific policies, this is the role of the Government. As a result, there are a number of the Commission's recommendations that we support in principle, but there will need to be further work to determine viable policy solutions.

The scale and breadth of policy work that is required to develop the Government's Emission Reduction Plan means that it is essential ~~that~~ this work is well coordinated across government departments. The structures and frameworks to ensure this happens are currently being developed and we agree with the Commission's advice that these will be critical to enabling coordinated and timely action.

EECA has a key role in implementing the policies that would flow from the Commission's advice

EECA's function under the Energy Efficiency and Conservation Act 2000 is to *encourage, promote, and support energy efficiency, energy conservation, and the use of renewable sources of energy.* Given that a significant portion of New Zealand's emissions are from energy, emission reduction has become the primary~~an increasing~~ focus of our strategic and operational activity. The goals of efficient use of energy the use of ~~and~~renewables and emission reductions are inseparable.

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EECA works in an interesting space — we are a Crown Agent but have close relationships with both Government and industry. This gives us a unique ability to provide the Government with an 'ear to the ground' to understand the impact of policies on businesses~~industry~~ and improve the evidence base and implication of policy development.

We utilise our three levers, motivation (~~information and~~ public engagement and behaviour change), co-investment and regulation to carry out our functions and we are one of the few government agencies currently~~capable of~~ directly investing in emission abatement through co-investment in low emission technologies.

Given our experience with direct emission mitigation projects, we welcome this~~e~~ opportunity to make a submission to the Commission on the draft Budgets and share our insights.

There are a few key areas of focus for EECA

There is a lot of interdependence between the areas covered by the Commission's advice. We have focussed our submission on the main areas of relevance to EECA's activities. This is primarily transport, heat, industry and power and the multi-sector strategy.

Given the wide range of subject matter and recommendations covered by the Commission's advice, it is essential ~~that~~ there is coherence as an overall package. For this reason we strongly support the recommendations that relate to developing overarching strategies, such as the national energy strategy or bioeconomy plan, to provide clear and coherent direction. Targets such as those proposed by the Commission should be developed as part of those strategies, to ensure ~~that~~ the targets are consistent, based on strong evidence, and support the overall outcome of reducing greenhouse gas emissions.

Another point that is relevant across all sectors is the important balance between effort to transition existing technology and processes compared to interventions that stop the introduction of new high emission technologies and processes. Using the vehicle fleet as an example it will be much more difficult to transition the existing fleet to low emission vehicles if we continue importing high emission vehicles into the fleet. For this reason we recommend that Government should place short-term priority on initiatives that keep high-emitting technologies out of the country and on shore asset investment that is not reflecting minimum carbon principles.

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The sector-specific key points in EECA's submission are summarised below.

Transport

- EECA generally agrees with the Commission's advice relating to reducing travel by private vehicles and shifting to low emission modes.
- We strongly support the Commission highlighting accelerating zero emission light electric vehicle (EV) uptake as a time-critical necessary action and the recommendations to achieve this.
- We agree that EV supply constraints and high upfront costs are two of the key barriers that need to be addressed to increase EV uptake. EECA's work suggests ~~that~~ supply constraints are likely to limit the extent to which all domestic market segments can be supplied with EV's until about 2030.
- Noting the potential short/ medium term supply constraints for EV's, it would be valuable if the Commission could include analysis on the uptake of Internal Combustion Engine (ICE) hybrids (as a cost effective near term transition option for consumers) and the impact this would have on its modelling scenarios and EV uptake up to about 2030.
- The recommendation to develop a national charging infrastructure plan is of particular relevance to EECA and we are working with government departments to progress this.

- We agree that low carbon fuels such as biofuel and hydrogen could play a role in decarbonising hard to electrify transport applications but currently there are considerable cost barriers to overcome before widespread uptake could occur.
- EECA supports the development of 'green' hydrogen (produced from renewable electricity) that is economic and can cost-effectively reduce emissions. However, in line with the Commission's approach to rely on existing technologies to transition, the assumptions on emissions reductions delivered by the hydrogen pathway should be conservative as there are still major barriers to overcome.
- We urge caution with the Commission's proposal to set a volumetric target for biofuel uptake, based on the potential for domestic production using woody biomass. Biofuels are not all low emissions, so a volumetric target does not ensure emission reduction is the priority.
- We suggest that an aggregate emission reduction target for all low carbon fuels would be more appropriate, based on wider analysis of fuels and feedstocks, including technical feasibility, demand-supply dynamics or maximising emissions reductions.
- EECA recently commissioned research regarding liquid biofuels which accompanies our submission. The research covers demand and supply constraints, technology readiness for drop-in biofuels and life-cycle and supply ~~emissions~~chain emissions analysis by feedstock. This will help to better understand the viable biofuel sources with greatest emission reduction potential, whether imported or domestically produced.
- The Commission's recommendation for the development of a national plan for the bioeconomy (Necessary Action 6) would be an appropriate and valuable opportunity to discuss the priority uses of our bio-resources, including the place for biofuel.

Heat industry and power

- EECA generally agrees with the Commission's recommendations. Our detailed submission includes some qualifying statements and issues for further consideration.
- EECA agrees that process heat, along with transport, is one of New Zealand's best emissions reduction opportunities. In EECA's experience, achieving this potential will require government to work alongside industry to overcome the financial and non-financial barriers to rapidly transitioning from fossil fuels to renewables.
- EECA highlights the Government Investment for Decarbonising Industry (GIDI) fund as an example of a mechanism to realise the technical potential to accelerate emissions reduction in process heat. The projects receiving funding in the first round of the GIDI Fund will deliver significant emission reductions, at average marginal capital abatement cost (private + co-funding) of $23.6 per tonne CO2e.
- Electrification is a key pillar in the Commission's decarbonisation plan, however the necessary actions in the advice document do not capture all of the most critical changes needed to maximise the use of electricity to support the transition. Many advice recommendations are incremental or peripheral. In particular, electricity market settings and generation investment should be highlighted as an area of policy focus. Optimising electricity demand through efficiency improvements will also be a critical enabler to transport and process heat electrification.
- EECA agrees with the Commission that electrification will be critical to decarbonising the economy. Given the scale and complexity of the challenge of achieving a rapid, economy-wide electrification that is optimal and equitable, EECA advocates for a similar approach to that recommended elsewhere, for example for the bio-economy. A strategy or roadmap for ~~a~~ electrification ~~strategy' (or 'roadmap')~~ will be a critical component of any national energy

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strategy, to achieve a fit-for-purpose electricity system that enables decarbonisation while maintaining security of supply and optimising system-wide cost.

- ~~EECA highlights the Government Investment for Decarbonising Industry (GIDI) fund as an example of a mechanism to realise the technical potential to accelerate emissions reduction in process heat.~~
- EECA strongly supports developing a national energy strategy (potentially by updating the New Zealand Energy Strategy 2011-21) and agrees there is good rationale for expanding New Zealand's policy focus beyond achieving 100% renewable ~~the~~ electricity generation ~~mix~~ to encompass renewable energy use more broadly.
- EECA agrees there is a need for long-term planning on bio-resources, including prioritisation of use (particularly between liquid biofuels for transport, ~~and~~ biomass for process heat and the underlying primary existing use of biomass as wood fibre for various uses eg construction and packaging).
- EECA supports measures to increase the energy efficiency of buildings, and also notes the significant co-benefits of improved buildings in terms of health and wellbeing. However, due to emission reduction potential we ~~but~~ caution investment in this area before more cost effective em~~m~~issions reductions are achieved elsewhere eg process heat.
- Regarding buildings, EECA strongly endorses a strategic view being taken of New Zealand's future energy systems. A number of overseas jurisdictions are moving to 'all-electric' homes and commercial buildings as a low-cost decarbonisation pathway, and to avoid stranded assets in gas distribution infrastructure. The national energy strategy should therefore consider the best timing of a potential ban on new gas connections (~~-~~as r~~eferenced~~commended by the Commission) and the role of biofuels.
- We agree that the interrelationship between land use transport and infrastructure justifies significant attention from Government and that emission reduction needs to be prioritised in decision making.

Multi-sector strategy

- We strongly support the proposal that behaviour change at organisational and business level, as well as an individual one, is critical to achieving our emission reduction targets. EECA has promoted behaviour change through the "Gen Less" public engagement platform since 2019.
- We support measures to engender coordinated action on behaviour change and suggest several steps to support this through concrete deliverables and dedicated funding.
- EECA strongly agrees with the recommendations related to aligning investment with climate outcomes (as well as it being a time critical necessary action) and we offer some comment and questions that may assist the commission in clarifying its advice for maximum impact.
- EECA agrees with the recommendations for a general strengthening of ETS settings and the intent behind these, but the specific wording in the advice could potentially be enhanced and clarified.
- We support the recommendation about clarifying the role of voluntary mitigation, although it would be helpful if the Commission could provide a clearer position. This could be used as a starting point for inter-agency discussion on the matter.

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Commented [DB16R15]: Yes, just waiting to hear back from Eva at the CCC.

EECA's response at a glance

Key: We favour | Recommend change | We do not favour

Transport

Necessary action 2 - Develop an integrated national transport network to reduce travel by private vehicles and increase walking, cycling, low emissions public and shared transport		
		We recommend that, in the first budget period the Government progress the following steps to meet emissions budgets:
a		Deliver specific and timebound targets to increase low emissions public and shared transport and walking and cycling, and supporting infrastructure through strengthening the direction of the Government Policy Statement on Land Transport.
b		Significantly increase the share of central government funding available for these types of transport investment, and link funding with achieving our emissions budgets.
c		Improve mobility outcomes through measures including supporting public transport uptake nationally and locally by reducing fares for targeted groups (such as for those under 25 years of age), and improving the quality and integration of services.
d		Encourage Councils to implement first and last kilometre travel solutions in their transport networks, such as increased on-demand and shared vehicle and bike services, secure park and ride solutions at public transport, and encouraging micro-mobility options.
e		Further government encouragement for working from home arrangements.
Time-critical necessary action 2 - Accelerate light electric vehicle uptake		
		Light electric vehicle uptake needs to be accelerated as fast as possible. To meet our proposed emissions budgets and be on track for 2050, at least 50% of all light vehicle (cars, SUVs, vans and utes) and motorbike imports should be electric by 2027 (both battery EV and plug-in hybrid EV). To achieve this, we recommend in the first budget period the Government:
a		Place a time limit on light vehicles with internal combustion engines entering, being manufactured, or assembled in Aotearoa, other than in specified exceptional circumstances. The limit should be no later than 2035 and, if possible, as early as 2030.
b		Introduce a package of measures to ensure there are enough EVs entering Aotearoa, and to reduce the upfront cost of purchasing light electric vehicles until such time as they are cost competitive with the equivalent ICE vehicle.
c		Improve the efficiency of the light vehicle fleet and stop Aotearoa receiving inefficient vehicles by introducing an emissions target for light vehicles new to Aotearoa of 105 grams CO2 per kilometre by 2028.
d		Develop a charging infrastructure plan for the rapid uptake of EVs to ensure greater coverage, multiple points of access and rapid charging, and continue to support the practical roll out of charging infrastructure.
Progress indicators		
a		Government to have consulted, no later than 30 June 2022, on preferred policy options for accelerating EV uptake (including a date for placing a time limit on the import of ICEs).
b		Cabinet decisions on preferred policy options to be made, as soon as possible but no later than 31 December 2022, on accelerating EV uptake.
c		Government to have implemented regulations on improving the fuel efficiency by 30 June 2022.

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Necessary action 3 – Accelerate light electric vehicle uptake		
		We recommend that, in the first budget period the Government make progress on the following:
a		As part of a policy package introduce a fiscal incentive, such as a feebate or subsidy, to reduce the upfront cost of EVs until such time as there is price parity with ICEs.
b		As part of an equitable transition, evaluate and support interventions such as leasing, hire and sharing schemes to remove barriers and address some of the upfront capital costs of EVs.
c		Investigate ways to bulk procure and ensure the supply of EVs into Aotearoa and work with the private sector to do so.
d		Evaluate how to use the tax system to incentivise EV uptake and discourage the purchase and continued operation of ICE vehicles.
e		Work with the private sector to roll out EV battery refurbishment, collection and recycling systems to support sustainable electrification of light vehicle fleet.
f		Evaluate the role of other pricing mechanisms beyond the NZ ETS, such as road pricing, can play in supporting the change to a low emissions and equitable transport system.
g		In setting these policies the Government needs to mitigate impacts for low-income households and people with disabilities, regional and remote access, and with limited access to electricity.

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Necessary action 4 – Increase the use of low carbon fuels for trains, ships, heavy trucks and planes		
		We recommend that, in the first budget period the Government take the following steps to support the use of low carbon fuels for heavy vehicles such as trucks, planes, ships, and off-road vehicles to meet emissions budgets:
a		Set a target and introduce polices so that at least 140 million litres of low carbon liquid fuels are sold in Aotearoa by 31 December 2035.
b		Introduce low carbon fuel standards or mandates to increase demand for low carbon fuels, with specific consideration given to aviation.
c		Introduce incentives to establish low emissions fuel plants, such as biofuel sustainable aviation fuel, and make those fuels more competitive with traditional fossil fuels.
d		Place further emphasis on decarbonising the rail system, and establish an investment strategy and clear targets to increase the share of rail and coastal shipping.

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Heat, Industry & Power

Time-critical necessary action 3 – Target 60% renewable energy no later than 2035		
		Setting a target for renewable energy enables the Government to signal the required emissions reductions across the full energy system. Within that context, the 100% renewable electricity target should be treated as aspirational and considered in the broader context of the energy system that includes electricity, process and building heat and transport. We recommend the Government:
a		Develop a long-term national energy strategy that provides clear objectives and a predictable pathway away from fossil fuels and towards low emissions fuels, and the infrastructure to support delivery.
b		Under the framework of the national energy strategy, set a renewable energy target to increase renewable energy to at least 60% by 31 December 2035.
Progress indicator		

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		The Government to have, by 30 June 2023, set a renewable energy target of at least 60% by 31 December 2035, set milestones for 2025 and 2030, and released an energy strategy to deliver this target.
Necessary action 5 - Maximise the use of electricity as a low emissions fuel		
		We recommend that, in the first budget period the Government take steps to ensure a low emissions, reliable and affordable electricity system to support electrifying transport and industry through progress on the following:
a		Under the framework of a national energy strategy, set a date by which coal electricity generation assets must be retired.
b		Under the framework of a national energy strategy, decide how to progress solutions to the dry year problem, when this should happen, and at what cost.
c		Introduce measures, such as a disclosure regime, to reduce wholesale electricity market uncertainty over Emissions Budgets 1 and 2, to encourage investment in new renewable generation.
d		Assess whether electricity distributors are equipped, resourced and incentivised to innovate and support the adoption on their networks of new technologies, platforms and business models, including the successful integration of EVs.
e		Enable more independent generation and distributed generation, especially for remote rural and Māori communities, and ensure access to capital for this purpose.
f		Monitor and review to ensure electricity remains affordable and accessible, and measures are in place to keep system costs down, such as demand response management.
Necessary action 6 - Scale up provision of low emissions energy sources		
		We recommend that, in the first budget period the Government make progress in scaling up the provision of new low emissions fuels by:
a		Developing a plan for the bioeconomy alongside the new national energy strategy, across transport, buildings, energy, waste, land use and industry.
b		Assessing the place that hydrogen has in the new national energy strategy.
Necessary action 7 - Reduce emissions from process heat		
		We recommend that, in the first budget period the Government take steps to reduce carbon emissions from fossil fuelled boilers by:
a		Urgently introducing regulation to ensure no new coal boilers are installed.
b		Introducing measures to help reduce process heat emissions from boilers by 1.4 Mt CO2e over 2018 levels by 2030 and by 2 Mt CO2e by 2035.
c		Increasing support for identifying and reporting on emissions reduction opportunities in industry, ~~nclud ng energy eff c ency, process opt m sat on, and fuel sw tch ng.~~
d		Helping people to access capital to reduce barriers to the uptake of technology or infrastructure ~~upgrades such as bo ler convers ons, energy eff c ency technolog es, and electr c ty network upgrades.~~
Necessary action 8 - Support innovation to reduce emissions from industrial processes		
		We recommend that, in the first budget period the Government take steps to support innovation in hard-to-abate industrial processes, including by:
a		Developing a long-term strategy for the future of hard-to-abate industries, including iron, steel making, cement and lime production and petrochemical production. This strategy should be developed alongside the national energy strategy, future Economic Plans and strategies for an equitable transition (see time-critical necessary actions 1 and 3).

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b	●	Based on the outcome of the strategy, investigating whether bespoke solutions requiring research and development specific to Aotearoa will be required.

Buildings

Necessary action 9 - Increase energy efficiency in buildings

		We recommend that, in the first budget period the Government introduce measures to transform, transition and reduce energy use in buildings. Measures should include:
a	●	Continuing to improve energy efficiency standards for all buildings, new and existing stock, through measures like improving insulation requirements. Expand assistance which targets low-income households.
b	●	Introducing mandatory measures to improve the operational energy performance of commercial and public buildings.
c	●	Setting a date by when no new natural gas connections are permitted, and where feasible, all new or replacement heating systems installed are electric or bioenergy. This should be no later than 2025 and earlier if possible.

Necessary action 10 – Reduce emissions from urban form

		We recommend that in the first budget period the Government promote the evolution of urban form to enable low emissions transport and buildings through ongoing legislative reform:
a	●	Develop a consistent approach to estimate the long-term emissions impacts of urban development decisions and continually improve the way emissions consequences are integrated into decision making on land use, transport and infrastructure investments.
b	●	Ensure a coordinated approach to decision making is used across Government agencies and local councils to embed a strong relationship between urban planning, design, and transport so that communities are well designed, supported by integrated, accessible transport options, including safe cycleways between home, work and education.

Multisector

Necessary action 16 - Support behaviour change

	●	We recommend that, in the first budget period the Government embed behaviour change as a desired outcome in its climate change policies and programmes in order to enable New Zealanders to make choices that support low emissions outcomes.

Time-critical necessary action 6 - Align investments for climate outcomes

		To meet emissions budgets and achieve the 2050 target, it is important that policy decisions and investments made now do not lock Aotearoa into a high emissions development pathway. Safeguards and signals will be needed to prevent this, including a specific focus on ensuring long-lived assets such as infrastructure are net-zero compatible. To achieve this, we recommend in the first budget period the Government:
a	●	Immediately start to factor target-consistent long-term abatement cost values into policy and investment analysis in central government. These values should be informed by the Commission's analysis which suggests values of at least $140 per tonne by 2030 and $250 by 2050 in real prices.
b	●	Encourage local government and the private sector to also use these values in policy and investment analysis.
c	●	Ensure that economic stimulus to support post-COVID-19 recovery helps to bring forward the transformational investment that needs to happen anyway to reach our joint climate and economic goals.

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d		Investigate and develop a plan for potential incentives for businesses to retire emissions intensive assets early.
e		Require the Infrastructure Commission to include climate change as part of its decision- and investment-making framework, including embedded emissions and climate resilience
f		Investigate and develop plans to mobilise private sector finance for low emissions and climate-resilient investments.
Progress indicators		
a		Government to start, as soon as possible and by no later than 31 March 2022, factoring target-consistent long-term abatement cost values into policy and investment analysis.
b		Government to publish, as soon as possible and by no later than 31 March 2022, how the COVID-19 economic stimulus is helping to accelerate the climate transition.
Time-critical necessary action 7 - Driving low emissions choices through the NZ ETS		
		The Emissions Trading Scheme (NZ ETS) needs to drive low emissions choices consistent with emissions reduction targets in Aotearoa, including a focus on gross emissions reductions. In the first budget period the Government should:
a		In the next annual update to NZ ETS settings:
i		Align unit volumes with emissions budgets, taking into account the need to reduce the NZU stockpile.
ii		Increase the cost containment reserve trigger price to $70 as soon as practical and then every year by at least 10% plus inflation.
iii		To maintain continuity with recent prices, immediately increase the auction reserve trigger price to $30 as soon as practical, followed by annual increases of 5% plus inflation per year.
b		Amend the NZ ETS so that it contributes, as part of a package of policies (see time-critical necessary action 5), to delivering the amount of afforestation aligned with our advice on the proportion of emissions reductions and removals, consistent with budget recommendation 2.
c		Establish a sound market governance regime for the NZ ETS as soon as possible to mitigate risks to market function, as some of these risks are potentially catastrophic for the scheme's effectiveness. This work should be advanced through an interagency team including MBIE for its financial markets expertise.
Progress indicators		
a		Government ensure that, in the next annual update to the NZ ETS settings, unit volumes are aligned with emissions budgets and price control settings are increased.
b		Government to develop proposals as soon as possible to establish a sound market governance regime for the NZ ETS, and to have legislated to address the most significant risks by no later than 30 June 2023.
Necessary action 19 - Combined ETS improvements		
		We recommend that, in the first budget period the Government make progress on:
a		Developing options and implementing a plan for recycling some or all of the proceeds from NZ ETS unit auctions into emissions reductions, adaptation, equitable transitions and meeting international climate change obligations.
b		Undertaking a first principles review of industrial allocation policy.
c		Continuing to phase out industrial allocation.

d	🟢	Exploring alternative policy instruments that could address the risk of emissions leakage.
e	🟢	Providing more information to reduce uncertainty about adjustments to NZ ETS settings, particularly how it intends to manage unit volumes in light of the split-gas 2050 target.
f	🟡	Clarifying the role and avenues for voluntary mitigation in Aotearoa.

Detailed response to the CCC's consultation documents

Consultation question 1: Principles to guide our advice (p. 30)

Do you support the principles we have used to guide our analysis? Is there anything we should change, and why?

EECA supports the principles as proposed. In particular:

- **Principle 3: Create options –** EECA's *Energy Efficiency First* report shows how nationwide uptake of energy efficient technology – the 'first fuel' – could lower the system cost of decarbonisation, thereby preserving and unlocking investment options in the future.

- **Principle 4: Avoid unnecessary cost –** EECA recognises the need to decarbonise our sectors on as natural an investment cycle as possible in order to reduce the overall costs of the transition, while identifying areas where we can move faster and the barriers that need to be overcome.

  The challenges and costs associated with transitioning existing infrastructure and fleets means that significant attention should be placed on interventions that restrict the adoption of new high emission technologies and processes. This needs to be done with urgency to avoid locking in emissions and future cost associated with stranded assets. The Commission seems to take this approach in several areas, as demonstrated by recommendations related to stopping the import of internal combustion engine vehicles, banning coal boilers etc. We suggest that this could be reflected in Principle 4 or included as a separate principle.

  Commented [AC25]: Are we therefore saying they need to have another principle?

- **Principle 7: Leverage co-benefits –** EECA has long advocated the co-benefits of energy efficiency, conservation and renewable energy. These range from the health and wellbeing benefits of warmer, dryer, more energy efficient homes, to the potential of energy efficiency to act as a 'jobs machine'. According to the International Energy Agency, every $1 invested in energy efficiency retrofits for houses and small business internationally, $0.60 goes to labour costs.[1]

[1] https://www.iea.org/articles/energy-efficiency-and-economic-stimulus

Consultation question 4: Limit on offshore mitigation for emissions budgets and circumstances justifying its use (p. 38)

Do you support budget recommendation 4? Is there anything we should change, and why?

EECA supports the recommendation to limit offshore mitigation for the first emissions budgets. EECA's work has identified there is a significant pool of emissions reductions opportunities that could be unlocked domestically at a cost for government and taxpayers below the cost of offshore mitigation (particularly if you only accept high quality credits from credible markets). Energy efficiency also has well-documented co-benefits[2] that can be realised within New Zealand if we pursue domestic mitigation.

[2] Capturing the Multiple Benefits of Energy Efficiency – Analysis - IEA (2015)

Consultation question 9: Establish processes for incorporating the views of all New Zealanders (p. 44)

Do you support enabling recommendation 5? Is there anything we should change, and why?

EECA supports the intent to make New Zealanders' views front and centre of the discussions that need to happen to balance the fairness of the transition. We do not suggest change to this recommendation but we see an opportunity to use EECA's existing *Gen Less* platform to further these objectives.

EECA's own research into perceptions about climate change and energy emissions shows that New Zealanders understand the need to take climate action, but are seeking direction on how this should occur and what role they need to play. With the right level of effort and investment we can address this through public education, awareness and communication.

A majority of New Zealanders want others to do more to reduce our climate change impact. EECA research (January 2019) found that 88% of people want companies to do more, 76% want government to do more and 76% want other people to do more. It also found that there are some important information gaps or linkages that need to be made in the minds of consumers, such as strengthening the link between transport and consumers overall energy emissions.

If government intends to step proactively into engaging with the public on climate change it will be important to identify shared objectives across relevant agencies, which can guide coordinated action on public awareness, communication and education. As a starting point we have laid out three potential cross-government objectives below:

- ensure the public are **well-informed** and understand government plans and policies
- **engage people in effective consultation and co-development** on plans and policies to help ensure the best decisions are made for New Zealand and New Zealanders as we transition to a low emissions economy
- motivate people to **take action** in their own lives to reduce emissions and make **long-term decisions** that will support the transition.

Any effort to inform and engage New Zealanders should build upon what is already in place. EECA's public *Gen Less* platform, is a well-suited and increasingly well-recognised platform to host a public engagement programme which seeks to increase the public and business' engagement with climate change.

Consultation questions 13: An equitable, inclusive and well-planned climate transition (p. 103)

Do you support the package of recommendations and actions we have proposed to increase the likelihood of an equitable, inclusive and well-planned climate transition? Is there anything we should change, and why?

EECA supports the emphasis placed on ensuring that the climate transition is equitable and inclusive.

Of particular relevance for EECA, the Commission's Necessary Action 1 (d) recommends there is a need to "Assess the Government's current standards and funding programmes for insulation and efficient heating to determine whether they are delivering at an appropriate pace and scale, and how they could impact housing and energy affordability. The Government should give particular consideration to potential flow through costs to tenants, and to government owned housing stock".

EECA's current low-income home retrofit programme *Warmer Kiwi Homes* is one of government's key interventions in alleviating energy hardship in New Zealand. It is the latest iteration of a low-income home retrofit subsidy programme that has been running in various forms since 2009. Since the start of the current programme in July 2018, 53,177 retrofits (39,491 insulation and 13,686 heating respectively) have been completed.

EECA regularly reviews the design and targeting of this programme to ensure that it delivers maximum benefit to low-income households at maximum cost-effectiveness for public money. A recent cost-benefit analysis returned a benefit to cost ratio for this programme of 4.7:1.

EECA is beginning a scheduled outcome evaluation of the WKH programme which is expected by February 2022. This will provide an important source of information for the design of future wellbeing interventions.

Consultation question 14: Transport (p. 110)

Do you support the package of recommendations and actions for the transport sector? Is there anything we should change, and why?

Necessary action 2 - Develop an integrated national transport network to reduce travel by private vehicles and increase walking, cycling, low emissions public and shared transport

EECA supports action to increase the use of low emission transport modes, such as walking, cycling and public and shared transport, as well as optimising or reducing travel.

EECA research shows that only 4 in 10 New Zealanders understand that transport is their single largest contributor to carbon emissions. Behaviour change will be a key enabler to help people to choose low emission transport modes such as walking, cycling and public transport and alternate choices such as working from home. EECA's *Gen Less* campaign has been getting the message out to the public to help people understand the impact of their transport choices on carbon emissions.

Nearly a third of car trips in New Zealand are under 2km[3], and there is opportunity for these "first and last kilometre" trips to be provided by other low emission transport modes and services. EECA agrees that a key challenge to address will be the provision of safe, affordable, convenient and accessible frequent public or shared transport choices. Provision of infrastructure and the design of cities and regions will allow the shift away from private fossil fuel vehicle use and EECA will support the role of government agencies in this important work.

EECA has also supported the demonstration of several electric bus and car share projects through the Low Emission Vehicle Contestable Fund. These technologies and services are now being rolled out in cities around New Zealand, however, there is a need to accelerate their adoption.

Time-critical necessary action 2 - Accelerate light electric vehicle uptake

EECA supports the Commission highlighting the transition of the light vehicle fleet as a time critical necessary action. New Zealand's emissions breakdown makes it clear that the light vehicle fleet provides the greatest opportunity for reducing transport emissions, particularly as there are low emission alternatives already available in the form of battery and plug in hybrid electric vehicles.

The modelling of the Commission's preferred path ~~makes the following assumptions~~includes the following forecasts relating to the uptake of electric vehicles (EV):

- 50% of light vehicle imports will be electric by 2027, with 40% of the fleet electric by 2035.
- Of the trucks imported in 2030, 15% of medium trucks and 8% of heavy trucks would be electric. By 2035, these would increase to 84% and 69% respectively.

This modelling appears quite optimistic however we acknowledge it is dependent on a number of assumptions that represent significant coordinated policy action as well as overcoming supply constraints and seeing the closing of the significant price gap between EV's and ICE's.

~~The Commission's assumptions of light EV uptake seem to be reasonable, when compared to EECA's internal modeling. The Commission's assumed rapid increase in electric truck uptake from 2030 to 2035 seem quite optimistic and would be dependent on significant policy support and overcoming supply constraints.~~

[3] Ministry of Transport NZ Household Travel Survey Data 2015-2017.

Below are EECA's comments on the Commission's recommended package of measures for accelerating light electric vehicle uptake.

Recommendation A - Place a time limit on light vehicles with internal combustion engines entering, being manufactured, or assembled in Aotearoa, other than in specified exceptional circumstances. The limit should be no later than 2035 and, if possible, as early as 2030

EECA agrees that it will be necessary for New Zealand to set a date from which the importation/manufacture/assembly of light internal combustion engine vehicles will not be allowed. With the target year of the Clean Car Import Standard being 2025, and many of our trading partners adopting similar policies, it seems appropriate to set this date sometime between 2030 and 2035, as suggested by the Commission.

Recommendation B - Introduce a package of measures to ensure there are enough EVs entering Aotearoa, and to reduce the upfront cost of purchasing light electric vehicles until such time as they are cost competitive with the equivalent ICE vehicle

We agree that EV supply constraints and high upfront costs are two of the key barriers that need to be addressed to increase EV uptake.

Constraints to the access of electric vehicle supply from overseas markets could result in a scarcity of vehicle volume and choice, potentially slowing the progress of transitioning the domestic fleet. EECA's work suggests that:

- In the near term (up to 2025) there are expected to be supply constraints because of the limited number of EV models and volumes being produced, which is expected to limit the extent to which all domestic market segments can be supplied. Further compounding this is the limited domestic sales of EV's in Japan, which limits what is available to import into New Zealand particularly as second hand vehicles. This warrants New Zealand looking at emerging EV manufacturing markets to secure EV supply, not just Japan.

- By 2030 it is expected that global production rates of new vehicles increases and there are unlikely to be supply constraints for imports of new EV's. This can be further supported by strategic supplier sourcing strategies with other emerging markets such as China, who is already a major producer and consumer of EV's (although it does not export high volumes currently). Policies will further enable access to the models and volumes of vehicles to be supplied into New Zealand.

Noting the potential short term supply and cost constraints for EV's, it would be valuable if the Commission could include analysis on the uptake of Internal Combustion Engine (ICE) hybrids and the impact this would have on the modelling scenarios and EV uptake in New Zealand, recognising the current dependence (~60% of used vehicles are imported from Japan) and the recent trend of ~~hybrid~~increased hybrid vehicle imports (new and used ~~from~~) from Japan.

We note that the supply of EV's to New Zealand is primarily influenced by the commercial decisions of overseas vehicle manufacturers, and the Government has little ability to change that. However, manufacturers are known to prioritise supply to countries with 'EV-friendly' policies, such as strong vehicle emissions standards and discounts on upfront vehicle cost.

While the upfront cost of electric vehicles is currently acting as a barrier to EV uptake, we note that the lower ongoing costs (such as fuel and maintenance) compared to fossil-fuelled vehicles improves the competitiveness of electric vehicles.[4]

The Commission assumes that lifetime price parity between EV's and ICE vehicles will be reached by 2024. This is a realistic assumption, but the timing of upfront capital cost parity may be of more importance to stimulating EV uptake. EECA's work suggests capital price parity between light EV's and ICE vehicles being reached in about 2030.

The assumption of price parity convergence and increase of EV manufacturing to meet supply-demand imbalances by 2030 will support a rapid acceleration of EV uptake from this time. However, we agree that the scale and urgency of the decarbonisation required from the light vehicle fleet means that strong supporting policies are needed immediately to accelerate the fleet transition as much as possible.

Recommendation C - Improve the efficiency of the light vehicle fleet and stop Aotearoa receiving inefficient vehicles by introducing an emissions target for light vehicles new to Aotearoa of 105 grams CO2 per kilometre by 2028

EECA supports the introduction of a vehicle fuel economy standard and welcomes the Government's announcement that the target year for the Clean Car Import Standard will be 2025.

Recommendation D - Develop a charging infrastructure plan for the rapid uptake of EVs to ensure greater coverage, multiple points of access and rapid charging, and continue to support the practical roll out of charging infrastructure

EECA has had an important role in the rollout of New Zealand's electric vehicle charging network. The Low Emission Vehicle Contestable Fund has provided co-funding to over 1,100 EV charging projects (over 600 for public EV chargers). So far, the rollout of New Zealand's EV charging network has started from a low base and is led by a few charging service providers. This has been an appropriate approach up to this point as the number of electric vehicles on the network has been low. However, with the introduction of policies to significantly increase the uptake of EV's, a more coordinated plan for future EV charging infrastructure and investment is required.

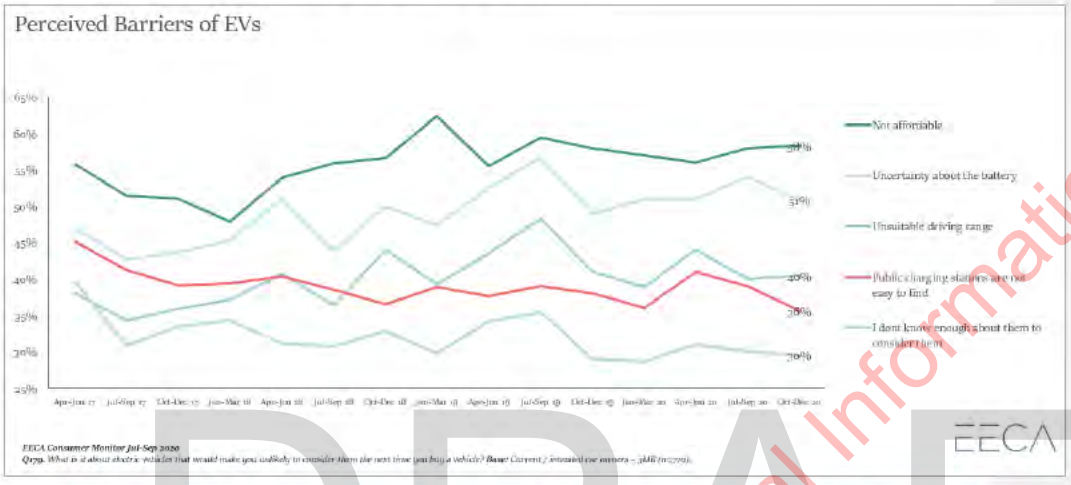
EECA supports the recommendation of a national EV charging infrastructure strategy and is working with other government departments to advance this work.

Any charging strategy should go beyond simply setting out the proposed location and level of investment required for public EV charging infrastructure. The strategy should also factor in and be able to respond to the future EV uptake scenarios that influence charging requirements, wider electrification policies and strategies, current government programmes for co-investment and feed into consideration of electricity distribution network upgrades. The factors will vary across the short term and long term, and be influence by the rapidly changing nature of technology and EV owner expectations and needs. The plan should also consider issues such as the asymmetry of information, lack of competition, capability and capacity from charging infrastructure providers, rural gaps, low and middle-income communities, workplace and commercial buildings and residential charging.

Necessary action 3 - Accelerate light electric vehicle uptake

[4] EECA analysis on total cost of ownership of EV and ICE.

EECA also supports the range of recommended actions for accelerating light electric vehicle uptake under Necessary Action 3. A coordinated package of actions is needed to make the New Zealand vehicle market more supportive of EV's, including reducing the cost and increasing the supply of EVs in New Zealand. EECA's consumer monitoring shows that the upfront cost premium of electric vehicles is the primary barrier to EV uptake in New Zealand.



Necessary action 4 - Increase the use of low carbon fuels for trains, ships, heavy trucks and planes

EECA agrees that a range of low carbon fuels, such as biofuel and hydrogen, will be needed for New Zealand to decarbonise hard to electrify applications such as planes and ships. Our view is technologically agnostic – we anticipate that the 'right' fuel will vary from application to application. It is not clear at this stage whether applications in heavy duty road freight will be better suited for direct electrification or use of low carbon liquid or gaseous fuels, or a combination of both.

Hydrogen

In 2019, EECA jointly commissioned Concept Consulting to undertake research on the cost effectiveness of hydrogen technologies for decarbonising the New Zealand economy relative to alternatives.[5] We also recently assisted Are Ake in their initial study of the economics of using green hydrogen to decarbonise long-distance heavy freight in New Zealand. Through the delivery of our funding programmes, we have also had insight into hydrogen technology and applications.[6]

EECA supports the development of 'green' hydrogen (produced from renewable electricity) that is economic and can cost-effectively reduce emissions. Growing policy commitment and global investment have the potential to make hydrogen a commercially viable low-carbon alternative to some fossil fuel applications in the future (as New Zealand is a technology taker). Green hydrogen is part of the journey to electrifying the economy and its role should be considered as part of any electrification strategy (or the national energy strategy, as referred to later).

[5] The research, titled 'H2 in NZ - A study of the potential economics of hydrogen technologies in New Zealand' can be found here: https://www.concept.co.nz/updates.html.
[6] Low Emission Vehicles Contestable Fund (Round 9 Hyundai FCEV trucks project and Round 5 Ports of Auckland Hydrogen Demonstration project).

At present, there are significant challenges for the commercial scale deployment of green hydrogen in New Zealand relative to its carbon abatement impact. EECA agrees that there are significant barriers and challenges on both the supply and demand side for hydrogen to become an economically viable alternative.

Deployment of hydrogen in New Zealand still remains in the demonstration phase. Pilot and demonstration projects have the potential to de-risk the technology for first adopters and reduce safety, regulatory and technical barriers.

Biofuel

EECA recently commissioned research regarding liquid biofuels, which covers demand and supply constraints, technology readiness for drop-in biofuels and life-cycle emissions analysis by feedstock.

We have attached this report to this submission as it informs EECA's view on the liquid biofuels opportunity for New Zealand.

Recommendation A - Set a target and introduce polices so that at least 140 million litres of low carbon liquid fuels are sold in Aotearoa by 31 December 2035

From discussion with the Commission, we understand this target was calculated based on liquid biofuels (but is currently worded to also cover other low carbon liquid fuels). Due to the variance in lifecycle emissions of different biofuel types and feedstocks, we suggest that a volumetric target (i.e. in litres) may not be the best approach to achieve emissions reductions. We would support instead an emissions reduction target (i.e. in CO2-e) for low carbon fuels.

The 140ML target appears to be based on production estimates from available wood feedstock rather than on a wider analysis including technical feasibility, demand-supply dynamics or maximising emissions reductions. This raises several points:

- The life-cycle emissions vary a lot from one biofuel to another (mainly depending on feedstock and associated land use change). Therefore, emissions reduction should be the main driver of any biofuel policy (especially incentives) in order to prevent the use of biofuels with poor emissions benefits (or even increased emissions compared to fossil fuels).
- There might be more valuable (such as chemicals) or efficient (such as direct combustion for process heat) uses of wood than the production of liquid biofuels. A national discussion is needed on what are the priority uses of this limited resource. The Commission's recommendation for the development of a national plan for the bioeconomy (Necessary Action 6) would be an appropriate and valuable opportunity for this discussion to take place.
- So as not to delay action while developing a bioeconomy plan, interventions such as a biofuel mandate or low carbon fuel standards should still be implemented (which prioritise the emissions and sustainability of the biofuel) so long as adequate conditions apply fopr life cycle emissions of the biofuels supplied into the blended fuels.
- The blending limits for biodiesel and bioethanol suggest that the potential demand for these fuels on an energy basis could be 6% of current demand for diesel fuels by heavy trucks and marine, and 6% of current demand for petrol fuels by light vehicles respectively (biodiesel is not suitable for aviation). This potential could be realised immediately with the import of biofuels, rather than waiting to set up a domestic production industry to provide 3% of demand (as seems to be suggested in the Commission's draft advice). It would be useful if the Commission could be more explicit about if it sees a role for biofuel importation.
- The potential incremental demand for drop-in diesel is much higher assuming a 50% concentration limit, i.e. around 44% of total energy required by diesel heavy trucks, marine and aviation, and 47% of total energy required by light petrol vehicles.

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- Our research suggests that, due to technological readiness, production of drop-in biofuel from wood biomass is unlikely to be at scale before 2035.
- Our research includes a progressive scenario where liquid biofuel uptake increases from 0.88 PJ (28.38 million litres) p.a. in 2022 to 8.06 (256.5 million litres) p.a. by 2030, reaching a maximum output of 43.14 PJ (1,287.2 million litres) p.a. by 2043.

Recommendation C - Introduce incentives to establish low emissions fuel plants, such as biofuel sustainable aviation fuel, and make those fuels more competitive with traditional fossil fuels

This recommendation seems to cover incentivising production of biofuels, as well as incentivising demand for biofuels (reducing the cost premium of the fuel).

Demand and production are two different aspects and we feel should be treated separately in the Commission's advice.

The experience with Marsden Point shows that ensuring availability for the domestic market is more complex than building a local production capacity: securing feedstock is a starting point, and ensuring demand is key.

The challenge is that feedstocks are globally tradable commodities, as are biofuels. This can create a complete disconnect between local production and local availability.

We agree that there may be a role for incentives for increasing demand in the short term. However, we are cautious about the proposal to provide incentives for domestic production. The opportunity cost to subsidise domestic production is unlikely to be justified by domestic emissions reduction only, and there is a need to factor in other considerations such as security of supply, economic impact, competing usages for the feedstock and factors that would result in a competitive advantage for production in New Zealand.

The capital cost alone for producing 100 million litres by 2030 would be in the range of $300-$760 million, depending on the conversion technology.[7] Such projects will not take place if investors have low confidence in capital cost recovery and prospects to scale production to reduce costs per unit of energy.

We suggest that the potential for incentives for biofuel production or demand should be considered as part of the wider bioeconomy plan recommended in Necessary Action 6. This would need to consider the risks of government support for biofuel production, including:

- New Zealand subsidising production of biofuels which are then exported to other countries.
- New Zealand building production capacity put in global competition for feedstock.
- New Zealand taking technology development risks in isolation - the scale of investments call for global effort.

Commented [AC27]: Clumsy - reword

Off-road diesel

[7] For FT catalysis and hydro-cracking, the estimate assumes a current capex of $9.12/litre fuel as per (BioPacific Partners, 2020), and a 3% p a. learning curve to 2030. For pyrolysis oil upgrade, the estimate assumes a capex value of $3 03-$7.6/litre fuel depending on whether the hydrogen is produced or purchased. This cost range is derived from capex estimates by (Wright, et al., 2010) for the n-th plant and a pioneer plant. The pioneer plant is assumed to be built in 2035, and the n-th plant in 2025.

We would like to draw the Commission's attention to an opportunity not mentioned in the advice and that might have been overlooked: Off-road diesel. This umbrella term refers to the following (non-road) uses of diesel:

Sector	Application examples
Aviation	Airport ground service equipment
Rail	Rail maintenance equipment
Marine	Recreational boating, personal watercraft, fishing
Agriculture	All-terrain farm vehicles, farm motorcycles, tractors
Construction	Off-road trucks and tractors, generators, machinery
Industrial	Forklifts, generators, other industrial equipment
Mining	Mining equipment, off-road mining trucks
Forestry	Forestry equipment (eg haulers)- off-road logging trucks
Residential	Residential lawn and garden equipment
Commercial	Commercial lawn and garden equipment, heating, forklifts
Government	Defence, lawn and garden equipment
Recreational	Motorsport, off-road motorbikes

There was about 36PJ of non-transport diesel use in 2019[8] (including an unknown portion for heating). This is equivalent to 2.6 Mt CO2e/year, so the opportunity for emission reduction is likely to be within the range of 1 to 2 Mt CO2e/year.

EECA has commissioned research to increase the understanding of this opportunity, for which solutions such as hybrid and biofuels could be relevant. We will share these insights with the Commission when they are available in mid-2021.

In the meantime, the Commission could mention the opportunity of off-road diesel in the list of potential targets for low-carbon fuels in its advice.

[8] MBIE Energy Balance Tables

Consultation question 15: Heat, industry and power sectors (p. 118, p. 111)

Do you support the package of recommendations and actions for the heat, industry and power sectors? Is there anything we should change, and why?

Time-critical necessary action 3: Target 60% renewable energy no later than 2035

Recommendation A - Develop a long-term national energy strategy that provides clear objectives and a predictable pathway away from fossil fuels and towards low emissions fuels, and the infrastructure to support delivery

EECA supports the development and implementation of a long-term national energy strategy to transition away from fossil fuels to renewable fuels. Any energy strategy should be complementary to and aligned with the New Zealand Energy Efficiency and Conservation Strategy (NZEECS) 2017-2022.

Commented [AC28]: [redacted]

We note we are in the final year of the existing New Zealand Energy Strategy 2011-2021.

Recommendation B - Under the framework of the national energy strategy, set a renewable energy target to increase renewable energy to at least 60% by 31 December 2035

EECA agrees there is technical and economic potential for New Zealand to significantly increase its use of renewable energy, and that doing so will be critical to achieving New Zealand's climate change goals.

Under the NZEECS, New Zealand has an existing target of 90 per cent of electricity generation from renewable sources by 2025. EECA agrees there is good rationale for expanding New Zealand's policy focus beyond the electricity generation mix to encompass renewable energy use more broadly and potentially framed as an emissions reduction target. This approach aligns with the overall goal of reducing economy-wide emissions. An appropriate energy target should be developed as part of any long-term energy strategy, with emissions reduction prioritised as the outcome.

The development of a target should be based on an accurate evidence base. We note the current 40% renewable energy figure, and presumably 60% target, is based on Total Primary Energy Supply (TPES). We note that TPES is significantly impacted by the treatment of geothermal electricity generation[9] and consequently a TPES renewable energy target may not be the most appropriate.

Necessary Action 5: Maximise the use of electricity as a low-emission fuel

EECA agrees electrification will be critical to achieving New Zealand's climate change objectives. Optimising electricity demand through efficiency improvements will be a critical enabler to transport and process heat electrification. EECA's 2019 *Energy Efficiency First* report found potential for cost-effective efficiency measures that collectively comprise an estimated 10-12% of electricity demand.

[9] This occurs because International Energy Agency (IEA) rules for calculating TPES treats geothermal electricity generation differently to hydro, solar or wind electricity generation. In essence, all the energy extracted from geothermal fluid is added to the TPES rather than the net electricity generation. As the thermodynamic potential of low temperature heat is low, only about 15% of this extracted geothermal heat becomes electricity that is available for use. If geothermal electricity generation was accounted for the same way as hydro generation, i e. electricity exported from the power station, then New Zealand's renewable energy percentage would fall to around 26%.

At costs between $15-$50/MWh, this efficiency potential is significantly cheaper than even the lowest-cost new renewable generation currently available.[10]

EECA has a range of existing policies that contribute to this, including energy product regulations under the trans-Tasman Equipment Energy Efficiency (E3) Programme. The 86 million products sold under the programme since 2002 have saved 59.55 PJ of electricity, equating to $1.45 billion of national benefit, and 2.33 Mt of CO2-e. It will also be critical to ensure market and regulatory settings enable and encourage the integration of new innovative technologies, such as demand response / flexibility and battery storage, to improve power system flexibility and security as the percentage of electricity supplied by intermittent renewables increases.

EECA supports the Commission's recommendations below, as they will contribute to achieving a fit-for-purpose electricity system that enables decarbonisation via electrification. However, given the scale and complexity of the challenge they are unlikely to be sufficient to overcome the barriers to achieving rapid, economy-wide electrification that is optimal and equitable. EECA therefore suggests a similar approach to electrification to that recommended elsewhere, for example for the bioeconomy. An 'electrification strategy' (or 'roadmap') will be a critical component of any national energy strategy, to ensure an optimal and coordinated increase in electricity demand and supply across the economy while managing the many barriers and issues that are likely to arise, in particular:

- Security and predictability of demand: major new sources and locations of electricity demand (new connections) need to be signalled early enough to allow infrastructure investment to keep pace, and to ensure price 'stability'
- Ensuring the cost of upgrading transmission and distribution infrastructure is spread equitably and rationally across the electricity system
- Ensuring the regulatory framework and consent and planning rules do not unduly dis-incentivise new generation or use of electricity as an energy source
- Energy Efficiency First: by optimising electricity demand, energy efficiency will be a critical enabler to electrification across the economy
- Future proofing: ensuring New Zealand's electricity system enables (and does not unnecessarily dis-incentivise) the adoption of new technologies and innovations will be critical to optimising the transition to an electrified economy.

Such an electrification strategy will require input from a range of public and private stakeholders across the electricity system.

The Commission provides a number of recommendations under this action covering a wide range of areas. It would be useful if these recommendations could more explicitly provide a sense of priority, to assist consideration of where resource is best focussed.

Recommendation A - Under the framework of a national energy strategy, set a date by which coal electricity generation assets must be retired

Any regulation to mandate the phase-out of coal or other fossil fuel electricity generation assets should be considered carefully under the framework of a national energy strategy and balance the energy trilemma of affordability, sustainability and security.

Whether mandating the phase-out of coal electricity generation is necessary to achieve a highly renewable electricity system that enables electrification while balancing the trilemma will need to

[10] https://www.eeca.govt.nz/our-work/research/research-papers-and-guides/energy-efficiency-first/

be carefully considered in the context of New Zealand's climate goals and existing market and policy settings. Mandating the retirement of plant is just one option among other options that could be explored, for example:

- setting a mean-year coal generation target of zero
- setting grid emissions factor targets/pathways
- requiring thermal generation usage to be tied to new renewable build.

Recommendation B - Under the framework of a national energy strategy, decide how to progress solutions to the dry year problem, when this should happen, and at what cost

As noted above, efficiency measures to optimise demand will be critical to integrating a higher percentage of intermittent renewable generation while mitigating against dry year risk.

This recommendation could be strengthened to require dry year solutions to be optimised for cost and carbon reduction impact. The current recommendation relies on a national energy strategy putting these in place, however this cannot be guaranteed without more direct guidance.

Recommendation C - Introduce measures, such as a disclosure regime, to reduce wholesale electricity market uncertainty over Emissions Budgets 1 and 2, to encourage investment in new renewable generation

Encouraging investment in new renewable generation is desirable and necessary. It is not clear whether a disclosure regime can sufficiently address the prevailing uncertainties. A liquid and long term wholesale contracts market or some other minimum price mechanism may be necessary.

Recommendation D - Assess whether electricity distributors are equipped, resourced and incentivised to innovate and support the adoption on their networks of new technologies, platforms and business models, including the successful integration of EVs

Agree (see above).

This is important, however the Commission should perhaps go further in terms of what needs to happen if the assessment finds distributors are insufficiently equipped to facilitate the transition.

Recommendation E - Enable more independent generation and distributed generation, especially for remote rural and Māori communities, and ensure access to capital for this purpose

Community, independent and distributed generation has a role to play in the electricity system where they support balancing of the energy trilemma (affordability, security, sustainability). It is important to be clear on what problems the different technologies and interventions are trying to solve (e.g. energy affordability, ~~poverty~~, emission reduction, cold damp housing etc). At a time when very large volumes of capital investment are needed, care needs to be taken to ensure that this capital delivers on the desired outcomes.

Another key consideration is that any rules or regulations introduced should be set so that independent generation is not unnecessarily impeded.

It is also important that distributed generation is provided in a coordinated manner, for example under a demand flexibility framework that ties together the different elements in the system (e.g. solar photovoltaics, home energy management systems, storage, electric vehicles and appliances).

Recommendation F - Monitor and review to ensure electricity remains affordable and accessible, and measures are in place to keep system costs down, such as demand response management

This recommendation could be interpreted as suggesting price controls. It is important not to conflate system efficiency with affordability. Both are important for the transition, however mechanisms to achieve them are different, and potentially operate in conflict with one another. Preventing electricity from becoming uncompetitive when priced against fossil alternatives is a key element of the transition, and an efficient system will be needed to enable this. However, an efficient system also relies on cost-reflective pricing and effective cost recovery. Where measures are needed to address affordability issues related to poverty, these should be implemented by the appropriate social agencies.

As noted above, energy efficiency, and demand response / flexibility will be critical to enabling a highly renewable electricity system that supports decarbonisation through electrification.

Necessary Action 6: Scale up the provision of low-emission energy sources

Recommendation A - Developing a plan for the bioeconomy alongside the new national energy strategy, across transport, buildings, energy, waste, land use and industry

EECA agrees there is a need for long-term planning on bio-resources, including prioritisation of use. This is required to optimise the balance between value added and energy security. It is an important aspect of an orderly transition avoiding unnecessary costs. Hence, any plan will need to address trade-offs for using limited bio-resources, particularly between liquid biofuels for transport and biomass for process heat. It will also need to balance the costs and benefits of both domestic and imported bio-resources.

The barriers to developing bio-resource supply-chains are unlikely to be uniform across sectors. For example, process heat usage is diffused across multiple sites through the country, while any biofuel production site will likely be concentrated in one region. The coordination challenge of matching process heat demand with bioenergy supply is much less complex than for matching fuel demand with biofuel production which is assumed to have a much larger 'minimum viable quantity required' to enable plants to achieve economies of scale. These dynamics have important implications for supply-chains and distribution of costs.

As noted by the Commission, there are significant opportunities to replace fossil fuels for process heat with biomass. However, many process heat users face significant financial and non-financial barriers to implementing these opportunities, and policy to help overcome these barriers can catalyse deepening and broadening of bio-resource supply-chains. The Government Investment to Decarbonise Industry (GIDI) Fund has funding available for projects to convert process heat boilers to biomass.

We also note there will be challenges meeting fuel demand for some large process heat sites currently using coal – particularly in Otago and Invercargill – from biomass due to concentration of demand and insufficient supply in those regions, and competition from wood processors for this resource.

Recommendation B - Assessing the place that hydrogen has in the new national energy strategy

As noted in our comments on Necessary Action 4 in the transport section, green hydrogen is part of the journey to electrifying the economy. EECA agrees that the role of hydrogen should be considered as part of any electrification strategy (such as through the national energy strategy).

Necessary Action 7: Reduce emissions from process heat

Recommendation A - Urgently introducing regulation to ensure no new coal boilers are installed

EECA agrees there is a need for regulation to ensure no new coal boilers are installed, and that such regulatory action is consistent with New Zealand's climate change objectives. EECA also supports investigating regulatory options to optimise process heat efficiency and accelerate the phase-out of existing coal and other fossil fuelled boilers. Regulations can provide an effective mechanism for reducing 'avoidable' emissions, that is, emissions from fossil fuel usage that could be cost-effectively reduced through efficiency and/or replaced by renewables using existing technologies.

Regulations can complement the ETS and complementary measures, such as the GIDI Fund.

Recommendation B - Introducing measures to help reduce process heat emissions from boilers by 1.4 Mt CO2e over 2018 levels by 2030 and by 2 Mt CO2e by 2035

EECA agrees process heat, along with transport, is one of New Zealand's best emissions reduction opportunities. The Commission's proposed level of process heat emissions reduction is technically viable at marginal abatement costs consistent with the Commission's modelling. In EECA's experience working with large emitting businesses, achieving this level of abatement within the emissions budget timeframes will require government to support industry to overcome the financial and non-financial barriers to rapidly transition from fossil fuels to renewables, alongside a combination of higher emissions prices and/or regulations.

The proposed quantum of process heat emissions reductions is technically feasible and, according to the Ministry for the Environment's marginal abatement cost analysis, can be achieved at costs to the economy that are well within the Commission's assumed marginal abatement cost (not to be confused with future ETS price) of around $140 in 2030 needed to achieve the 2050 target. To the extent that process heat abatement opportunities can be achieved at marginal abatement costs to the economy lower than the Commission's expected 'shadow' carbon price pathway (and in some cases below current ETS prices or at negative abatement costs), these abatement opportunities can be considered 'no regrets' and should therefore be prioritised within the next emissions budget period.

Notwithstanding the fact average marginal abatement costs to the economy of reducing process heat emissions may fall within current or future ETS prices, the actual costs and benefits to individual businesses will reflect the highly site-specific nature of process heat fuel switching projects and vary depending on a range of factors. These include decisions by other businesses that can increase or decrease the cost of subsequent businesses decarbonising in that region (i.e. first mover advantages or disadvantages). Achieving the Commission's proposed process heat emissions reductions within the emissions budget timeframes will also require process heat users to act quickly: for some businesses, the challenge of finding upfront capital will be compounded by the need to replace existing fossil fuel assets before the end of their useful lives. Businesses often require capital investment projects to have payback periods far shorter than the project lifetime (can be as low as two years in some sectors). Moreover, process heat fuel switching projects can take multiple years to implement, and many large process heat users have multiple sites meaning they will need to carefully plan their own long-term transition pathways.

Even where ETS prices make some process heat abatement opportunities economic, financial barriers are often compounded by technical and other non-financial barriers associated with the

complexity of large process heat projects. This is borne out by the not insignificant level of unrealised abatement that is already technically available at or below current ETS prices.

Consistent with EECA's response to Necessary Action 5 ('Maximise the use of electricity as a low-emissions fuel') and Necessary Action 6 ('Scale up the provision of low-emission energy sources'), government support for fuel switching projects can ensure a steady and coordinated increase in demand for electricity and biomass, thereby enabling steady and coordinated investment in infrastructure in the electricity system and biomass supply chains.

The new $70 million GIDI Fund, administered by EECA, provides businesses with access to capital co-funding that, alongside EECA's suite of other energy service programmes (including the Energy Transition Accelerator), are supporting businesses to start transitioning away from fossil fuels to renewables. The first round of the GIDI Fund received a large number of very high quality applications seeking $79 million in co-funding. The expected impact of the 16 projects that will receive funding in the first round is significant:

- Together these projects will deliver 185,000 tonnes CO2e in annual emissions savings, and 3.8 million tonnes CO2e over their lifetimes.
- The projects will deliver 9 – 13% of the total gross reductions required in the Commission's first draft budget period (2022-25) and 4.7% and 1.6% of the reductions required in the second and third draft budget periods respectively.
- The average marginal capital abatement cost (private + co-funding) of these 16 projects is $23.6 per tonne CO2e. The cost for EECA co-funding is $11.34 per tonne

Commented [DB29]: Remove if it looks like GIDI won't be announced by 28 March.

Clarity on the phasing out of coal

It would be useful if the Commission's advice relating to recommendations A and B could be a bit clearer and consistent with the preferred pathway for coal, as outlined in other parts of the Commission's advice. For example:

- In table 3.1, the "process heat" line states "Replace coal with biomass and electricity" during the first two budgets (with the third budget focussing on replacement of gas by biomass and electricity).
- In Part 3.8.5 Industry and Heat, figure 3.15 (page 64), the graph shows that almost all coal use disappears by 2035 and just a third of it remains in 2030.
- On page 76, it is stated that "Deep cuts in coal use between 2020 and 2030 (by about ~75% from 2010 levels)" are required to be consistent with a 1.5C trajectory.

The wording of the advice under Necessary Action 7 is not explicit that coal use in process heat should be largely phased out within the next decade. It is important to be clear about this as it has implications for existing consents under the Resource Management Act.

Potential wording to make this recommendation explicit could be "Introducing measures to help reduce process heat emissions from boilers by 1.4 Mt CO2e over 2018 levels by 2030 and by 2 Mt CO2e by 2035. *This means the phasing out of coal in process heat use needs to start now and be mostly achieved during the first two budgets.*"

Recommendation C - Increasing support for identifying and reporting on emissions reduction opportunities in industry, including energy efficiency, process optimisation, and fuel switching

EECA agrees, and we note MBIE's 2019 discussion document 'Accelerating Renewable Energy and Energy Efficiency' included options under section 1 to address information failures, including requiring large energy users to publish Corporate Energy Transition Plans (including reporting emissions annually) and conducting energy audits every four years.

Businesses face a range of information barriers with the result that many existing cost-effective opportunities to improve energy efficiency and reduce emissions (including at or below current ETS prices) remain unrealised. Moreover, requiring businesses to report on emissions reduction opportunities will improve transparency and data inputs to guide policy and long-term transition planning.

EECA has been increasingly active in this space in the past few years, with the roll out of our Energy Transition Accelerator programme, which offers bespoke technical support to large emitters to develop long-term transition plans. EECA also offers a range of support to help large energy users and other businesses overcome information barriers to improving energy efficiency and identifying fuel switching opportunities, including energy audits, feasibility studies, support for energy graduates, and technology demonstration funding.

We would like to highlight that support is only one part of the equation, and not necessarily the main barrier to wider and faster uptake. Other barriers that need to be addressed include:

- EECA's mandate is limited to energy related emissions, while businesses logically want to assess their emissions as a whole. An alignment of EECA's mandate with a consistent approach of the low-carbon transition would facilitate uptake and reduce costs for businesses.
- While some businesses are thinking about the transition and are willing to work with and be supported by EECA, others lack the incentives to address this long-term challenge.
- Triggering a review of existing consents and mandating transition plans would create the required incentive.

Based on the above points, we suggest tweaking the recommendation to *"Increasing identification and reporting on emissions reduction opportunities in industry, including energy efficiency, process optimisation, and fuel switching"*

Recommendation D - Helping people to access capital to reduce barriers to the uptake of technology or infrastructure upgrades such as boiler conversions, energy efficiency technologies, and electricity network upgrades.

As noted above there is technical potential to accelerate emissions reduction consistent with the Commission's draft process heat emissions reduction targets. EECA's GIDI Fund is an existing mechanism for achieving this.

Any increased government funding should be complementary to the ETS, and carefully considered alongside both regulatory and non-regulatory options.

EECA is experienced in working with industry to address barriers to uptake of technology, energy efficiency and renewable energy. While some can struggle to access capital (because they are over-indebted for example), it is not our experience that access to capital is the main issue.

Overall, in a context of low regulatory incentives, the challenge is mostly about improving the return on investment of the transition projects so they can be attractive enough for decision makers and become a priority for their organisation. The Commission may want to reflect this in its advice.

Necessary Action 8: Support innovation to reduce emissions from industrial processes

Recommendation A - Developing a long-term strategy for the future of hard-to-abate industries, including iron, steel making, cement and lime production and petrochemical production. This strategy should be developed alongside the national energy strategy, future Economic Plans and strategies for an equitable transition (see time-critical necessary actions 1 and 3).

Recommendation B - Based on the outcome of the strategy, investigating whether bespoke solutions requiring research and development specific to Aotearoa will be required.

EECA agrees with the intent to support innovation to reduce emissions from industrial processes, however, this does not necessarily extend to specifically supporting innovation in the hard-to-abate industries.

In New Zealand, hard-to-abate industrial processes consist of "one-plant sectors". Most innovation in these globalised sectors are likely to come from abroad, especially to reduce emissions, which involves significant rethinking of these processes (hence the name "hard-to-abate").

Therefore, the required investments would be very expensive for a small country alone.

In addition, these plants are controlled by international owners, which can decide to move their plant at will. So there is a real risk at investing significant amount of taxpayer money in these assets.

However, there is a need to support a wider adoption of innovations reducing emissions in a wide range of sectors of New Zealand economy.

EECA published an international technology scan[11] listing some of the innovation which wider use would help the transition, with a range of co-benefits.

Necessary Action 9: Increase energy efficiency in buildings

EECA strongly supports measures to increase the energy efficiency of buildings, and also notes the significant co-benefits of improved buildings in terms of health and wellbeing.

[11] https://genless.govt.nz/assets/Business-Resources/International-technology-scan.pdf

The Commission's *Evidence Report Chapter 9: Which path could we take?* includes some assumed levels of energy efficiency and energy intensity improvement. EECA's view on these assumptions is included below:

- **Residential / existing:** The Commission assumes that existing homes' energy intensity improves by 6% by 2035. We feel that this level of improvement is eminently achievable, particularly if you consider that this level of improvement would be achieved with a conversion to heat pump water heating alone.
- **Residential / new build:** The Commission assumes that by 2035, new builds are 35% more energy efficient compared to today's performance. While it is unclear if the Commission is comparing to today's new builds or today's average house, either way it should be achievable. This seems to align with the timeline of the "final step" of the Ministry of Business, Innovation and Employment's (MBIE) Building for Climate Change programme in terms of timeline and probably energy use, which we support.
- **Commercial:** The Commission assumes a 30% improvement in commercial and public buildings' energy intensity is possible by 2035 compared to today's performance. Based on experience with the NABERSNZ building energy efficiency rating system, we feel that this level of improvement is achievable.

Recommendation A - Continuing to improve energy efficiency standards for all buildings, new and existing stock, through measures like improving insulation requirements. Expand assistance which targets low-income households

The Warmer Kiwi Homes programme, administered by EECA and targeting low-income households, supports insulation and clean, efficient heating to improve the energy efficiency of homes. Support for this programme should continue until all target homes have received retrofits.

EECA is also strongly supportive of the Building for Climate Change programme, administered by MBIE, which will initially focus on improved standards for new builds.

Recommendation B - Introducing mandatory measures to improve the operational energy performance of commercial and public buildings

EECA continues to support the use of the NABERSNZ tool, a system for rating the energy efficiency of office buildings. There are already a number of public and private sector organisation that use NABERSNZ as a straightforward means of helping to make their building more efficient.

The use of this tool could be expanded as a means of delivering on the Commission's budget of a 30% improvement in commercial and public buildings' energy intensity by 2035. For example, the tool could be used to drive energy efficiency improvements in apartment buildings, shopping centres, data centres, hotels and public hospitals.

Recommendation C - Setting a date by when no new natural gas connections are permitted, and where feasible, all new or replacement heating systems installed are electric or bioenergy. This should be no later than 2025 and earlier if possible

EECA strongly endorses a strategic view being taken of New Zealand's future energy systems. A number of overseas jurisdictions are moving to 'all-electric' homes and commercial buildings as a low-cost decarbonisation pathway, and to avoid stranded assets in gas distribution infrastructure. The national energy strategy should therefore consider the best timing of a potential ban on new gas connections, and the role of biofuels. However, any such timeframe for a ban on new gas

Commented [DB30]: Are these countries just shift to all-electric new builds or also existing?

connections must strike a balance between decarbonisation, energy security, and energy affordability.

Necessary action 10 – Reduce emissions from urban form

EECA strongly endorses the Commission's messaging about the importance of understanding the emission impacts of urban form and the need for coordinated decision-making across local and central government.

We recognise that the Commission was unable to go into much detail on the issues and opportunities in this area. We agree that the interrelationship between land use, transport and infrastructure justifies significant attention from Government and that emission reduction needs to be prioritised in decision making.

Consultation question 19: Multisector strategy (p. 134)

Do you support the package of recommendations and actions to create a multisector strategy? Is there anything we should change, and why?

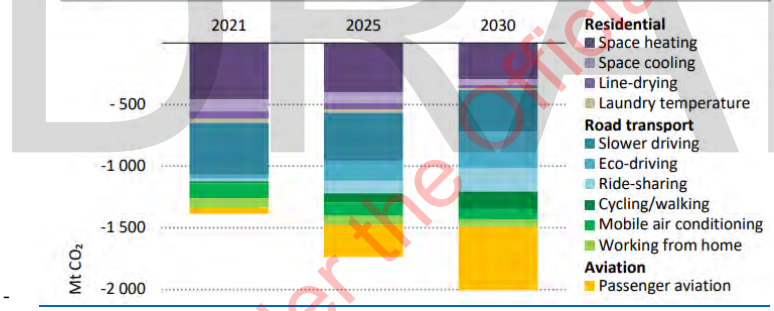
General comments on the multi-sector approach

A combination of policies and market interventions will be necessary the meet the emissions targets. Although the introduction to chapter 6 accurately describes the types of measures needed to reach these targets, the multisector section is quite limited in what it considers. The Commission's advice does not refer to areas such as innovation, research, and training, which all seem to be critical multi-sector aspects of delivering the emissions budgets, but are not apparent in the Commission's multisector strategy. We are interested to understand if this is based on the Commission's perception of priority or need.

Necessary action 16 - Support behaviour change

EECA agrees that behaviour change is a key component of any plan to escape carbon lock-in. We strongly support the proposal that behaviour change at organisational and business level, as well as an individual level, is critical to achieving net zero. IEA modelling in the World Energy Outlook 2020 highlight the critical role of behaviour change in reaching New Zealand's net-zero target, and the scale of the behaviour change activity that is needed.

Figure 4.15 ▷ Impact of behaviour changes on CO_2 emissions in the NZE2050



Source: IEA, World Energy Outlook 2020

EECA advises caution, however, against limiting the discussion to specific, small-scale changes. Ad-hoc behaviour change efforts risk creating only short-lived impact – we must pursue deep and long-term systemic change to lock-in behaviour change at the scale required. Identifying the role of government in driving this systemic change will be a key challenge.

EECA has an active work programme on behaviour change, and has been promoting behaviour change through its *Gen Less* public engagement platform since 2019.

Gen Less is aimed at influencing energy-related purchasing and other behavioural choices at the individual level. It has been informed by ongoing market research and monitoring of individuals' and businesses' values and actions related to climate change. Noting the importance of building upon what is already in place, we would reiterate the opportunity to harness the Gen Less platform as a

channel for increased behaviour change efforts by government (see our comments on consultation question 9 above).

EECA has a strategic process underway to develop better ways of influencing values and addressing the value-action gap through effective communications and behaviour change – our *Hearts and Minds* strategy. By combining bottom up individual behaviour change with top down systemic influencing actions, the *Hearts and Minds* strategy aims to create fertile ground for systemic change.

EECA also intends to measure the gap between what people and businesses will need to do in a net-zero world, and what they are doing today. This will inform our progress towards our objectives and the evolution from year to year.

We agree that meaningful behaviour change action will require a collaborative, focused and multi-agency approach, but suggest dedicated funding with a discrete structure is necessary to convert collaboration into action.

Discussion between government agencies with relevant activities around public engagement (and behaviour change) on climate change has already begun in the context of the Government's Emissions Reduction Plan. Given coordination groups already exist, next steps need to move current activities from simple information sharing to meaningful coordinated action.

There is precedent for creating a distinct team or government agency focused on behaviour change internationally. Dedicated agencies have been established at the highest level, as with Australia's Behavioural Economics Team, and dedicated teams have been nested within a ministry or regulatory agency, such as in Japan and the UK.

It is worth noting that EECA currently occupies analogous role to that of Waka Kotahi New Zealand Transport Agency, performing our role as the operations arm of the energy system, implementing MBIE's energy policy function. With additional resourcing, EECA may be well placed to lead delivery of future cross government coordinated behaviour change activities in climate change.

We agree that piloting, testing and evaluation of behavioural interventions will be a key activity.

While continuous monitoring can shed light on the long-term impacts of behavioural interventions, evaluation remains the responsibility of individual agencies, which generally lack resource to monitor these effects over long-enough time periods. A stronger direction from central government requiring rigorous and systematic policy and programme evaluation is needed to support this in practice.

There is an opportunity to support the continuous improvement of climate change related interventions through improved coordination and knowledge sharing among groups conducting research and evaluation. This function could be delivered by a behavioural insights body or by another centralised monitoring and evaluation team.

Time-critical necessary action 6 - Align investments with climate outcomes

EECA strongly agrees with this recommendation and the priority given to it.

We would like to offer some comment and questions that may assist the commission in clarifying its advice for maximum impact.

Recommendation A - Immediately start to factor target-consistent long-term abatement cost values into policy and investment analysis in central government. These values should be informed by the

Commission's analysis which suggests values of at least $140 per tonne by 2030 and $250 by 2050 in real prices

EECA notes that Treasury has recently published shadow-pricing guidance for use in government investment decision-making[12]. Establishing appropriate shadow carbon prices is a complex task with a wide range of uncertainty. It would be helpful if the Commission could clarify the recommendation in terms of the process it recommends be used to establish 'target-consistent prices' (a term which will be a key component of implementing this recommendation). We agree that the Commission's own modelling will be a useful resource, however there are other potential sources that may give different or more nuanced results.

Recommendation B - Encourage local government and the private sector to also use these values in policy and investment analysis

EECA supports this recommendation. The use of consistent long-term abatement cost values by all levels of government and the private sector would help future-proof investments.

Recommendation C - Ensure that economic stimulus to support post-COVID-19 recovery helps to bring forward the transformational investment that needs to happen anyway to reach our joint climate and economic goals

EECA agrees with this recommendation and has made resources available to help out with this where appropriate (for example feeding in to consideration of Infrastructure Reference Group projects and the Government Investment to Decarbonise Industry (GIDI) Fund.

Recommendation D - Investigate and develop a plan for potential incentives for businesses to retire emissions intensive assets early

EECA agrees that some additional incentives may need to be made available to businesses if some assets are to be retired early. However, we would urge caution in developing a specific plan for this component. Any scheme will have the risk of being manipulated and the asset retirement barrier will need to be addressed in the wider context of barriers. One role for voluntary carbon markets could be to bring forward replacement of high emissions assets, thus addressing the 'time gap' problem.

Recommendation F - Investigate and develop plans to mobilise private sector finance for low emissions and climate-resilient investments

EECA is exploring options around the growing demand for ways to demonstrate climate action and address climate related risk in the private sector. Driven by risk management, new participants are increasingly channelling capital in directions that contribute to climate mitigation and adaption. We support this action and we would like to highlight the potential of the voluntary carbon market (VCM) as a vehicle for private sector finance investments. Today, the existing VCM is niche and could be scaled up significantly.

EECA has been working with Motu and a wide range of stakeholders to address this challenge using the voluntary carbon market opportunity arising from the beginning of the Paris Agreement period.

[12] Appendix 4 of the CBAx User Tool Guidance: https://www.treasury.govt.nz/sites/default/files/2020-12/cbax-guide-dec20.pdf

Motu and EECA will soon publish a summary report outlining the problems, the opportunities and the current thinking in term of solutions. This report also addresses the waterbed effects with the ETS.

Voluntary mitigation can help to bridge current gaps in mitigation ambition, financing, and speed that could undermine the long-term goals of the Paris Agreement.

Through our work, EECA identified a convergence of trends, barriers and opportunities and concluded that the VCM has the potential to be a vehicle for private finance to help unlock emissions reduction by funding domestic energy transition.

There are domestic emission reduction opportunities in New Zealand that are cost effective compared to alternatives such as forestry or offshore credits. These opportunities (energy efficiency and renewable energy projects) are not responsive to energy (and therefore carbon) prices because they face non-price barriers or the price signal is not yet sufficient to trigger investments.

As demonstrated with the GIDI Fund, an injection of capital could unlock some of these opportunities by improving the return on investment of the projects. The VCM could be a source of private funding for these projects.

Additionally, there is an incentive mismatch between businesses with cost-effective opportunities but low incentives/willingness to act and businesses with willingness to transition but few opportunities (overly expensive or not technically mature). Enabling these businesses to split the value and the claims for these projects would enable a shift from the zero-sum game status quo to a collaborative environment.

Shortcomings of the Kyoto period offsetting and carbon neutral approach have resulted in relatively low uptake and low trust in this market. Fixing the accounting issue by increasing transparency is key to increase trust and fix the behaviour issues related to current offsetting practices.

Allowing the VCM to fund domestic projects could also improve trust by bringing the outcomes of the spending closer to New Zealanders.

Time Critical necessary action 7 - Driving low emissions choices through the NZ ETS
Recommendation A - In the next annual update to NZ ETS settings:
(i) Align unit volumes with emissions budgets, taking into account the need to reduce the NZU stockpile *(ii) Increase the cost containment reserve trigger price to $70 as soon as practical and then every year by at least 10% plus inflation*

EECA agrees with the general strengthening of ETS settings and the intent behind these.

The specific wording in the advice could potentially be enhanced and clarified.

Specifically:

Recommendation A(i) - This recommendation could be more specific about the expected change in unit auction volumes. The current recommendation specifies a principle for adjustment (i.e.

alignment with budgets) but stops short of identifying the quantum of adjustment the Commission expects to see. This means that if government adjusts the auction volumes at all, this could be claimed to be complying with this recommendation, when actually it is not a sufficient adjustment. A specific range of auction volumes "i.e. Commission analysis suggests that the appropriate range of auction volumes is X to Y million units per year" would be a more effective recommendation.

Recommendation A (i) and (ii) - A fundamental principle of the ETS is that it makes use of a market mechanism to determine the price. While having well signalled price corridors is a useful feature of the ETS, as it provided a degree of confidence about price levels, care should be taken that the ETS is not over-constrained.

The recommendations are set at specific prices, with specific escalation rates. Given the timeframe, the starting price is unlikely to be problematic, however the escalation rates may need to be revisited over time. A more useful approach would be to reference the price setting to ETS market outcomes from a preceding period. For example, "The auction reserve trigger price will be set at the average of the previous 3 months published ETS price".

The justifying comment "these changes are needed because maintaining current settings will lead to failure to meet emissions budgets" could be rephrased for clarity and accuracy. At present it implies a direct link between the ETS settings and New Zealand's emissions. While the ETS is a key tool in managing emissions, it is neither fully effective, nor the only measure being applied to the emissions problem.

Recommendation B - Amend the NZ ETS so that it contributes, as part of a package of policies (see time-critical necessary action 5), to delivering the amount of afforestation aligned with our advice on the proportion of emissions reductions and removals, consistent with budget recommendation 2

This recommendation would benefit from improved clarity and further explanation. It implies some sort of differentiation between forest types, but it is not easy to determine how this would work in practice. While the detail will be developed in consultation with affected parties, a more tangible strawperson example would provide affected parties with a better basis for discussion.

Recommendation C - Establish a sound market governance regime for the NZ ETS as soon as possible to mitigate risks to market function, as some of these risks are potentially catastrophic for the scheme's effectiveness. This work should be advanced through an interagency team including MBIE for its financial markets expertise

Our understanding is that the intent of this recommendation is for the Government to speed up implementation of the market governance work programme already identified. The progress indicator refers to 'the most significant risks' however it is not clear from the advice what the Commission believes these to be.

Necessary action 19 - Continued ETS improvements

Recommendation A - Developing options and implementing a plan for recycling some or all of the proceeds from NZ ETS unit auctions into emissions reductions, adaptation, equitable transitions and meeting international climate change obligations

Recycling of ETS revenue is one among many options to increase government funding for emissions reductions, adaptation, equitable transitions and meeting international climate change obligations.

While we support in principle the need to examine this opportunity, it should be examined alongside the range of other potential funding mechanisms.

Recommendation B - Undertaking a first principles review of industrial allocation policy

EECA supports a first-principles review of industrial allocation policy to ensure it is fit for purpose.

Recommendation C - Continuing to phase out industrial allocation

The Government has put in place a policy to phase out industrial allocation slowly and over a long timeframe. It would be useful to understand if the Commission recommends maintaining this policy or accelerating the phase-out of industrial allocation to be consistent with targets and budgets and ensuring a fair and equitable burden of action across the economy.

Recommendation D - Exploring alternative policy instruments that could address the risk of emissions leakage

Emissions leakage can occur from all sectors of the economy. It would be useful if the Commission can clarify whether this recommendation relates to industrial allocation to Emission Intensive and Trade Exposed (EITE) sectors, or more broadly (i.e. including agriculture). If the recommendation does not include primary production then perhaps the Commission could consider merging recommendation b, c, and d into a single recommendation that says "Adjust the industrial allocation regime and related policies to be consistent with targets and budgets while managing risks of carbon leakage".

Recommendation E - Providing more information to reduce uncertainty about adjustments to NZ ETS settings, particularly how it intends to manage unit volumes in light of the split-gas 2050 target

Reducing uncertainty in the ETS settings is important for encouraging long-term investment activity in emissions reduction. However, the need to reduce uncertainty is somewhat inconsistent with discussions in the advice about managing 'the waterbed effect' (Evidence report Chapter 16, page 8), which suggests fluidly adjusting auction volumes to account for actual emissions reductions both inside and outside the ETS. It would be helpful if the Commission could clarify how these competing objectives would best be managed.

Recommendation F - Clarifying the role and avenues for voluntary mitigation in Aotearoa

We do not share the Commission's view that, providing an adjustment, when a NZU is cancelled, it is equivalent to removing a tonne of emissions from the atmosphere. This theoretical reasoning does not seem to take into account the significant amount of NZUs stockpiled by some businesses, most of which were received for free as a result of over allocation.

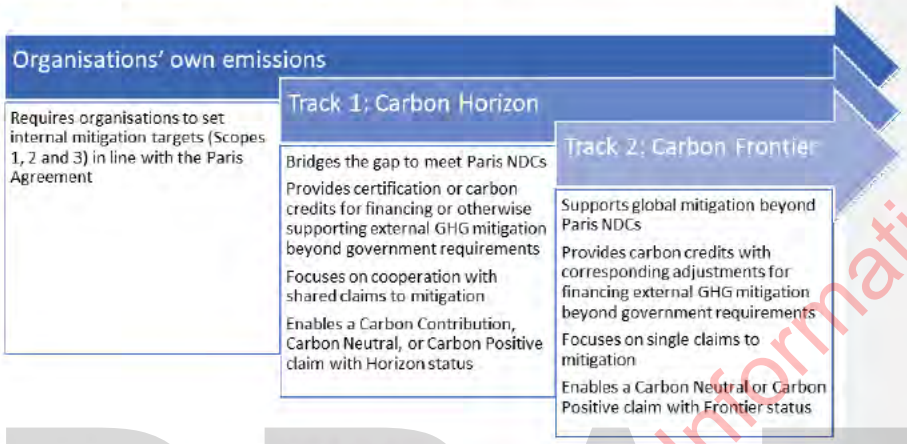
We do support the general recommendation, although it would be helpful if the Commission could provide a clearer position. This could be used as a starting point for inter-agency discussion on the matter.

As mentioned in Recommendation F of Time Critical Necessary Action 7, EECA has been working on this topic with Motu and a wide range of stakeholders.

We think that the voluntary carbon market (VCM) has a key role to play to unlock domestic transition projects facing non-price barriers, or for which the price signal is not yet sufficient to trigger investments when the opportunity arise (e.g. asset replacement).

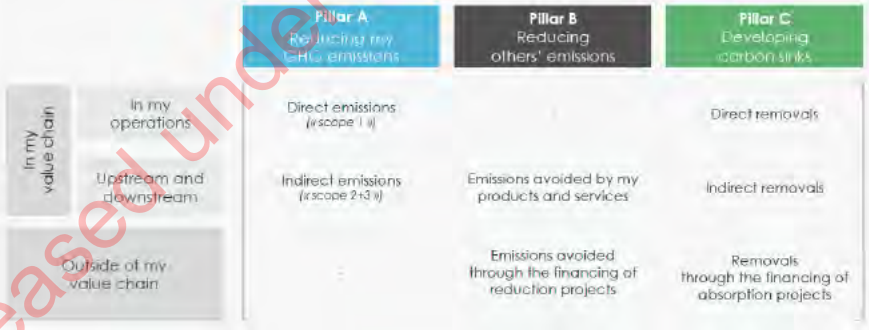
From the joint work with Motu and the workshops participants, we suggest potential solutions, including:

a) A straw proposal for a two-track system intended to boost voluntary mitigation at scale with benefits for both organisations and government.



In the past, voluntary mitigation typically focused on generating and trading VCCs eligible for carbon-neutral offsetting claims. While retaining that option with new features to make it Paris-compatible, this proposal expands the scope of eligible voluntary mitigation to include recognition for more diverse forms of cooperation with shared gains and greater valuation of environmental, social, cultural, and economic co-benefits. It is scalable for the global transition toward net-zero emissions.

b) An alternative, "dashboard" approach to carbon accountability for organisations, increasing transparency and allowing shared claims to favour collaboration.
With this approach, an organisation's performance would be distinct from helping others, and the gross emissions would be distinct from removals. It would result in a clearer risk exposure for investors and shareholders.
An example of such approach has been developed by the Net Zero Initiative:



Adoption of such reporting would unlock better outcomes such as:

- Allowing increase of gross emissions from a company producing goods or services that unlock greater emissions reductions for their customers (such as energy providers).

- For the state sector, it would highlight investments in domestic reduction projects as a valid option compared to purchasing offshore credits to cancel.

Cover page

EECA's submission to the Climate Change Commission's 2021 draft advice for consultation

Letter from the Chair

To the Climate Change Commission,

On behalf of the Energy Efficiency and Conservation Authority (EECA), I would like to congratulate the Commission on the release of its draft advice. This represents the first major release from the Commission and the product you have delivered reflects the amount of work that has gone into its development.

It is essential for New Zealand to have clear, evidence-based, independent advice on how we can progressively meet our 2050 net zero emission targets. The Commission's draft advice provides a clear message that the emissions budgets and proposed policy direction are 'ambitious but achievable'.

EECA has prioritised its resources to provide input to the Commission's work, based on our experience working with the public and private sectors to encourage, promote, and support the uptake of energy efficiency, energy conservation, and the use of renewable sources of energy in New Zealand.

EECA's purpose and statutory functions mean we have an important role as the authority and delivery agency for the ~~in the implementation of the~~ government's response to several key areas covered by the Commission's advice. Our current work programme already supports reducing the carbon footprint across a wide range of sectors. We look forward to continue working with the Commission, wider government, industry and the public on our transition to a low emission economy.

Kind regards

Elena Trout
Chair, EECA Board

About EECA

The Energy Efficiency and Conservation Authority (EECA) is ~~a~~the Crown entity established under the Energy Efficiency and Conservation Act 2000 to encourage, promote, and support the uptake of energy efficiency, energy conservation, and the use of renewable sources of energy in New Zealand. This mandate provides us with the authorising environment to work with a wide range of stakeholders and customers, as we transition to a low carbon and sustainable economy.

Key points of EECA's submission

EECA generally supports the Commission's advice and recommendations

EECA welcomes and supports the Commission's overarching finding that we can meet our 2050 targets with existing technology, noting that significant change and action is required as well as the need to overcome some of the cost barriers associated with the existing technology. EECA strongly advocates that interventions such as supporting energy efficiency and the uptake of electric vehicles, and the move to renewable energy sources for our process heat needs can make a significant contribution to our decarbonisation goals.

We recognise there are many new low emission technologies being developed in most sectors of the economy, and these have the potential to unlock significant emission reduction options with the increasing potential for lower cost decarbonisation pathways. However, the long timeframes normally required to scale up new technologies and the urgency of our need to decarbonise mean the existing barriers need to be overcome.

We appreciate the Commission has not been tasked with identifying specific policies, this is the role of the Government. As a result, there are a number of the Commission's recommendations that we support in principle, but there will need to be further work to determine viable policy solutions.

The scale and breadth of policy work that is required to develop the Government's Emission Reduction Plan means that it is essential this work is well coordinated across government departments. The structures and frameworks to ensure this happens are currently being developed and we agree with the Commission's advice that these will be critical to enabling coordinated and timely action.

EECA has a key role in implementing the policies that would flow from the Commission's advice

EECA's function under the Energy Efficiency and Conservation Act 2000 is to *encourage, promote, and support energy efficiency, energy conservation, and the use of renewable sources of energy*. Given that a significant portion of New Zealand's emissions are from energy, emission reduction has become the primary focus of our strategic and operational activity. The goals of efficient use of energy, the use of renewables and emission reductions are inseparable.

EECA works in an interesting space — we are a Crown Agent but have close relationships with both Government and industry. This gives us a unique ability to provide the Government with an 'ear to the ground' to understand the impact of policies on businesses and improve the evidence base and implication of policy development.

We utilise our three levers, motivation (public engagement and behaviour change), co-investment and regulation to carry out our functions. We are the authority on behalf of Government in a range of areas related to emission reduction and we are one of the few government agencies currently directly investing in emission abatement through co-investment in low emission technologies. Our public engagement campaigns such as Gen Less and earlier successful campaigns related to reducing energy and energy efficiency have demonstrated our role and experience in promoting low emission behaviours.

Given our experience with direct emission mitigation projects, we welcome this opportunity to make a submission to the Commission on the draft Budgets and share our insights.

There are a few key areas of focus for EECA

There is a lot of interdependence between the areas covered by the Commission's advice. We have focussed our submission on the main areas of relevance to EECA's activities. This is primarily transport, heat, industry and power and the multi-sector strategy.

Given the wide range of subject matter and recommendations covered by the Commission's advice, it is essential there is coherence as an overall package. For this reason we strongly support the recommendations that relate to developing overarching strategies, such as the national energy strategy or bioeconomy plan, to provide clear and coherent direction. Targets such as those proposed by the Commission should be developed as part of those strategies and include strong transition planning, to ensure the targets are consistent, based on strong evidence, do not create perverse outcomes and support the overall outcome of reducing greenhouse gas emissions. While reducing emissions it is important to also maintain a path towards [redacted] n equitable and affordable transition to a low emission economy.

Another point that is relevant across all sectors is the important balance between effort to transition existing technology and processes, compared to interventions that stop the introduction of new high emission technologies and processes. Using the vehicle fleet as an example, it will be much more difficult to transition the existing fleet to low emission vehicles if we continue importing high emission vehicles into the fleet. For this reason we recommend that Government should place short-term priority on initiatives that keep high-emitting technologies out of the country as well as restricting domestic asset investment that does not align with our low emission goals.

The sector-specific key points in EECA's submission are summarised below.

Transport

- EECA generally agrees with the Commission's advice relating to reducing travel by private vehicles and shifting to low emission modes.
- We strongly support the Commission highlighting accelerating light electric vehicle (EV) uptake as a time-critical necessary action and the recommendations to achieve this.
- We agree that EV supply constraints and high upfront costs are two of the key barriers that need to be addressed to increase EV uptake. EECA's work suggests supply constraints are likely to limit the extent to which all domestic market segments can be supplied with EV's until about 2030.
- Noting the potential short/medium term supply constraints for EV's, it would be valuable if the Commission could include analysis on the uptake of Internal Combustion Engine (ICE) hybrids (as a cost effective near term transition option for consumers) and the impact this would have on its modelling scenarios and EV uptake up to about 2030.
- The recommendation to develop a national charging infrastructure plan is of particular relevance to EECA and we are working with government departments to progress this.

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- We agree that low carbon fuels such as biofuel and hydrogen could play a role in decarbonising hard to electrify transport applications but currently there are considerable cost barriers to overcome before widespread uptake could occur.
- EECA supports the development of 'green' hydrogen (produced from renewable electricity) that is economic and can cost-effectively reduce emissions compared to alternatives. However, in line with the Commission's approach to rely on existing technologies to transition, the assumptions on emissions reductions delivered by the hydrogen pathway should be conservative as there are still major barriers to overcome.
- We urge caution with the Commission's proposal to set a volumetric target for biofuel uptake, based on the potential for domestic production using woody biomass. Biofuels are not all low emissions, so a volumetric target does not ensure emission reduction is the priority.
- We suggest that an aggregate emission reduction target for all low carbon fuels would be more appropriate, based on wider analysis of fuels and feedstocks, including technical feasibility, demand-supply dynamics or maximising emissions reductions.
- EECA recently commissioned research regarding liquid biofuels which accompanies our submission. The research covers demand and supply constraints, technology readiness for drop-in biofuels and life-cycle and supply chain emissions analysis by feedstock. This will help to better understand the viable biofuel sources with greatest emission reduction potential, whether imported or domestically produced.
- The Commission's recommendation for the development of a national plan for the bioeconomy (Necessary Action 6) would be an appropriate and valuable opportunity to discuss the priority uses of our bio-resources, including the place for biofuel.

Heat industry and power

- EECA generally agrees with the Commission's recommendations. Our detailed submission includes some qualifying statements and issues for further consideration.
- EECA agrees that process heat, along with transport, is one of New Zealand's best emissions reduction opportunities. In EECA's experience, achieving this potential will require government to work alongside industry to overcome the financial and non-financial barriers to rapidly transitioning from fossil fuels to renewables.
- EECA highlights the Government Investment for Decarbonising Industry (GIDI) fund as an example of a mechanism to realise the technical potential to accelerate emissions reduction in process heat.
- Electrification is a key pillar in the Commission's decarbonisation plan, however the necessary actions in the advice document do not capture all of the most critical changes needed to maximise the use of electricity to support the transition. Many advice recommendations are incremental or peripheral. In particular, electricity market settings and generation investment should be highlighted as an area of policy focus. Optimising electricity demand through efficiency improvements will also be a critical enabler to transport and process heat electrification.
- EECA agrees with the Commission that electrification will be critical to decarbonising the economy. Given the scale and complexity of the challenge of achieving a rapid, economy-wide electrification that is optimal and equitable, EECA advocates for a similar approach to that recommended elsewhere, for example for the bio-economy. A strategy or roadmap for electrification will be a critical component of any national energy strategy, to achieve a fit-for-purpose electricity system that enables decarbonisation while maintaining security of supply and optimising system-wide cost.
- EECA strongly supports developing a national energy strategy (potentially by updating the New Zealand Energy Strategy 2011-21) and agrees there is good rationale for expanding

New Zealand's policy focus beyond achieving 100% renewable electricity generation to encompass renewable energy use more broadly.

- EECA agrees there is a need for long-term planning on bio-resources, including prioritisation of use (particularly between liquid biofuels for transport, biomass for process heat and the underlying primary existing use of biomass as wood fibre for various uses e.g. construction and packaging).
- EECA supports measures to increase the energy efficiency of buildings, and also notes the significant co-benefits of improved buildings in terms of health and wellbeing. However, due to emission reduction potential we caution investment in this area before more cost effective emissions reductions are achieved elsewhere e.g. process heat.
- Regarding buildings, EECA strongly endorses a strategic view being taken of New Zealand's future energy systems. A number of overseas jurisdictions are moving to 'all-electric' homes and commercial buildings as a low-cost decarbonisation pathway, and to avoid stranded assets in gas distribution infrastructure. The national energy strategy should therefore consider the best timing of a potential ban on new gas connections (as recommended by the Commission), and the role of biofuels.
- We agree that the interrelationship between land use, transport and infrastructure justifies significant attention from Government and that emission reduction needs to be prioritised in decision making.

<u>Multi-sector strategy</u>

- We strongly support the proposal that behaviour change at organisational and business level, as well as an individual one, is critical to achieving our emission reduction targets. EECA has promoted behaviour change through the "Gen Less" public engagement platform since 2019.
- We support measures to engender coordinated action on behaviour change and suggest several steps to support this through concrete deliverables and dedicated funding.
- EECA strongly agrees with the recommendations related to aligning investment with climate outcomes (as well as it being a time critical necessary action) and we offer some comment and questions that may assist the commission in clarifying its advice for maximum impact.
- EECA agrees with the recommendations for a general strengthening of ETS settings and the intent behind these, but the specific wording in the advice could potentially be enhanced and clarified.
- We support the recommendation about clarifying the role of voluntary mitigation, although it would be helpful if the Commission could provide a clearer position. This could be used as a starting point for inter-agency discussion on the matter.

EECA's response at a glance

Key: We favour | Recommend change | We do not favour

Transport

Necessary action 2 - Develop an integrated national transport network to reduce travel by private vehicles and increase walking, cycling, low emissions public and shared transport		
		We recommend that, in the first budget period the Government progress the following steps to meet emissions budgets:
a	●	Deliver specific and timebound targets to increase low emissions public and shared transport and walking and cycling, and supporting infrastructure through strengthening the direction of the Government Policy Statement on Land Transport.
b	●	Significantly increase the share of central government funding available for these types of transport investment, and link funding with achieving our emissions budgets.
c	●	Improve mobility outcomes through measures including supporting public transport uptake nationally and locally by reducing fares for targeted groups (such as for those under 25 years of age), and improving the quality and integration of services.
d	●	Encourage Councils to implement first and last kilometre travel solutions in their transport networks, such as increased on-demand and shared vehicle and bike services, secure park and ride solutions at public transport, and encouraging micro-mobility options.
e	●	Further government encouragement for working from home arrangements.
Time-critical necessary action 2 - Accelerate light electric vehicle uptake		
		Light electric vehicle uptake needs to be accelerated as fast as possible. To meet our proposed emissions budgets and be on track for 2050, at least 50% of all light vehicle (cars, SUVs, vans and utes) and motorbike imports should be electric by 2027 (both battery EV and plug-in hybrid EV). To achieve this, we recommend in the first budget period the Government:
a	●	Place a time limit on light vehicles with internal combustion engines entering, being manufactured, or assembled in Aotearoa, other than in specified exceptional circumstances. The limit should be no later than 2035 and, if possible, as early as 2030.
b	●	Introduce a package of measures to ensure there are enough EVs entering Aotearoa, and to reduce the upfront cost of purchasing light electric vehicles until such time as they are cost competitive with the equivalent ICE vehicle.
c	●	Improve the efficiency of the light vehicle fleet and stop Aotearoa receiving inefficient vehicles by introducing an emissions target for light vehicles new to Aotearoa of 105 grams CO2 per kilometre by 2028.
d	●	Develop a charging infrastructure plan for the rapid uptake of EVs to ensure greater coverage, multiple points of access and rapid charging, and continue to support the practical roll out of charging infrastructure.
Progress indicators		
a	●	Government to have consulted, no later than 30 June 2022, on preferred policy options for accelerating EV uptake (including a date for placing a time limit on the import of ICEs).
b	●	Cabinet decisions on preferred policy options to be made, as soon as possible but no later than 31 December 2022, on accelerating EV uptake.
c	●	Government to have implemented regulations on improving the fuel efficiency by 30 June 2022.

Necessary action 3 - Accelerate light electric vehicle uptake		
		We recommend that, in the first budget period the Government make progress on the following:
a	●	As part of a policy package introduce a fiscal incentive, such as a feebate or subsidy, to reduce the upfront cost of EVs until such time as there is price parity with ICEs.
b	●	As part of an equitable transition, evaluate and support interventions such as leasing, hire and sharing schemes to remove barriers and address some of the upfront capital costs of EVs.
c	●	Investigate ways to bulk procure and ensure the supply of EVs into Aotearoa and work with the private sector to do so.
d	●	Evaluate how to use the tax system to incentivise EV uptake and discourage the purchase and continued operation of ICE vehicles.
e	●	Work with the private sector to roll out EV battery refurbishment, collection and recycling systems to support sustainable electrification of light vehicle fleet.
f	●	Evaluate the role of other pricing mechanisms beyond the NZ ETS, such as road pricing, can play in supporting the change to a low emissions and equitable transport system.
g	●	In setting these policies the Government needs to mitigate impacts for low-income households and people with disabilities, regional and remote access, and with limited access to electricity.
Necessary action 4 - Increase the use of low carbon fuels for trains, ships, heavy trucks and planes		
		We recommend that, in the first budget period the Government take the following steps to support the use of low carbon fuels for heavy vehicles such as trucks, planes, ships, and off-road vehicles to meet emissions budgets:
a	●	Set a target and introduce polices so that at least 140 million litres of low carbon liquid fuels are sold in Aotearoa by 31 December 2035.
b	●	Introduce low carbon fuel standards or mandates to increase demand for low carbon fuels, with specific consideration given to aviation.
c	●	Introduce incentives to establish low emissions fuel plants, such as biofuel sustainable aviation fuel, and make those fuels more competitive with traditional fossil fuels.
d	●	Place further emphasis on decarbonising the rail system, and establish an investment strategy and clear targets to increase the share of rail and coastal shipping.

Heat, Industry & Power

Time-critical necessary action 3 - Target 60% renewable energy no later than 2035		
		Setting a target for renewable energy enables the Government to signal the required emissions reductions across the full energy system. Within that context, the 100% renewable electricity target should be treated as aspirational and considered in the broader context of the energy system that includes electricity, process and building heat and transport. We recommend the Government:
a	●	Develop a long-term national energy strategy that provides clear objectives and a predictable pathway away from fossil fuels and towards low emissions fuels, and the infrastructure to support delivery.
b	●	Under the framework of the national energy strategy, set a renewable energy target to increase renewable energy to at least 60% by 31 December 2035.
Progress indicator		

		The Government to have, by 30 June 2023, set a renewable energy target of at least 60% by 31 December 2035, set milestones for 2025 and 2030, and released an energy strategy to deliver this target.
Necessary action 5 - Maximise the use of electricity as a low emissions fuel		
		We recommend that, in the first budget period the Government take steps to ensure a low emissions, reliable and affordable electricity system to support electrifying transport and industry through progress on the following:
a		Under the framework of a national energy strategy, set a date by which coal electricity generation assets must be retired.
b		Under the framework of a national energy strategy, decide how to progress solutions to the dry year problem, when this should happen, and at what cost.
c		Introduce measures, such as a disclosure regime, to reduce wholesale electricity market uncertainty over Emissions Budgets 1 and 2, to encourage investment in new renewable generation.
d		Assess whether electricity distributors are equipped, resourced and incentivised to innovate and support the adoption on their networks of new technologies, platforms and business models, including the successful integration of EVs.
e		Enable more independent generation and distributed generation, especially for remote rural and Māori communities, and ensure access to capital for this purpose.
f		Monitor and review to ensure electricity remains affordable and accessible, and measures are in place to keep system costs down, such as demand response management.
Necessary action 6 - Scale up provision of low emissions energy sources		
		We recommend that, in the first budget period the Government make progress in scaling up the provision of new low emissions fuels by:
a		Developing a plan for the bioeconomy alongside the new national energy strategy, across transport, buildings, energy, waste, land use and industry.
b		Assessing the place that hydrogen has in the new national energy strategy.
Necessary action 7 - Reduce emissions from process heat		
		We recommend that, in the first budget period the Government take steps to reduce carbon emissions from fossil fuelled boilers by:
a		Urgently introducing regulation to ensure no new coal boilers are installed.
b		Introducing measures to help reduce process heat emissions from boilers by 1.4 Mt CO_2e over 2018 levels by 2030 and by 2 Mt CO_2e by 2035.
c		Increasing support for identifying and reporting on emissions reduction opportunities in industry, including energy efficiency, process optimisation, and fuel switching.
d		Helping people to access capital to reduce barriers to the uptake of technology or infrastructure upgrades such as boiler conversions, energy efficiency technologies, and electricity network upgrades.
Necessary action 8 - Support innovation to reduce emissions from industrial processes		
		We recommend that, in the first budget period the Government take steps to support innovation in hard-to-abate industrial processes, including by:
a		Developing a long-term strategy for the future of hard-to-abate industries, including iron, steel making, cement and lime production and petrochemical production. This strategy should be developed alongside the national energy strategy, future Economic Plans and strategies for an equitable transition (see time-critical necessary actions 1 and 3).

b		Based on the outcome of the strategy, investigating whether bespoke solutions requiring research and development specific to Aotearoa will be required.

Buildings

Necessary action 9 – Increase energy efficiency in buildings

		We recommend that, in the first budget period the Government introduce measures to transform, transition and reduce energy use in buildings. Measures should include:
a		Continuing to improve energy efficiency standards for all buildings, new and existing stock, through measures like improving insulation requirements. Expand assistance which targets low-income households.
b		Introducing mandatory measures to improve the operational energy performance of commercial and public buildings.
c		Setting a date by when no new natural gas connections are permitted, and where feasible, all new or replacement heating systems installed are electric or bioenergy. This should be no later than 2025 and earlier if possible.

Necessary action 10 – Reduce emissions from urban form

		We recommend that, in the first budget period the Government promote the evolution of urban form to enable low emissions transport and buildings through ongoing legislative reform:
a		Develop a consistent approach to estimate the long-term emissions impacts of urban development decisions and continually improve the way emissions consequences are integrated into decision making on land use, transport and infrastructure investments.
b		Ensure a coordinated approach to decision making is used across Government agencies and local councils to embed a strong relationship between urban planning, design, and transport so that communities are well designed, supported by integrated, accessible transport options, including safe cycleways between home, work and education.

Multisector

Necessary action 16 – Support behaviour change

		We recommend that, in the first budget period the Government embed behaviour change as a desired outcome in its climate change policies and programmes in order to enable New Zealanders to make choices that support low emissions outcomes.

Time-critical necessary action 6 – Align investments for climate outcomes

		To meet emissions budgets and achieve the 2050 target, it is important that policy decisions and investments made now do not lock Aotearoa into a high emissions development pathway. Safeguards and signals will be needed to prevent this, including a specific focus on ensuring long-lived assets such as infrastructure are net-zero compatible. To achieve this, we recommend in the first budget period the Government:
a		Immediately start to factor target-consistent long-term abatement cost values into policy and investment analysis in central government. These values should be informed by the Commission's analysis which suggests values of at least $140 per tonne by 2030 and $250 by 2050 in real prices.
b		Encourage local government and the private sector to also use these values in policy and investment analysis.
c		Ensure that economic stimulus to support post-COVID-19 recovery helps to bring forward the transformational investment that needs to happen anyway to reach our joint climate and economic goals.
d		Investigate and develop a plan for potential incentives for businesses to retire emissions intensive assets early.

e	●	Require the Infrastructure Commission to include climate change as part of its decision- and investment-making framework, including embedded emissions and climate resilience
f	●	Investigate and develop plans to mobilise private sector finance for low emissions and climate-resilient investments.
Progress indicators		
a	●	Government to start, as soon as possible and by no later than 31 March 2022, factoring target-consistent long-term abatement cost values into policy and investment analysis.
b	●	Government to publish, as soon as possible and by no later than 31 March 2022, how the COVID-19 economic stimulus is helping to accelerate the climate transition.
Time-critical necessary action 7 - Driving low emissions choices through the NZ ETS		
		The Emissions Trading Scheme (NZ ETS) needs to drive low emissions choices consistent with emissions reduction targets in Aotearoa, including a focus on gross emissions reductions. In the first budget period the Government should:
a		In the next annual update to NZ ETS settings:
i	●	Align unit volumes with emissions budgets, taking into account the need to reduce the NZU stockpile.
ii	●	Increase the cost containment reserve trigger price to $70 as soon as practical and then every year by at least 10% plus inflation.
iii	●	To maintain continuity with recent prices, immediately increase the auction reserve trigger price to $30 as soon as practical, followed by annual increases of 5% plus inflation per year.
b	●	Amend the NZ ETS so that it contributes, as part of a package of policies (see time-critical necessary action 5), to delivering the amount of afforestation aligned with our advice on the proportion of emissions reductions and removals, consistent with budget recommendation 2.
c	●	Establish a sound market governance regime for the NZ ETS as soon as possible to mitigate risks to market function, as some of these risks are potentially catastrophic for the scheme's effectiveness. This work should be advanced through an interagency team including MBIE for its financial markets expertise.
Progress indicators		
a	●	Government ensure that, in the next annual update to the NZ ETS settings, unit volumes are aligned with emissions budgets and price control settings are increased.
b	●	Government to develop proposals as soon as possible to establish a sound market governance regime for the NZ ETS, and to have legislated to address the most significant risks by no later than 30 June 2023.
Necessary action 19 - Continued ETS improvements		
		We recommend that, in the first budget period the Government make progress on:
a	●	Developing options and implementing a plan for recycling some or all of the proceeds from NZ ETS unit auctions into emissions reductions, adaptation, equitable transitions and meeting international climate change obligations.
b	●	Undertaking a first principles review of industrial allocation policy.
c	●	Continuing to phase out industrial allocation.
d	●	Exploring alternative policy instruments that could address the risk of emissions leakage.
e	●	

		Providing more information to reduce uncertainty about adjustments to NZ ETS settings, particularly how it intends to manage unit volumes in light of the split-gas 2050 target.
f	🟡	Clarifying the role and avenues for voluntary mitigation in Aotearoa.

Detailed response to the CCC's consultation questions

Consultation question 1: Principles to guide our advice (p. 30)

Do you support the principles we have used to guide our analysis? Is there anything we should change, and why?

EECA supports the principles as proposed. In particular:

- **Principle 3: Create options –** EECA's *Energy Efficiency First* report shows how nationwide uptake of energy efficient technology – the 'first fuel' – could lower the system cost of decarbonisation, thereby preserving and unlocking investment options in the future.

- **Principle 4: Avoid unnecessary cost –** EECA recognises the need to decarbonise our sectors on as natural an investment cycle as possible in order to reduce the overall costs of the transition, while identifying areas where we can move faster and the barriers that need to be overcome.

  The challenges and costs associated with transitioning existing infrastructure and fleets means that significant attention should be placed on interventions that restrict the adoption of new high emission technologies and processes. This needs to be done with urgency to avoid locking in emissions and future cost associated with stranded assets. The Commission seems to take this approach in several areas, as demonstrated by recommendations related to stopping the import of internal combustion engine vehicles, banning coal boilers etc. We suggest that this could be reflected in Principle 4 or included as a separate principle.

- **Principle 7: Leverage co-benefits –** EECA has long advocated the co-benefits of energy efficiency, conservation and renewable energy. These range from the health and wellbeing benefits of warmer, dryer, more energy efficient homes, to the potential of energy efficiency to act as a 'jobs machine'. According to the International Energy Agency, every $1 invested in energy efficiency retrofits for houses and small business internationally, $0.60 goes to labour costs.[1]

[1] https://www.iea org/articles/energy-efficiency-and-economic-stimulus

Consultation question 4: Limit on offshore mitigation for emissions budgets and circumstances justifying its use (p. 38)

Do you support budget recommendation 4? Is there anything we should change, and why?

EECA supports the recommendation to limit offshore mitigation for the first emissions budgets. EECA's work has identified there is a significant pool of emissions reductions opportunities that could be unlocked domestically at a cost for government and taxpayers below the cost of offshore mitigation (particularly if you only accept high quality credits from credible markets). Energy efficiency also has well-documented co-benefits[2] that can be realised within New Zealand if we pursue domestic mitigation.

[2] Capturing the Multiple Benefits of Energy Efficiency – Analysis - IEA (2015)

Consultation question 9: Establish processes for incorporating the views of all New Zealanders (p. 44)

Do you support enabling recommendation 5? Is there anything we should change, and why?

EECA supports the intent to make New Zealanders' views front and centre of the discussions that need to happen to balance the fairness of the transition. We do not suggest change to this recommendation but we see an opportunity to use EECA's existing *Gen Less* platform to further these objectives.

EECA's own research into perceptions about climate change and energy emissions shows that New Zealanders understand the need to take climate action, but are seeking direction on how this should occur and what role they need to play. With the right level of effort and investment we can address this through public education, awareness and communication.

A majority of New Zealanders want others to do more to reduce our climate change impact. EECA research (January 2019) found that 88% of people want companies to do more, 76% want government to do more and 76% want other people to do more. It also found that there are some important information gaps or linkages that need to be made in the minds of consumers, such as strengthening the link between transport and consumers overall energy emissions.

If government intends to step proactively into engaging with the public on climate change it will be important to identify shared objectives across relevant agencies, which can guide coordinated action on public awareness, communication and education. As a starting point we have laid out three potential cross-government objectives below:

- ensure the public are **well-informed** and understand government plans and policies
- **engage people in effective consultation and co-development** on plans and policies to help ensure the best decisions are made for New Zealand and New Zealanders as we transition to a low emissions economy
- motivate people to **take action** in their own lives to reduce emissions and make **long-term decisions** that will support the transition.

Any effort to inform and engage New Zealanders should build upon what is already in place. EECA's public *Gen Less* platform, is a well-suited and increasingly well-recognised platform to host a public engagement programme which seeks to increase the public and business' engagement with climate change.

Consultation questions 13: An equitable, inclusive and well-planned climate transition (p. 103)

Do you support the package of recommendations and actions we have proposed to increase the likelihood of an equitable, inclusive and well-planned climate transition? Is there anything we should change, and why?

EECA supports the emphasis placed on ensuring that the climate transition is equitable and inclusive.

Of particular relevance for EECA, the Commission's Necessary Action 1 (d) recommends there is a need to "Assess the Government's current standards and funding programmes for insulation and efficient heating to determine whether they are delivering at an appropriate pace and scale, and how they could impact housing and energy affordability. The Government should give particular consideration to potential flow through costs to tenants, and to government owned housing stock".

EECA's current low-income home retrofit programme *Warmer Kiwi Homes* is one of government's key interventions in alleviating energy hardship in New Zealand. It is the latest iteration of a low-income home retrofit subsidy programme that has been running in various forms since 2009. Since the start of the current programme in July 2018, 53,177 retrofits (39,491 insulation and 13,686 heating respectively) have been completed.

EECA regularly reviews the design and targeting of this programme to ensure that it delivers maximum benefit to low-income households at maximum cost-effectiveness for public money. A recent cost-benefit analysis returned a benefit to cost ratio for this programme of 4.7:1.

EECA is beginning a scheduled outcome evaluation of the WKH programme which is expected by February 2022. This will provide an important source of information for the design of future wellbeing interventions.

Consultation question 14: Transport (p. 110)

Do you support the package of recommendations and actions for the transport sector? Is there anything we should change, and why?

Necessary action 2 - Develop an integrated national transport network to reduce travel by private vehicles and increase walking, cycling, low emissions public and shared transport

EECA supports action to increase the use of low emission transport modes, such as walking, cycling and public and shared transport, as well as optimising or reducing travel.

EECA research shows that only 4 in 10 New Zealanders understand that transport is their single largest contributor to carbon emissions. Behaviour change will be a key enabler to help people to choose low emission transport modes such as walking, cycling and public transport and alternate choices such as working from home. EECA's *Gen Less* campaign has been getting the message out to the public to help people understand the impact of their transport choices on carbon emissions.

Nearly a third of car trips in New Zealand are under 2km[3], and there is opportunity for these "first and last kilometre" trips to be provided by other low emission transport modes and services. EECA agrees that a key challenge to address will be the provision of safe, affordable, convenient and accessible frequent public or shared transport choices. Provision of infrastructure and the design of cities and regions will allow the shift away from private fossil fuel vehicle use and EECA will support the role of government agencies in this important work.

EECA has also supported the demonstration of several electric bus and car share projects through the Low Emission Vehicle Contestable Fund. These technologies and services are now being rolled out in cities around New Zealand, however, there is a need to accelerate their adoption.

Time-critical necessary action 2 - Accelerate light electric vehicle uptake

EECA supports the Commission highlighting the transition of the light vehicle fleet as a time critical necessary action. New Zealand's emissions breakdown makes it clear that the light vehicle fleet provides the greatest opportunity for reducing transport emissions, particularly as there are low emission alternatives already available in the form of battery and plug in hybrid electric vehicles.

The modelling of the Commission's preferred path includes the following forecasts relating to the uptake of electric vehicles (EV):

- 50% of light vehicle imports will be electric by 2027, with 40% of the fleet electric by 2035.
- Of the trucks imported in 2030, 15% of medium trucks and 8% of heavy trucks would be electric. By 2035, these would increase to 84% and 69% respectively.

This modelling appears quite optimistic, however we acknowledge it is dependent on a number of assumptions that represent significant coordinated policy action, as well as overcoming supply constraints and seeing the closing of the significant price gap between EV's and internal combustion engine vehicles.

Below are EECA's comments on the Commission's recommended package of measures for accelerating light electric vehicle uptake.

[3] Ministry of Transport NZ Household Travel Survey Data 2015-2017.

Recommendation A - Place a time limit on light vehicles with internal combustion engines entering, being manufactured, or assembled in Aotearoa, other than in specified exceptional circumstances. The limit should be no later than 2035 and, if possible, as early as 2030

EECA agrees that it will be necessary for New Zealand to set a date from which the importation/manufacture/assembly of light internal combustion engine vehicles will not be allowed. With the target year of the Clean Car Import Standard being 2025, and many of our trading partners adopting similar policies, it seems appropriate to set this date sometime between 2030 and 2035, as suggested by the Commission.

Recommendation B - Introduce a package of measures to ensure there are enough EVs entering Aotearoa, and to reduce the upfront cost of purchasing light electric vehicles until such time as they are cost competitive with the equivalent ICE vehicle

We agree that EV supply constraints and high upfront costs are two of the key barriers that need to be addressed to increase EV uptake.

Constraints to the access of electric vehicle supply from overseas markets could result in a scarcity of vehicle volume and choice, potentially slowing the progress of transitioning the domestic fleet. EECA's work suggests that:

- In the near term (up to 2025) there are expected to be supply constraints because of the limited number of EV models and volumes being produced, which is expected to limit the extent to which all domestic market segments can be supplied. Further compounding this is the limited domestic sales of EV's in Japan, which limits what is available to import into New Zealand particularly as second hand vehicles. This warrants New Zealand looking at emerging EV manufacturing markets to secure EV supply, not just Japan.
- By 2030 it is expected that global production rates of new vehicles increases and there are unlikely to be supply constraints for imports of new EV's. This can be further supported by strategic supplier sourcing strategies with other emerging markets such as China, who is already a major producer and consumer of EV's (although it does not export high volumes currently). Policies will further enable access to the models and volumes of vehicles to be supplied into New Zealand.

Noting the potential short term supply and cost constraints for EV's, it would be valuable if the Commission could include analysis on the uptake of Internal Combustion Engine (ICE) hybrids and the impact this would have on the modelling scenarios and EV uptake in New Zealand, recognising the current dependence (~60% of used vehicles are imported from Japan) and the recent trend of increased hybrid vehicle imports (new and used) from Japan.

We note that the supply of EV's to New Zealand is primarily influenced by the commercial decisions of overseas vehicle manufacturers, and the Government has little ability to change that. However, manufacturers are known to prioritise supply to countries with 'EV-friendly' policies, such as strong vehicle emissions standards and discounts on upfront vehicle cost.

While the upfront cost of electric vehicles is currently acting as a barrier to EV uptake, we note that the lower ongoing costs (such as fuel and maintenance) compared to fossil-fuelled vehicles improves the competitiveness of electric vehicles.[4]

[4] EECA analysis on total cost of ownership of EV and ICE.

The Commission assumes that lifetime price parity between EV's and ICE vehicles will be reached by 2024. This is a realistic assumption, but the timing of upfront capital cost parity may be of more importance to stimulating EV uptake. EECA's work suggests capital price parity between light EV's and ICE vehicles being reached in about 2030.

The assumption of price parity convergence and increase of EV manufacturing to meet supply-demand imbalances by 2030 will support a rapid acceleration of EV uptake from this time. However, we agree that the scale and urgency of the decarbonisation required from the light vehicle fleet means that strong supporting policies are needed immediately to accelerate the fleet transition as much as possible.

Recommendation C - Improve the efficiency of the light vehicle fleet and stop Aotearoa receiving inefficient vehicles by introducing an emissions target for light vehicles new to Aotearoa of 105 grams CO2 per kilometre by 2028

EECA supports the introduction of a vehicle fuel economy standard and welcomes the Government's announcement that the target year for the Clean Car Import Standard will be 2025.

Recommendation D - Develop a charging infrastructure plan for the rapid uptake of EVs to ensure greater coverage, multiple points of access and rapid charging, and continue to support the practical roll out of charging infrastructure

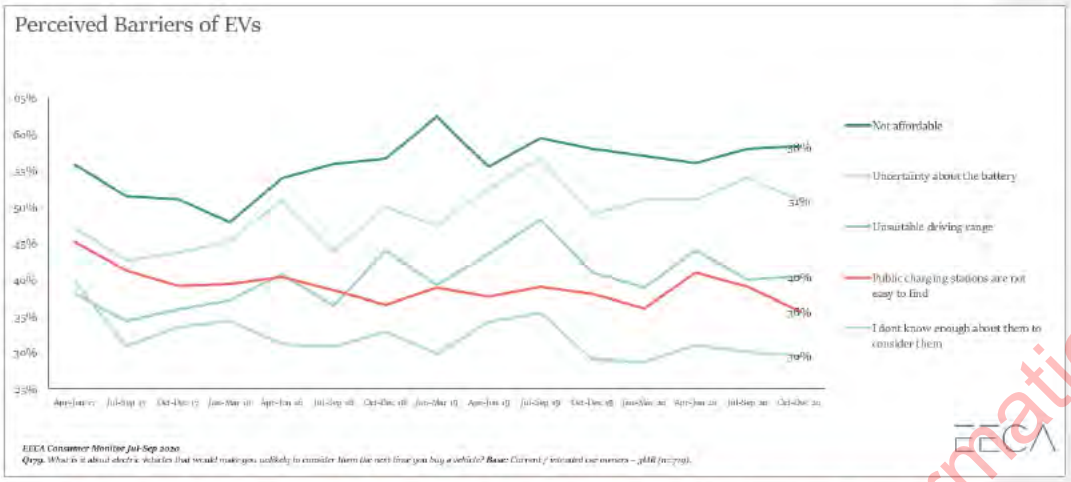
EECA has had an important role in the rollout of New Zealand's electric vehicle charging network. The Low Emission Vehicle Contestable Fund has provided co-funding to over 1,100 EV charging projects (over 600 for public EV chargers). So far, the rollout of New Zealand's EV charging network has started from a low base and is led by a few charging service providers. This has been an appropriate approach up to this point as the number of electric vehicles on the network has been low. However, with the introduction of policies to significantly increase the uptake of EV's, a more coordinated plan for future EV charging infrastructure and investment is required.

EECA supports the recommendation of a national EV charging infrastructure strategy and is working with other government departments to advance this work.

Any charging strategy should go beyond simply setting out the proposed location and level of investment required for public EV charging infrastructure. The strategy should also factor in and be able to respond to the future EV uptake scenarios that influence charging requirements, wider electrification policies and strategies, current government programmes for co-investment and feed into consideration of electricity distribution network upgrades. The factors will vary across the short term and long term, and be influence by the rapidly changing nature of technology and EV owner expectations and needs. The plan should also consider issues such as the asymmetry of information, lack of competition, capability and capacity from charging infrastructure providers, rural gaps, low and middle-income communities, workplace and commercial buildings and residential charging.

Necessary action 3 - Accelerate light electric vehicle uptake

EECA also supports the range of recommended actions for accelerating light electric vehicle uptake under Necessary Action 3. A coordinated package of actions is needed to make the New Zealand vehicle market more supportive of EV's, including reducing the cost and increasing the supply of EVs in New Zealand. EECA's consumer monitoring shows that the upfront cost premium of electric vehicles is the primary barrier to EV uptake in New Zealand.



Necessary action 4 - Increase the use of low carbon fuels for trains, ships, heavy trucks and planes

EECA agrees that a range of low carbon fuels, such as biofuel and hydrogen, will be needed for New Zealand to decarbonise hard to electrify applications such as planes and ships. Our view is technologically agnostic – we anticipate that the 'right' fuel will vary from application to application. It is not clear at this stage whether applications in heavy duty road freight will be better suited for direct electrification or use of low carbon liquid or gaseous fuels, or a combination of both.

Hydrogen

In 2019, EECA jointly commissioned Concept Consulting to undertake research on the cost effectiveness of hydrogen technologies for decarbonising the New Zealand economy relative to alternatives.[5] We also recently assisted Are Ake in their initial study of the economics of using green hydrogen to decarbonise long-distance heavy freight in New Zealand. Through the delivery of our funding programmes, we have also had insight into hydrogen technology and applications.[6]

EECA supports the development of 'green' hydrogen (produced from renewable electricity) that is economic and can cost-effectively reduce emissions compared to alternatives. Growing policy commitment and global investment have the potential to make hydrogen a commercially viable low-carbon alternative to some fossil fuel applications in the future (as New Zealand is a technology taker). Green hydrogen is part of the journey to electrifying the economy and its role should be considered as part of any electrification strategy (or the national energy strategy, as referred to later).

At present, there are significant challenges for the commercial scale deployment of green hydrogen in New Zealand relative to its carbon abatement impact. EECA agrees that there are significant barriers and challenges on both the supply and demand side for hydrogen to become an economically viable alternative.

[5] The research, titled 'H2 in NZ - A study of the potential economics of hydrogen technologies in New Zealand' can be found here: https://www.concept.co.nz/updates.html.
[6] Low Emission Vehicles Contestable Fund (Round 9 Hyundai FCEV trucks project and Round 5 Ports of Auckland Hydrogen Demonstration project).

Deployment of hydrogen in New Zealand still remains in the demonstration phase. Pilot and demonstration projects have the potential to de-risk the technology for first adopters and reduce safety, regulatory and technical barriers.

Biofuel

EECA recently commissioned research regarding liquid biofuels, which covers demand and supply constraints, technology readiness for drop-in biofuels and life-cycle emissions analysis by feedstock.

We have attached this report to this submission as it informs EECA's view on the liquid biofuels opportunity for New Zealand.

Recommendation A - Set a target and introduce polices so that at least 140 million litres of low carbon liquid fuels are sold in Aotearoa by 31 December 2035

From discussion with the Commission, we understand this target was calculated based on liquid biofuels (but is currently worded to also cover other low carbon liquid fuels). Due to the variance in lifecycle emissions of different biofuel types and feedstocks, we suggest that a volumetric target (i.e. in litres) may not be the best approach to achieve emissions reductions. We would support instead an emissions reduction target (i.e. in CO2-e) for low carbon fuels.

The 140ML target appears to be based on production estimates from available wood feedstock rather than on a wider analysis including technical feasibility, demand-supply dynamics or maximising emissions reductions. This raises several points:

- The life-cycle emissions vary a lot from one biofuel to another (mainly depending on feedstock and associated land use change). Therefore, life cycle emissions reduction should be the main driver of any biofuel policy (especially incentives) in order to prevent the use of biofuels with poor emissions benefits (or even increased emissions compared to fossil fuels).
- There might be more valuable (such as chemicals) or efficient (such as direct combustion for process heat) uses of wood than the production of liquid biofuels. A national discussion is needed on what are the priority uses of this limited resource. The Commission's recommendation for the development of a national plan for the bioeconomy (Necessary Action 6) would be an appropriate and valuable opportunity for this discussion to take place.
- So as not to delay action while developing a bioeconomy plan, interventions such as a biofuel mandate or low carbon fuel standards should still be implemented (which prioritise the emissions and sustainability of the biofuel) so long as adequate conditions apply for life cycle emissions of the biofuels supplied into the blended fuels.
- The blending limits for biodiesel and bioethanol suggest that the potential demand for these fuels on an energy basis could be 6% of current demand for diesel fuels by heavy trucks and marine, and 6% of current demand for petrol fuels by light vehicles respectively (biodiesel is not suitable for aviation). This potential could be realised immediately with the import of biofuels, rather than waiting to set up a domestic production industry to provide 3% of demand (as seems to be suggested in the Commission's draft advice). It would be useful if the Commission could be more explicit about if it sees a role for biofuel importation.
- The potential incremental demand for drop-in diesel is much higher assuming a 50% concentration limit, i.e. around 44% of total energy required by diesel heavy trucks, marine and aviation, and 47% of total energy required by light petrol vehicles.
- Our research suggests that, due to technological readiness, production of drop-in biofuel from wood biomass is unlikely to be at scale before 2035.
- Our research includes a progressive scenario where liquid biofuel uptake increases from 0.88 PJ (28.38 million litres) p.a. in 2022 to 8.06 (256.5 million litres) p.a. by 2030, reaching a maximum output of 43.14 PJ (1,287.2 million litres) p.a. by 2043.

Recommendation C - Introduce incentives to establish low emissions fuel plants, such as biofuel sustainable aviation fuel, and make those fuels more competitive with traditional fossil fuels

This recommendation seems to cover incentivising production of biofuels, as well as incentivising demand for biofuels (reducing the cost premium of the fuel).

Demand and production are two different aspects and we feel should be treated separately in the Commission's advice.

The experience with Marsden Point shows that ensuring availability for the domestic market is more complex than building a local production capacity: securing feedstock is a starting point, and ensuring demand is key.

The challenge is that feedstocks are globally tradable commodities, as are biofuels. This can create a complete disconnect between local production and local availability.

We agree that there may be a role for incentives for increasing demand in the short term. However, we are cautious about the proposal to provide incentives for domestic production. The opportunity cost to subsidise domestic production is unlikely to be justified by domestic emissions reduction only, and there is a need to factor in other considerations such as security of supply, economic impact, competing usages for the feedstock and factors that would result in a competitive advantage for production in New Zealand.

The capital cost alone for producing 100 million litres by 2030 would be in the range of $300-$760 million, depending on the conversion technology.[7] Such projects will not take place if investors have low confidence in capital cost recovery and prospects to scale production to reduce costs per unit of energy.

We suggest that the potential for incentives for biofuel production or demand should be considered as part of the wider bioeconomy plan recommended in Necessary Action 6. This would need to consider the risks of government support for biofuel production, including:

- New Zealand subsidising production of biofuels which are then exported to other countries.
- New Zealand developing production capacity which is put in global competition for feedstock.
- New Zealand taking technology development risks in isolation - the scale of investments call for global effort.

Off-road diesel

We would like to draw the Commission's attention to an opportunity not mentioned in the advice and that might have been overlooked: Off-road diesel. This umbrella term refers to the following (non-road) uses of diesel:

Sector	**Application examples**
Aviation	Airport ground service equipment

[7] For FT catalysis and hydro-cracking, the estimate assumes a current capex of $9.12/litre fuel as per (BioPacific Partners, 2020) and a 3% p a. learning curve to 2030. For pyrolysis oil upgrade, the estimate assumes a capex value of $3 03-$7.6/litre fuel depending on whether the hydrogen is produced or purchased. This cost range is derived from capex estimates by (Wright, et al., 2010) for the n-th plant and a pioneer plant. The pioneer plant is assumed to be built in 2035, and the n-th plant in 2025.

Rail	Rail maintenance equipment
Marine	Recreational boating, personal watercraft, fishing
Agriculture	All-terrain farm vehicles, farm motorcycles, tractors
Construction	Off-road trucks and tractors, generators, machinery
Industrial	Forklifts, generators, other industrial equipment
Mining	Mining equipment, off-road mining trucks
Forestry	Forestry equipment (eg haulers) off-road logging trucks
Residential	Residential lawn and garden equipment
Commercial	Commercial lawn and garden equipment, heating, forklifts
Government	Defence, lawn and garden equipment
Recreational	Motorsport, off-road motorbikes

There was about 36PJ of non-transport diesel use in 2019[8] (including an unknown portion for heating). This is equivalent to 2.6 Mt CO2e/year, so the opportunity for emission reduction is likely to be within the range of 1 to 2 Mt CO2e/year.

EECA has commissioned research to increase the understanding of this opportunity, for which solutions such as hybrid and biofuels could be relevant. We will share these insights with the Commission when they are available in mid-2021.

In the meantime, the Commission could mention the opportunity of off-road diesel in the list of potential targets for low-carbon fuels in its advice.

[8] MBIE Energy Balance Tables

Consultation question 15: Heat, industry and power sectors (p. 118, p. 111)

Do you support the package of recommendations and actions for the heat, industry and power sectors? Is there anything we should change, and why?

Time-critical necessary action 3: Target 60% renewable energy no later than 2035

Recommendation A - Develop a long-term national energy strategy that provides clear objectives and a predictable pathway away from fossil fuels and towards low emissions fuels, and the infrastructure to support delivery

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EECA supports the development and implementation of a long-term national energy strategy to transition away from fossil fuels to renewable fuels. It is essential that this strategy includes strong transition planning to ensure it doesn't create perverse outcomes (such as switching away from one energy source too soon leading to overall increased emissions or impacting the affordability of consumer electricity etc).

We note we are in the final year of the existing New Zealand Energy Strategy 2011-2021. Any energy strategy should be complementary to and aligned with the New Zealand Energy Efficiency and Conservation Strategy (NZEECS) which is to be updated in 2022.

~~We note we are in the final year of the existing New Zealand Energy Strategy 2011-2021.~~

Recommendation B - Under the framework of the national energy strategy, set a renewable energy target to increase renewable energy to at least 60% by 31 December 2035

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EECA agrees there is technical and economic potential for New Zealand to significantly increase its use of renewable energy, and that doing so will be critical to achieving New Zealand's climate change goals.

Under the NZEECS, New Zealand has an existing target of 90 per cent of electricity generation from renewable sources by 2025. EECA agrees there is good rationale for expanding New Zealand's policy focus beyond the electricity generation mix to encompass renewable energy use more broadly and potentially framed as an emissions reduction target. This approach aligns with the overall goal of reducing economy-wide emissions. An appropriate energy target should be developed as part of any long-term energy strategy, with emissions reduction prioritised as the outcome.

The development of a target should be based on an accurate evidence base. We note the current 40% renewable energy figure, and presumably 60% target, is based on Total Primary Energy Supply (TPES). We note that TPES is significantly impacted by the treatment of geothermal electricity generation[9] and consequently a TPES renewable energy target may not be the most appropriate.

Necessary Action 5: Maximise the use of electricity as a low-emission fuel

EECA agrees electrification will be critical to achieving New Zealand's climate change objectives. Optimising electricity demand through efficiency improvements will be a critical enabler to transport

[9] This occurs because International Energy Agency (IEA) rules for calculating TPES treats geothermal electricity generation differently to hydro, solar or wind electricity generation. In essence, all the energy extracted from geothermal fluid is added to the TPES rather than the net electricity generation. As the thermodynamic potential of low temperature heat is low, only about 15% of this extracted geothermal heat becomes electricity that is available for use. If geothermal electricity generation was accounted for the same way as hydro generation, i e. electricity exported from the power station, then New Zealand's renewable energy percentage would fall to around 26%.

and process heat electrification. EECA's 2019 *Energy Efficiency First* report found potential for cost-effective efficiency measures that collectively comprise an estimated 10-12% of electricity demand. At costs between $15-$50/MWh, this efficiency potential is significantly cheaper than even the lowest-cost new renewable generation currently available.[10]

EECA has a range of existing policies that contribute to this, including energy product regulations under the trans-Tasman Equipment Energy Efficiency (E3) Programme. The 86 million products sold under the programme since 2002 have saved 59.55 PJ of electricity, equating to $1.45 billion of national benefit, and 2.33 Mt of CO2-e. It will also be critical to ensure market and regulatory settings enable and encourage the integration of new innovative technologies, such as demand response / flexibility and battery storage, to improve power system flexibility and security as the percentage of electricity supplied by intermittent renewables increases.

EECA supports the Commission's recommendations below, as they will contribute to achieving a fit-for-purpose electricity system that enables decarbonisation via electrification. However, given the scale and complexity of the challenge they are unlikely to be sufficient to overcome the barriers to achieving rapid, economy-wide electrification that is optimal and equitable. EECA therefore suggests a similar approach to electrification to that recommended elsewhere, for example for the bioeconomy. An 'electrification strategy' (or 'roadmap') will be a critical component of any national energy strategy, to ensure an optimal and coordinated increase in electricity demand and supply across the economy while managing the many barriers and issues that are likely to arise, in particular:

- Security and predictability of demand: major new sources and locations of electricity demand (new connections) need to be signalled early enough to allow infrastructure investment to keep pace, and to ensure price 'stability'
- Ensuring the cost of upgrading transmission and distribution infrastructure is spread equitably and rationally across the electricity system
- Ensuring the regulatory framework and consent and planning rules do not unduly dis-incentivise new generation or use of electricity as an energy source
- Energy Efficiency First: by optimising electricity demand, energy efficiency will be a critical enabler to electrification across the economy
- Future proofing: ensuring New Zealand's electricity system enables (and does not unnecessarily dis-incentivise) the adoption of new technologies and innovations will be critical to optimising the transition to an electrified economy.

Commented [DB3]: [redacted]

Commented [MP4R3]: [redacted]

Such an electrification strategy will require input from a range of public and private stakeholders across the electricity system.

The Commission provides a number of recommendations under this action covering a wide range of areas. It would be useful if these recommendations could more explicitly provide a sense of priority, to assist consideration of where resource is best focussed.

Recommendation A - Under the framework of a national energy strategy, set a date by which coal electricity generation assets must be retired

Any regulation to mandate the phase-out of coal or other fossil fuel electricity generation assets should be considered carefully under the framework of a national energy strategy and balance the energy trilemma of affordability, sustainability and security.

[10] https://www.eeca.govt.nz/our-work/research/research-papers-and-guides/energy-efficiency-first/

Whether mandating the phase-out of coal electricity generation is necessary to achieve a highly renewable electricity system that enables electrification while balancing the trilemma will need to be carefully considered in the context of New Zealand's climate goals and existing market and policy settings. Mandating the retirement of plant is just one option among other options that could be explored, for example:

- setting a mean-year coal generation target of zero
- setting grid emissions factor targets/pathways
- requiring thermal generation usage to be tied to new renewable build.

Recommendation B - Under the framework of a national energy strategy, decide how to progress solutions to the dry year problem, when this should happen, and at what cost

As noted above, efficiency measures to optimise demand will be critical to integrating a higher percentage of intermittent renewable generation while mitigating against dry year risk.

This recommendation could be strengthened to require dry year solutions to be optimised for cost and carbon reduction impact. The current recommendation relies on a national energy strategy putting these in place, however this cannot be guaranteed without more direct guidance.

Recommendation C - Introduce measures, such as a disclosure regime, to reduce wholesale electricity market uncertainty over Emissions Budgets 1 and 2, to encourage investment in new renewable generation

Encouraging investment in new renewable generation is desirable and necessary. It is not clear whether a disclosure regime can sufficiently address the prevailing uncertainties. A liquid and long term wholesale contracts market or some other minimum price mechanism may be necessary.

Recommendation D - Assess whether electricity distributors are equipped, resourced and incentivised to innovate and support the adoption on their networks of new technologies, platforms and business models, including the successful integration of EVs

Agree (see above).

This is important, however the Commission should perhaps go further in terms of what needs to happen if the assessment finds distributors are insufficiently equipped to facilitate the transition.

Recommendation E - Enable more independent generation and distributed generation, especially for remote rural and Māori communities, and ensure access to capital for this purpose

Community, independent and distributed generation has a role to play in the electricity system where they support balancing of the energy trilemma (affordability, security, sustainability). It is important to be clear on what problems the different technologies and interventions are trying to solve (e.g. energy affordability, emission reduction, cold damp housing etc). At a time when very large volumes of capital investment are needed, care needs to be taken to ensure that this capital delivers on the desired outcomes.

Another key consideration is that any rules or regulations introduced should be set so that independent generation is not unnecessarily impeded.

It is also important that distributed generation is provided in a coordinated manner, for example under a demand flexibility framework that ties together the different elements in the system (e.g. solar photovoltaics, home energy management systems, storage, electric vehicles and appliances).

Recommendation F - Monitor and review to ensure electricity remains affordable and accessible, and measures are in place to keep system costs down, such as demand response management

This recommendation could be interpreted as suggesting price controls. It is important not to conflate system efficiency with affordability. Both are important for the transition, however mechanisms to achieve them are different, and potentially operate in conflict with one another. Preventing electricity from becoming uncompetitive when priced against fossil alternatives is a key element of the transition, and an efficient system will be needed to enable this. However, an efficient system also relies on cost-reflective pricing and effective cost recovery. Where measures are needed to address affordability issues related to poverty, these should be implemented by the appropriate social agencies.

As noted above, energy efficiency, and demand response / flexibility will be critical to enabling a highly renewable electricity system that supports decarbonisation through electrification.

Necessary Action 6: Scale up the provision of low-emission energy sources

Recommendation A - Developing a plan for the bioeconomy alongside the new national energy strategy, across transport, buildings, energy, waste, land use and industry

EECA agrees there is a need for long-term planning on bio-resources, including prioritisation of use. This is required to optimise the balance between value added and energy security. It is an important aspect of an orderly transition avoiding unnecessary costs. Hence, any plan will need to address trade-offs for using limited bio-resources, particularly between liquid biofuels for transport and biomass for process heat but also for traditional wood product uses. It will also need to balance the costs and benefits of both domestic and imported bio-resources.

The barriers to developing bio-resource supply-chains are unlikely to be uniform across sectors. For example, process heat usage is diffused across multiple sites through the country, while any biofuel production site will likely be concentrated in one region. The coordination challenge of matching process heat demand with bioenergy supply is much less complex than for matching fuel demand with biofuel production which is assumed to have a much larger 'minimum viable quantity required' to enable plants to achieve economies of scale. These dynamics have important implications for supply-chains and distribution of costs.

As noted by the Commission, there are significant opportunities to replace fossil fuels for process heat with biomass. However, many process heat users face significant financial and non-financial barriers to implementing these opportunities, and policy to help overcome these barriers can catalyse deepening and broadening of bio-resource supply-chains. The Government Investment to Decarbonise Industry (GIDI) Fund has funding available for projects to convert process heat boilers to biomass.

We also note there will be challenges meeting fuel demand for some large process heat sites currently using coal – particularly in Southland and Canterbury – from biomass due to concentration of demand and insufficient supply in those regions, and competition from wood processors for this resource.

Recommendation B - Assessing the place that hydrogen has in the new national energy strategy

As noted in our comments on Necessary Action 4 in the transport section, green hydrogen is part of the journey to electrifying the economy. EECA agrees that the role of hydrogen should be considered as part of any electrification strategy (such as through the national energy strategy).

Necessary Action 7: Reduce emissions from process heat

Recommendation A - Urgently introducing regulation to ensure no new coal boilers are installed

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EECA agrees there is a need for regulation to ensure no new coal boilers are installed, and that such regulatory action is consistent with New Zealand's climate change objectives. EECA also supports investigating regulatory options to optimise process heat efficiency and accelerate the phase-out of existing coal and other fossil fuelled boilers. Regulations can provide an effective mechanism for reducing 'avoidable' emissions, that is, emissions from fossil fuel usage that could be cost-effectively reduced through efficiency and/or replaced by renewables using existing technologies.

Regulations can complement the ETS and complementary measures, such as the GIDI Fund.

Recommendation B - Introducing measures to help reduce process heat emissions from boilers by 1.4 Mt CO2e over 2018 levels by 2030 and by 2 Mt CO2e by 2035

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EECA agrees process heat, along with transport, is one of New Zealand's best emissions reduction opportunities. The Commission's proposed level of process heat emissions reduction is technically viable at marginal abatement costs consistent with the Commission's modelling. In EECA's experience working with large emitting businesses, achieving this level of abatement within the emissions budget timeframes will require government to support industry to overcome the financial and non-financial barriers to rapidly transition from fossil fuels to renewables, alongside a combination of higher emissions prices and/or regulations.

The proposed quantum of process heat emissions reductions is technically feasible and, according to the Ministry for the Environment's marginal abatement cost analysis, can be achieved at costs to the economy that are well within the Commission's assumed marginal abatement cost (not to be confused with future ETS price) of around $140 in 2030 needed to achieve the 2050 target. To the extent that process heat abatement opportunities can be achieved at marginal abatement costs to the economy lower than the Commission's expected 'shadow' carbon price pathway (and in some cases below current ETS prices or at negative abatement costs), these abatement opportunities can be considered 'no regrets' and should therefore be prioritised within the next emissions budget period.

Notwithstanding the fact average marginal abatement costs to the economy of reducing process heat emissions may fall within current or future ETS prices, the actual costs and benefits to individual businesses will reflect the highly site-specific nature of process heat fuel switching projects and vary depending on a range of factors. These include decisions by other businesses that can increase or decrease the cost of subsequent businesses decarbonising in that region (i.e. first mover advantages or disadvantages). Achieving the Commission's proposed process heat emissions reductions within the emissions budget timeframes will also require process heat users to act quickly: for some businesses, the challenge of finding upfront capital will be compounded by the need to replace existing fossil fuel assets before the end of their useful lives. Businesses often require capital investment projects to have payback periods far shorter than the project lifetime (can be as low as two years in some sectors). Moreover, process heat fuel switching projects can take

multiple years to implement, and many large process heat users have multiple sites meaning they will need to carefully plan their own long-term transition pathways.

Even where ETS prices make some process heat abatement opportunities economic, financial barriers are often compounded by technical and other non-financial barriers associated with the complexity of large process heat projects. This is borne out by the not insignificant level of unrealised abatement that is already technically available at or below current ETS prices.

Consistent with EECA's response to Necessary Action 5 ('Maximise the use of electricity as a low-emissions fuel') and Necessary Action 6 ('Scale up the provision of low-emission energy sources'), government support for fuel switching projects can ensure a steady and coordinated increase in demand for electricity and biomass, thereby enabling steady and coordinated investment in infrastructure in the electricity system and biomass supply chains.

The new $69 million GIDI Fund, administered by EECA, provides businesses with access to capital co-funding that, alongside EECA's suite of other energy service programmes (including the Energy Transition Accelerator), are supporting businesses to start transitioning away from fossil fuels to renewables.

Clarity on the phasing out of coal

It would be useful if the Commission's advice relating to recommendations A and B could be a bit clearer and consistent with the preferred pathway for coal, as outlined in other parts of the Commission's advice. For example:

- In table 3.1, the "process heat" line states "Replace coal with biomass and electricity" during the first two budgets (with the third budget focussing on replacement of gas by biomass and electricity).
- In Part 3.8.5 Industry and Heat, figure 3.15 (page 64), the graph shows that almost all coal use disappears by 2035 and just a third of it remains in 2030.
- On page 76, it is stated that "Deep cuts in coal use between 2020 and 2030 (by about ~75% from 2010 levels)" are required to be consistent with a 1.5C trajectory.

The wording of the advice under Necessary Action 7 is not explicit that coal use in process heat should be largely phased out within the next decade. It is important to be clear about this as it has implications for existing consents under the Resource Management Act.

Potential wording to make this recommendation explicit could be "Introducing measures to help reduce process heat emissions from boilers by 1.4 Mt CO2e over 2018 levels by 2030 and by 2 Mt CO2e by 2035. *This means the phasing out of coal in process heat use needs to start now and be mostly achieved during the first two budgets*."

Recommendation C - Increasing support for identifying and reporting on emissions reduction opportunities in industry, including energy efficiency, process optimisation, and fuel switching

EECA agrees, and we note MBIE's 2019 discussion document 'Accelerating Renewable Energy and Energy Efficiency' included options under section 1 to address information failures, including requiring large energy users to publish Corporate Energy Transition Plans (including reporting emissions annually) and conducting energy audits every four years.

Businesses face a range of information barriers with the result that many existing cost-effective opportunities to improve energy efficiency and reduce emissions (including at or below current ETS

prices) remain unrealised. Moreover, requiring businesses to report on emissions reduction opportunities will improve transparency and data inputs to guide policy and long-term transition planning.

EECA has been increasingly active in this space in the past few years, with the roll out of our Energy Transition Accelerator programme, which offers bespoke technical support to large emitters to develop long-term transition plans. EECA also offers a range of support to help large energy users and other businesses overcome information barriers to improving energy efficiency and identifying fuel switching opportunities, including energy audits, feasibility studies, support for energy graduates, and technology demonstration funding.

We would like to highlight that support is only one part of the equation, and not necessarily the main barrier to wider and faster uptake. Other barriers that need to be addressed include:

- EECA's mandate is limited to energy related emissions, while businesses logically want to assess their emissions as a whole.
- While some businesses are thinking about the transition and are willing to work with and be supported by EECA, others lack the incentives to address this long-term challenge.
- Triggering a review of existing consents and mandating transition plans would create the required incentive.

Based on the above points, we suggest tweaking the recommendation to *"Increasing identification and reporting on emissions reduction opportunities in industry, including energy efficiency, process optimisation, and fuel switching"*

Recommendation D - Helping people to access capital to reduce barriers to the uptake of technology or infrastructure upgrades such as boiler conversions, energy efficiency technologies, and electricity network upgrades.

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As noted above there is technical potential to accelerate emissions reduction consistent with the Commission's draft process heat emissions reduction targets. EECA's GIDI Fund is an existing mechanism for achieving this.

Any increased government funding should be complementary to the ETS, and carefully considered alongside both regulatory and non-regulatory options.

EECA is experienced in working with industry to address barriers to uptake of technology, energy efficiency and renewable energy. While some can struggle to access capital (because they are over-indebted for example), it is not our experience that access to capital is the main issue.

Overall, in a context of low regulatory incentives, the challenge is mostly about improving the return on investment of the transition projects so they can be attractive enough for decision makers and become a priority for their organisation. The Commission may want to reflect this in its advice.

Necessary Action 8: Support innovation to reduce emissions from industrial processes

Recommendation A - Developing a long-term strategy for the future of hard-to-abate industries, including iron, steel making, cement and lime production and petrochemical production. This strategy should be developed alongside the national energy strategy, future Economic Plans and strategies for an equitable transition (see time-critical necessary actions 1 and 3).

Recommendation B - Based on the outcome of the strategy, investigating whether bespoke solutions requiring research and development specific to Aotearoa will be required.

EECA agrees with the intent to support innovation to reduce emissions from industrial processes, however, this does not necessarily extend to specifically supporting innovation in the hard-to-abate industries.

In New Zealand, hard-to-abate industrial processes consist of "one-plant sectors". Most innovation in these globalised sectors are likely to come from abroad, especially to reduce emissions, which involves significant rethinking of these processes (hence the name "hard-to-abate").

Therefore, the required investments would be very expensive for a small country alone.

In addition, these plants are mostly controlled by international owners, which can decide to move their plant at will. So there is a real risk at investing significant amount of taxpayer money in these assets.

However, there is a need to support a wider adoption of innovations reducing emissions in a wide range of sectors of New Zealand economy.

EECA published an international technology scan[11] listing some of the innovation which wider use would help the transition, with a range of co-benefits.

Necessary Action 9: Increase energy efficiency in buildings

EECA strongly supports measures to increase the energy efficiency of buildings, and also notes the significant co-benefits of improved buildings in terms of health and wellbeing.

The Commission's *Evidence Report Chapter 9: Which path could we take?* includes some assumed levels of energy efficiency and energy intensity improvement. EECA's view on these assumptions is included below:

- **Residential / existing:** The Commission assumes that existing homes' energy intensity improves by 6% by 2035. We feel that this level of improvement is eminently achievable, particularly if you consider that this level of improvement would be achieved with a conversion to heat pump water heating alone.
- **Residential / new build:** The Commission assumes that by 2035, new builds are 35% more energy efficient compared to today's performance. While it is unclear if the Commission is comparing to today's new builds or today's average house, either way it should be achievable. This seems to align with the timeline of the "final step" of the Ministry of Business, Innovation and Employment's (MBIE) Building for Climate Change programme in terms of timeline and probably energy use, which we support.
- **Commercial:** The Commission assumes a 30% improvement in commercial and public buildings' energy intensity is possible by 2035 compared to today's performance. Based on experience with the NABERSNZ building energy efficiency rating system, we feel that this level of improvement is achievable.

Recommendation A - Continuing to improve energy efficiency standards for all buildings, new and existing stock, through measures like improving insulation requirements. Expand assistance which targets low-income households

[11] https://genless.govt.nz/assets/Business-Resources/International-technology-scan.pdf

The Warmer Kiwi Homes programme, administered by EECA and targeting low-income households, supports insulation and clean, efficient heating to improve the energy efficiency of homes. Support for this programme should continue until all target homes have received retrofits.

EECA is also strongly supportive of the Building for Climate Change programme, administered by MBIE, which will initially focus on improved standards for new builds.

Recommendation B - Introducing mandatory measures to improve the operational energy performance of commercial and public buildings

EECA continues to support the use of the NABERSNZ tool, a system for rating the energy efficiency of office buildings. There are already a number of public and private sector organisation that use NABERSNZ as a straightforward means of helping to make their building more efficient.

The use of this tool could be expanded as a means of delivering on the Commission's budget of a 30% improvement in commercial and public buildings' energy intensity by 2035. For example, the tool could be used to drive energy efficiency improvements in apartment buildings, shopping centres, data centres, hotels and public hospitals.

Recommendation C - Setting a date by when no new natural gas connections are permitted, and where feasible, all new or replacement heating systems installed are electric or bioenergy. This should be no later than 2025 and earlier if possible

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EECA strongly endorses a strategic view being taken of New Zealand's future energy systems. A number of overseas jurisdictions are moving to 'all-electric' homes and commercial buildings as a low-cost decarbonisation pathway, and to avoid stranded assets in gas distribution infrastructure. The national energy strategy should therefore consider the best timing of a potential ban on new gas connections, and the role of biofuels. However, any such timeframe for a ban on new gas connections must strike a balance between decarbonisation, energy security, and replacement energy sources affordability.

Necessary action 10 – Reduce emissions from urban form

EECA strongly endorses the Commission's messaging about the importance of understanding the emission impacts of urban form and the need for coordinated decision-making across local and central government.

We recognise that the Commission was unable to go into much detail on the issues and opportunities in this area. We agree that the interrelationship between land use, transport and infrastructure justifies significant attention from Government and that emission reduction needs to be prioritised in decision making.

Consultation question 19: Multisector strategy (p. 134)

Do you support the package of recommendations and actions to create a multisector strategy? Is there anything we should change, and why?

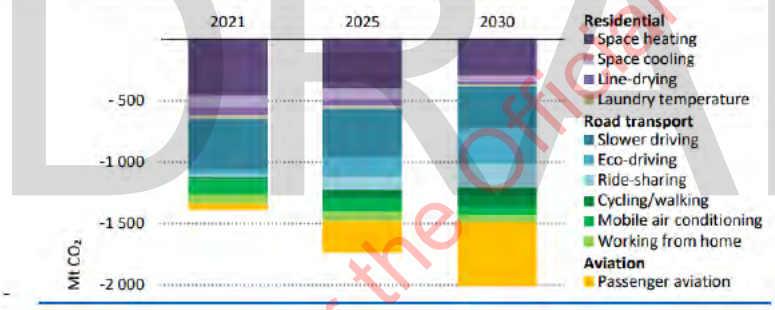
General comments on the multi-sector approach

A combination of policies and market interventions will be necessary the meet the emissions targets. Although the introduction to chapter 6 accurately describes the types of measures needed to reach these targets, the multisector section is quite limited in what it considers. The Commission's advice does not refer to areas such as innovation, research, and training, which all seem to be critical multi-sector aspects of delivering the emissions budgets, but are not apparent in the Commission's multisector strategy. We are interested to understand if this is based on the Commission's perception of priority or need.

Necessary action 16 - Support behaviour change

EECA agrees that behaviour change is a key component of any plan to escape carbon lock-in. We strongly support the proposal that behaviour change at organisational and business level, as well as an individual level, is critical to achieving net zero. IEA modelling in the World Energy Outlook 2020 highlighted the critical role of behaviour change in reaching New Zealand's net-zero target, and the scale of the behaviour change activity that is needed.

Figure 4.15 ▻ Impact of behaviour changes on CO_2 emissions in the NZE2050



Source: IEA, World Energy Outlook 2020

EECA advises caution, however, against limiting the discussion to specific, small-scale changes. Ad-hoc behaviour change efforts risk creating only short-lived impact – we must pursue deep and long-term systemic change to lock-in behaviour change at the scale required. Identifying the role of government in driving this systemic change will be a key challenge.

Since our formation in 2000, **EECA** ~~has an active work programme on behaviour change, and~~ **has** ~~been~~ successfully run programmes **promoting** energy and climate-related **behaviour change**, most recently **through** ~~it~~the ***Gen Less*** **public engagement platform** ~~since 2019~~**.**

Gen Less is aimed at influencing energy-related purchasing, consumption and other behavioural choices at the individual level. It has been informed by ongoing market research and monitoring of individuals' and businesses' values and actions related to climate change. Noting the importance of building upon what is already in place, we would reiterate the opportunity to harness the Gen Less

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platform as a channel for increased behaviour change efforts by government (see our comments on consultation question 9 above).

EECA has a strategic process underway to develop better ways of influencing values and addressing the value-action gap through effective communications and behaviour change – our *Hearts and Minds* strategy. By combining bottom up individual behaviour change with top down systemic influencing actions, the *Hearts and Minds* strategy aims to create fertile ground for systemic change.

EECA also intends to measure the gap between what people and businesses will need to do in a net-zero world, and what they are doing today. This will inform our progress towards our objectives and the evolution from year to year.

We agree that meaningful behaviour change action will require a collaborative, focused and multi-agency approach, but suggest dedicated funding with a discrete structure is necessary to convert collaboration into action.

Discussion between government agencies with relevant activities around public engagement (and behaviour change) on climate change has already begun in the context of the Government's Emissions Reduction Plan. Given coordination groups already exist, next steps need to move current activities from simple information sharing to meaningful coordinated action.

There is precedent for creating a distinct team focused on behaviour change internationally. Dedicated agencies have been established at the highest level, as with Australia's Behavioural Economics Team, and dedicated teams have been nested within a ministry or regulatory agency, such as in Japan and the UK.

It is worth noting that EECA currently occupies analogous role to that of Waka Kotahi New Zealand Transport Agency, performing our role as the operations arm of the energy system, implementing MBIE's energy policy function. With additional resourcing, EECA is well placed to lead delivery of future cross government coordinated behaviour change activities in climate change.

We agree that piloting, testing and evaluation of behavioural interventions will be a key activity.

While continuous monitoring can shed light on the long-term impacts of behavioural interventions, evaluation remains the responsibility of individual agencies, which generally lack resource to monitor these effects over long-enough time periods. A stronger direction from central government requiring periodic, rigorous and systematic policy and programme evaluation is needed to support this in practice.

There is an opportunity to support the continuous improvement of climate change related interventions through improved coordination and knowledge sharing among groups conducting research and evaluation. This function could be delivered by a behavioural insights body or by another centralised monitoring and evaluation team.

Time-critical necessary action 6 - Align investments with climate outcomes

EECA strongly agrees with this recommendation and the priority given to it.

We would like to offer some comment and questions that may assist the commission in clarifying its advice for maximum impact.

Recommendation A - Immediately start to factor target-consistent long-term abatement cost values into policy and investment analysis in central government. These values should be informed by the

Commission's analysis which suggests values of at least $140 per tonne by 2030 and $250 by 2050 in real prices

EECA notes that Treasury has recently published shadow-pricing guidance for use in government investment decision-making[12]. Establishing appropriate shadow carbon prices is a complex task with a wide range of uncertainty. It would be helpful if the Commission could clarify the recommendation in terms of the process it recommends be used to establish 'target-consistent prices' (a term which will be a key component of implementing this recommendation). We agree that the Commission's own modelling will be a useful resource, however there are other potential sources, such as the Carbon Pricing Leadership Coalition's High-Level Commission on Carbon Pricing and Competitiveness, that may give different or more nuanced results.

Recommendation B - Encourage local government and the private sector to also use these values in policy and investment analysis

EECA supports this recommendation. The use of consistent long-term abatement cost values by all levels of government and the private sector would help future-proof investments.

Recommendation C - Ensure that economic stimulus to support post-COVID-19 recovery helps to bring forward the transformational investment that needs to happen anyway to reach our joint climate and economic goals

EECA agrees with this recommendation and has made resources available to help out with this where appropriate (for example feeding in to consideration of Infrastructure Reference Group projects and the Government Investment to Decarbonise Industry (GIDI) Fund).

Recommendation D - Investigate and develop a plan for potential incentives for businesses to retire emissions intensive assets early

EECA agrees that some additional incentives may need to be made available to businesses if some assets are to be retired early. However, we would urge caution in developing a specific plan for this component. Any scheme will have the risk of being manipulated and the asset retirement barrier will need to be addressed in the wider context of barriers. One role for voluntary carbon markets could be to bring forward replacement of high emissions assets, thus addressing the 'time gap' problem.

Recommendation F - Investigate and develop plans to mobilise private sector finance for low emissions and climate-resilient investments

EECA is exploring options around the growing demand for ways to accelerate climate action and address climate related risk in the private sector. Driven by risk management, new participants are increasingly channelling capital in directions that contribute to climate mitigation and adaption. We support this action and we would like to highlight the potential of the voluntary carbon market (VCM) as a vehicle for private sector finance investments. Today, the existing VCM is niche and could be scaled up significantly.

EECA has been working with Motu and a wide range of stakeholders to address this challenge using the voluntary carbon market opportunity arising from the beginning of the Paris Agreement period.

[12] Appendix 4 of the CBAx User Tool Guidance: https://www.treasury.govt.nz/sites/default/files/2020-12/cbax-guide-dec20.pdf

Motu and EECA will soon publish a summary report outlining the problems, the opportunities and the current thinking in term of solutions. This report also addresses the waterbed effects[13] with the ETS.

Voluntary mitigation can help to bridge current gaps in mitigation ambition, financing, and speed that could undermine the long-term goals of the Paris Agreement.

Through our work, EECA identified a convergence of trends, barriers and opportunities and concluded that the VCM has the potential to be a vehicle for private finance to help unlock emissions reduction by funding domestic energy transition.

There are domestic emission reduction opportunities in New Zealand that are cost effective compared to alternatives such as forestry or offshore credits. These opportunities (energy efficiency and renewable energy projects) are not responsive to energy (and therefore carbon) prices because they face non-price barriers or the price signal is not yet sufficient to trigger investments.

As demonstrated with the GIDI Fund, an injection of capital could unlock some of these opportunities by improving the return on investment of the projects. The VCM could be a source of private funding for these projects.

Additionally, there is an incentive mismatch between businesses with cost-effective opportunities but low incentives/willingness to act and businesses with willingness to transition but few opportunities (overly expensive or not technically mature). Enabling these businesses to split the value and the claims for these projects would enable a shift from the zero-sum game status quo to a collaborative environment.

Shortcomings of the Kyoto period offsetting and carbon neutral approach have resulted in relatively low uptake and low trust in this market. Fixing the accounting issue by increasing transparency is key to increase trust and fix the behaviour issues related to past and current offsetting practices.

Allowing the VCM to fund domestic projects could also improve trust by bringing the outcomes of the spending closer to New Zealanders.

Time Critical necessary action 7 - Driving low emissions choices through the NZ ETS
Recommendation A - In the next annual update to NZ ETS settings:
(i) Align unit volumes with emissions budgets, taking into account the need to reduce the NZU stockpile *(ii) Increase the cost containment reserve trigger price to $70 as soon as practical and then every year by at least 10% plus inflation*

EECA agrees with the general strengthening of ETS settings and the intent behind these.

The specific wording in the advice could potentially be enhanced and clarified.

[13] The 'waterbed effect' describes a situation where action taken by one party (pushing down) is cancelled out by increases from other parties due to the reduced pressure under the overall unit cap.

Specifically:

Recommendation A(i) - This recommendation could be more specific about the expected change in unit auction volumes. The current recommendation specifies a principle for adjustment (i.e. alignment with budgets) but stops short of identifying the quantum of adjustment the Commission expects to see. This means that if government adjusts the auction volumes at all, this could be claimed to be complying with this recommendation, when actually it is not a sufficient adjustment. A specific range of auction volumes "i.e. Commission analysis suggests that the appropriate range of auction volumes is X to Y million units per year" would be a more effective recommendation.

Recommendation A (i) and (ii) - A fundamental principle of the ETS is that it makes use of a market mechanism to determine the price. While having well signalled price corridors is a useful feature of the ETS, as it provided a degree of confidence about price levels, care should be taken that the ETS is not over-constrained.

The recommendations are set at specific prices, with specific escalation rates. Given the timeframe, the starting price is unlikely to be problematic, however the escalation rates may need to be revisited over time. A more useful approach would be to reference the price setting to ETS market outcomes from a preceding period. For example, "The auction reserve trigger price will be set at the average of the previous 3 months published ETS price".

The justifying comment "these changes are needed because maintaining current settings will lead to failure to meet emissions budgets" could be rephrased for clarity and accuracy. At present it implies a direct link between the ETS settings and New Zealand's emissions. While the ETS is a key tool in managing emissions, it is neither fully effective, nor the only measure being applied to the emissions problem.

Recommendation B - Amend the NZ ETS so that it contributes, as part of a package of policies (see time-critical necessary action 5), to delivering the amount of afforestation aligned with our advice on the proportion of emissions reductions and removals, consistent with budget recommendation 2

This recommendation would benefit from improved clarity and further explanation. It implies some sort of differentiation between forest types, but it is not easy to determine how this would work in practice. While the detail will be developed in consultation with affected parties, a more tangible strawperson example would provide affected parties with a better basis for discussion.

Recommendation C - Establish a sound market governance regime for the NZ ETS as soon as possible to mitigate risks to market function, as some of these risks are potentially catastrophic for the scheme's effectiveness. This work should be advanced through an interagency team including MBIE for its financial markets expertise

Our understanding is that the intent of this recommendation is for the Government to speed up implementation of the market governance work programme already identified. The progress indicator refers to 'the most significant risks' however it is not clear from the advice what the Commission believes these to be.

Necessary action 19 - Continued ETS improvements

Recommendation A - Developing options and implementing a plan for recycling some or all of the proceeds from NZ ETS unit auctions into emissions reductions, adaptation, equitable transitions and meeting international climate change obligations

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Recycling of ETS revenue is one among many options to increase government funding for emissions reductions, adaptation, equitable transitions and meeting international climate change obligations. We strongly support the need to investigate this opportunity, alongside the range of other potential funding mechanisms. The benefit of hypothecating ETS revenues is it could make the increasing cost implications of the ETS more palatable to society as they see a direct correlation between the cost to consumers of an ETS and the direct investment from ETS revenues recycled into emission reduction efforts. Much in the same way the dedicated National Land Transport Fund has sought to do this with fuel excise duty and road user charges. However, direct hypothecation may also have downsides, in terms of being unable to provide certainty of forward funding.

Recommendation B - Undertaking a first principles review of industrial allocation policy

EECA supports a first-principles review of industrial allocation policy to ensure it is fit for purpose.

Recommendation C - Continuing to phase out industrial allocation

The Government has put in place a policy to phase out industrial allocation slowly and over a long timeframe. It would be useful to understand if the Commission recommends maintaining this policy or accelerating the phase-out of industrial allocation to be consistent with targets and budgets and ensuring a fair and equitable burden of action across the economy.

Recommendation D - Exploring alternative policy instruments that could address the risk of emissions leakage

Emissions leakage can occur from all sectors of the economy. It would be useful if the Commission can clarify whether this recommendation relates to industrial allocation to Emission Intensive and Trade Exposed (EITE) sectors, or more broadly (i.e. including agriculture). If the recommendation does not include primary production then perhaps the Commission could consider merging recommendation b, c, and d into a single recommendation that says "Adjust the industrial allocation regime and related policies to be consistent with targets and budgets while managing risks of carbon leakage".

Recommendation E - Providing more information to reduce uncertainty about adjustments to NZ ETS settings, particularly how it intends to manage unit volumes in light of the split-gas 2050 target

Reducing uncertainty in the ETS settings is important for encouraging long-term investment activity in emissions reduction. However, the need to reduce uncertainty is somewhat inconsistent with discussions in the advice about managing 'the waterbed effect' (Evidence report Chapter 16, page 8), which suggests fluidly adjusting auction volumes to account for actual emissions reductions both inside and outside the ETS. It would be helpful if the Commission could clarify how these competing objectives would best be managed.

Recommendation F - Clarifying the role and avenues for voluntary mitigation in Aotearoa

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We do not share the Commission's view that, providing an adjustment, when a NZU is cancelled, it is equivalent to removing a tonne of emissions from the atmosphere. This theoretical reasoning does not seem to take into account the significant amount of NZUs stockpiled by some businesses, most of which were received for free as a result of over allocation.

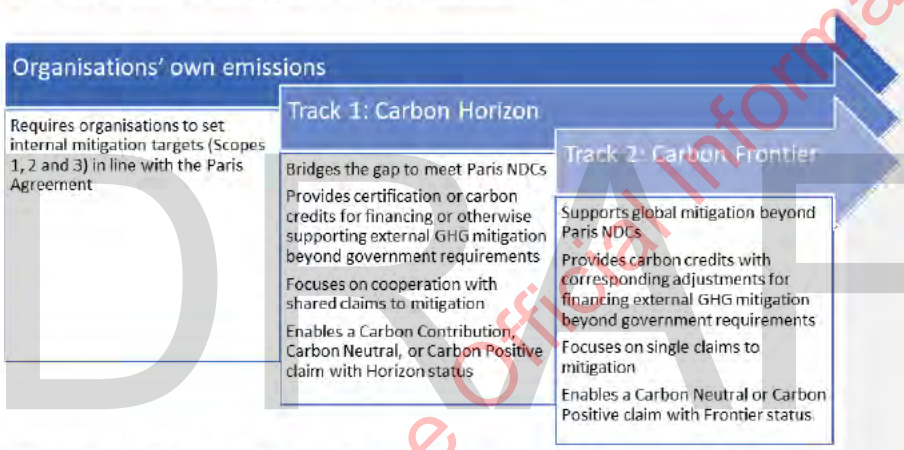
We do support the general recommendation, although it would be helpful if the Commission could provide a clearer position. This could be used as a starting point for inter-agency discussion on the matter.

As mentioned in Recommendation F of Time Critical Necessary Action 7, EECA has been working on this topic with Motu and a wide range of stakeholders.

We think that the voluntary carbon market (VCM) has a key role to play to unlock domestic transition projects facing non-price barriers, or for which the price signal is not yet sufficient to trigger investments when the opportunities arise (e.g. asset replacement).

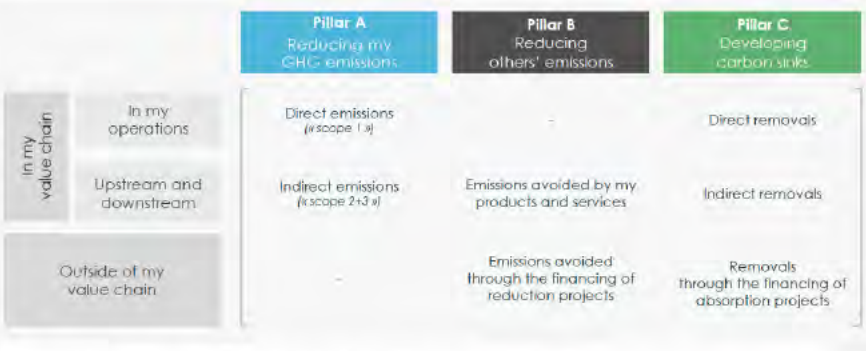
From the joint work with Motu and the workshops participants, we suggest potential solutions, including:

a) A strawperson proposal for a two-track system intended to boost voluntary mitigation at scale with benefits for both organisations and government.



In the past, voluntary mitigation typically focused on generating and trading voluntary carbon credits (VCCs) eligible for carbon-neutral offsetting claims. While retaining that option with new features to make it Paris-compatible, this proposal expands the scope of eligible voluntary mitigation to include recognition for more diverse forms of cooperation with shared gains and greater valuation of environmental, social, cultural, and economic co-benefits. It is scalable for the global transition toward net-zero emissions.

b) An alternative is a "dashboard" approach to carbon accountability for organisations, which increases transparency and allows shared claims to favour collaboration.
With this approach, an organisation's performance would be distinct from helping others, and the gross emissions would be distinct from removals. It would result in a clearer risk exposure for investors and shareholders.
An example of such approach has been developed by the Net Zero Initiative:



Adoption of such reporting would unlock better outcomes such as:

- Allowing an increase of gross emissions from a company producing goods or services that unlock greater emissions reductions for their customers (such as energy providers).
- For the state sector, it would highlight investments in domestic reduction projects as a valid option compared to purchasing offshore credits to cancel.

Board Report

TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY
EECA

Meeting Date	26/08/2021
Subject	Energy and Emission Policy Update and EECA Involvement and Impact
Purpose	To provide an update on significant policy developments relevant to EECA for [redacted] the Emissions Reduction Plan.
Action sought	To Note
Prepared by	Jesse Corlett, Manager, Policy and Engagement

Summary

1. This paper provides the Board with an update on significant policy developments relevant to EECA. This includes:
    a. [redacted]
    b. [redacted]
    c. The Emissions Reduction Plan.

[redacted]

[redacted]

Information withheld as out of scope

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Information withheld as out of scope

[redacted]

Emissions Reduction Plan and Emissions Budgets

Information withheld under section 9(2)(f)(iv)

[redacted]

The Government will soon consult publicly on its draft Emissions Reduction Plan

19. The Emissions Reduction Plan (ERP) is required to be in place by the end of the year and will set out the Government's plan to meet the emissions budgets. [redacted]

20. EECA has provided input to key sector chapters of the ERP, including Transport, Energy and Industry and Building and Construction. EECA has also been involved in other elements of the ERP, including related to research, science and innovation, funding and finance, bioeconomy and behaviour change.

[redacted]

[redacted]

Information withheld under section 9(2)(f)(iv)

Recommendations

25. It is recommended that the Board:

    a. **Note** and **Discuss** the contents of this paper, particularly as it relates to EECA.

[redacted]

Marcos Pelenur
GROUP MANAGER STRATEGY, INSIGHTS AND REGULATIONS

[redacted]

Andrew Caseley
CHIEF EXECUTIVE

Information withheld under section 9(2)(a)

Nesta Jones

From: Daniel Barber
Sent: Tuesday, 23 March 2021 3:22 pm
To: Justine Cannon; Janet Humphris; Suzannah Toulmin; Bertrand Ngai; Matthew Everett; Rachel M Ward; Christie Marsh; Ewan Delany; Joanna Pohatu; Terry Genet; Mitchell Trezona-Lecomte
Cc: Marcos Pelenur; Jesse Corlett; Mitchell Trezona-lecomte
Subject: EECA's submission to the Climate Change Commission
Attachments: EECA submission to CCC.docx

Good afternoon all, you are probably aware that EECA has been preparing a submission on the Commission's draft advice. Our submission has now been approved by our CE and Chair and is attached for your information.

The final version we submit to the Commission will be a designed-up version, which should be ready tomorrow. However, I figured you may prefer to receive a word version. We will submit to the Commission by Friday.

Regards
Dan

Daniel Barber
Senior Advisor
Policy and Engagement

EECA TE TARI TIAKI PŪNGAO

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www.eeca.govt.nz

EECA's submission to the Climate Change Commission's 2021 draft advice for consultation

Letter from the Chair

To the Climate Change Commission,

On behalf of the Energy Efficiency and Conservation Authority (EECA), I would like to congratulate the Commission on the release of its draft advice. This represents the first major release from the Commission and the product you have delivered reflects the amount of work that has gone into its development.

It is essential for New Zealand to have clear, evidence-based, independent advice on how we can progressively meet our 2050 net zero emission targets. The Commission's draft advice provides a clear message that the emissions budgets and proposed policy direction are 'ambitious but achievable'.

EECA has prioritised its resources to provide input to the Commission's work, based on our experience working with the public and private sectors to encourage, promote, and support the uptake of energy efficiency, energy conservation, and the use of renewable sources of energy in New Zealand.

EECA's purpose and statutory functions mean we have an important role as the authority and delivery agency for the government's response to several key areas covered by the Commission's advice. Our current work programme already supports reducing the carbon footprint across a wide range of sectors. We look forward to continue working with the Commission, wider government, industry and the public on our transition to a low emission economy.

Kind regards

Elena Trout
Chair, EECA Board

About EECA

The Energy Efficiency and Conservation Authority (EECA) is a Crown entity established under the Energy Efficiency and Conservation Act 2000 to encourage, promote, and support the uptake of energy efficiency, energy conservation, and the use of renewable sources of energy in New Zealand. This mandate provides us with the authorising environment to work with a wide range of stakeholders and customers, as we transition to a low carbon and sustainable economy.

Key points of EECA's submission

EECA generally supports the Commission's advice and recommendations

EECA welcomes and supports the Commission's overarching finding that we can meet our 2050 targets with existing technology, noting that significant change and action is required as well as the need to overcome some of the cost barriers associated with the existing technology. EECA strongly advocates that interventions such as supporting energy efficiency and the uptake of electric vehicles, and the move to renewable energy sources for our process heat needs can make a significant contribution to our decarbonisation goals.

We recognise there are many new low emission technologies being developed in most sectors of the economy, and these have the potential to unlock significant emission reduction options with the increasing potential for lower cost decarbonisation pathways. However, the long timeframes normally required to scale up new technologies and the urgency of our need to decarbonise mean the existing barriers need to be overcome.

We appreciate the Commission has not been tasked with identifying specific policies, this is the role of the Government. As a result, there are a number of the Commission's recommendations that we support in principle, but there will need to be further work to determine viable policy solutions.

The scale and breadth of policy work that is required to develop the Government's Emission Reduction Plan means that it is essential this work is well coordinated across government departments. The structures and frameworks to ensure this happens are currently being developed and we agree with the Commission's advice that these will be critical to enabling coordinated and timely action.

EECA has a key role in implementing the policies that would flow from the Commission's advice

EECA's function under the Energy Efficiency and Conservation Act 2000 is to *encourage, promote, and support energy efficiency, energy conservation, and the use of renewable sources of energy.* Given that a significant portion of New Zealand's emissions are from energy, emission reduction has become the primary focus of our strategic and operational activity. The goals of efficient use of energy, the use of renewables and emission reductions are inseparable.

EECA works in an interesting space — we are a Crown Agent but have close relationships with both Government and industry. This gives us a unique ability to provide the Government with an 'ear to the ground' to understand the impact of policies on businesses and improve the evidence base and implication of policy development.

We utilise our three levers, motivation (public engagement and behaviour change), co-investment and regulation to carry out our functions. We are the authority on behalf of Government in a range of areas related to emission reduction and we are one of the few government agencies currently directly investing in emission abatement through co-investment in low emission technologies. Our public engagement campaigns such as Gen Less and earlier successful campaigns related to reducing energy and energy efficiency have demonstrated our role and experience in promoting low emission behaviours.

Given our experience with direct emission mitigation projects, we welcome this opportunity to make a submission to the Commission on the draft Budgets and share our insights.

There are a few key areas of focus for EECA

There is a lot of interdependence between the areas covered by the Commission's advice. We have focussed our submission on the main areas of relevance to EECA's activities. This is primarily transport, heat, industry and power and the multi-sector strategy.

Given the wide range of subject matter and recommendations covered by the Commission's advice, it is essential there is coherence as an overall package. For this reason we strongly support the recommendations that relate to developing overarching strategies, such as the national energy strategy or bioeconomy plan, to provide clear and coherent direction. Targets such as those proposed by the Commission should be developed as part of those strategies and include strong transition planning, to ensure the targets are consistent, based on strong evidence, do not create perverse outcomes and support the overall outcome of reducing greenhouse gas emissions. While reducing emissions, it is important to also maintain a path towards an equitable and affordable transition to a low emission economy.

Another point that is relevant across all sectors is the important balance between effort to transition existing technology and processes, compared to interventions that stop the introduction of new high emission technologies and processes. Using the vehicle fleet as an example, it will be much more difficult to transition the existing fleet to low emission vehicles if we continue importing high emission vehicles into the fleet. For this reason we recommend that Government should place short-term priority on initiatives that keep high-emitting technologies out of the country as well as restricting domestic asset investment that does not align with our low emission goals.

The sector-specific key points in EECA's submission are summarised below.

<u>Transport</u>

- EECA generally agrees with the Commission's advice relating to reducing travel by private vehicles and shifting to low emission modes.
- We strongly support the Commission highlighting accelerating light electric vehicle (EV) uptake as a time-critical necessary action and the recommendations to achieve this.
- We agree that EV supply constraints and high upfront costs are two of the key barriers that need to be addressed to increase EV uptake. EECA's work suggests supply constraints are likely to limit the extent to which all domestic market segments can be supplied with EV's until about 2030.
- Noting the potential short/medium term supply constraints for EV's, it would be valuable if the Commission could include analysis on the uptake of Internal Combustion Engine (ICE) hybrids (as a cost effective near term transition option for consumers) and the impact this would have on its modelling scenarios and EV uptake up to about 2030.
- The recommendation to develop a national charging infrastructure plan is of particular relevance to EECA and we are working with government departments to progress this.
- We agree that low carbon fuels such as biofuel and hydrogen could play a role in decarbonising hard to electrify transport applications but currently there are considerable cost barriers to overcome before widespread uptake could occur.
- EECA supports the development of 'green' hydrogen (produced from renewable electricity) that is economic and can cost-effectively reduce emissions compared to alternatives. However, in line with the Commission's approach to rely on existing technologies to transition, the assumptions on emissions reductions delivered by the hydrogen pathway should be conservative as there are still major barriers to overcome.

- We urge caution with the Commission's proposal to set a volumetric target for biofuel uptake, based on the potential for domestic production using woody biomass. Biofuels are not all low emissions, so a volumetric target does not ensure emission reduction is the priority.
- We suggest that an aggregate emission reduction target for all low carbon fuels would be more appropriate, based on wider analysis of fuels and feedstocks, including technical feasibility, demand-supply dynamics or maximising emissions reductions.
- EECA recently commissioned research regarding liquid biofuels which accompanies our submission. The research covers demand and supply constraints, technology readiness for drop-in biofuels and life-cycle and supply chain emissions analysis by feedstock. This will help to better understand the viable biofuel sources with greatest emission reduction potential, whether imported or domestically produced.
- The Commission's recommendation for the development of a national plan for the bioeconomy (Necessary Action 6) would be an appropriate and valuable opportunity to discuss the priority uses of our bio-resources, including the place for biofuel.

Heat, industry and power

- EECA generally agrees with the Commission's recommendations. Our detailed submission includes some qualifying statements and issues for further consideration.
- EECA agrees that process heat, along with transport, is one of New Zealand's best emissions reduction opportunities. In EECA's experience, achieving this potential will require government to work alongside industry to overcome the financial and non-financial barriers to rapidly transitioning from fossil fuels to renewables.
- EECA highlights the Government Investment for Decarbonising Industry (GIDI) fund as an example of a mechanism to realise the technical potential to accelerate emissions reduction in process heat.
- Electrification is a key pillar in the Commission's decarbonisation plan, however the necessary actions in the advice document do not capture all of the most critical changes needed to maximise the use of electricity to support the transition. Many advice recommendations are incremental or peripheral. In particular, electricity market settings and generation investment should be highlighted as an area of policy focus. Optimising electricity demand through efficiency improvements will also be a critical enabler to transport and process heat electrification.
- EECA agrees with the Commission that electrification will be critical to decarbonising the economy. Given the scale and complexity of the challenge of achieving a rapid, economy-wide electrification that is optimal and equitable, EECA advocates for a similar approach to that recommended elsewhere, for example for the bio-economy. A strategy or roadmap for electrification will be a critical component of any national energy strategy, to achieve a fit-for-purpose electricity system that enables decarbonisation while maintaining security of supply and optimising system-wide cost.
- EECA strongly supports developing a national energy strategy (potentially by updating the New Zealand Energy Strategy 2011-21) and agrees there is good rationale for expanding New Zealand's policy focus beyond achieving 100% renewable electricity generation to encompass renewable energy use more broadly.
- EECA agrees there is a need for long-term planning on bio-resources, including prioritisation of use (particularly between liquid biofuels for transport, biomass for process heat and the underlying primary existing use of biomass as wood fibre for various uses e.g. construction and packaging).
- EECA supports measures to increase the energy efficiency of buildings, and also notes the significant co-benefits of improved buildings in terms of health and wellbeing. However, due

to emission reduction potential we caution investment in this area before more cost effective emissions reductions are achieved elsewhere e.g. process heat.

- Regarding buildings, EECA strongly endorses a strategic view being taken of New Zealand's future energy systems. A number of overseas jurisdictions are moving to 'all-electric' homes and commercial buildings as a low-cost decarbonisation pathway, and to avoid stranded assets in gas distribution infrastructure. The national energy strategy should therefore consider the best timing of a potential ban on new gas connections (as recommended by the Commission), and the role of biofuels.
- We agree that the interrelationship between land use, transport and infrastructure justifies significant attention from Government and that emission reduction needs to be prioritised in decision making.

Multi-sector strategy

- We strongly support the proposal that behaviour change at organisational and business level, as well as an individual one, is critical to achieving our emission reduction targets. EECA has promoted behaviour change through the "Gen Less" public engagement platform since 2019.
- We support measures to engender coordinated action on behaviour change and suggest several steps to support this through concrete deliverables and dedicated funding.
- EECA strongly agrees with the recommendations related to aligning investment with climate outcomes (as well as it being a time critical necessary action) and we offer some comment and questions that may assist the commission in clarifying its advice for maximum impact.
- EECA agrees with the recommendations for a general strengthening of ETS settings and the intent behind these, but the specific wording in the advice could potentially be enhanced and clarified.
- We support the recommendation about clarifying the role of voluntary mitigation, although it would be helpful if the Commission could provide a clearer position. This could be used as a starting point for inter-agency discussion on the matter.

EECA's response at a glance

Key: | 🟢 We favour | 🟡 Recommend change | 🔴 We do not favour |

Transport

Necessary action 2 - Develop an integrated national transport network to reduce travel by private vehicles and increase walking, cycling, low emissions public and shared transport		
		We recommend that, in the first budget period the Government progress the following steps to meet emissions budgets:
a	🟢	Deliver specific and timebound targets to increase low emissions public and shared transport and walking and cycling, and supporting infrastructure through strengthening the direction of the Government Policy Statement on Land Transport.
b	🟢	Significantly increase the share of central government funding available for these types of transport investment, and link funding with achieving our emissions budgets.
c	🟢	Improve mobility outcomes through measures including supporting public transport uptake nationally and locally by reducing fares for targeted groups (such as for those under 25 years of age), and improving the quality and integration of services.
d	🟢	Encourage Councils to implement first and last kilometre travel solutions in their transport networks, such as increased on-demand and shared vehicle and bike services, secure park and ride solutions at public transport, and encouraging micro-mobility options.
e	🟢	Further government encouragement for working from home arrangements.
Time-critical necessary action 2 - Accelerate light electric vehicle uptake		
		Light electric vehicle uptake needs to be accelerated as fast as possible. To meet our proposed emissions budgets and be on track for 2050, at least 50% of all light vehicle (cars, SUVs, vans and utes) and motorbike imports should be electric by 2027 (both battery EV and plug-in hybrid EV). To achieve this, we recommend in the first budget period the Government:
a	🟢	Place a time limit on light vehicles with internal combustion engines entering, being manufactured, or assembled in Aotearoa, other than in specified exceptional circumstances. The limit should be no later than 2035 and, if possible, as early as 2030.
b	🟢	Introduce a package of measures to ensure there are enough EVs entering Aotearoa, and to reduce the upfront cost of purchasing light electric vehicles until such time as they are cost competitive with the equivalent ICE vehicle.
c	🟢	Improve the efficiency of the light vehicle fleet and stop Aotearoa receiving inefficient vehicles by introducing an emissions target for light vehicles new to Aotearoa of 105 grams CO2 per kilometre by 2028.
d	🟢	Develop a charging infrastructure plan for the rapid uptake of EVs to ensure greater coverage, multiple points of access and rapid charging, and continue to support the practical roll out of charging infrastructure.
Progress indicators		
a	🟢	Government to have consulted, no later than 30 June 2022, on preferred policy options for accelerating EV uptake (including a date for placing a time limit on the import of ICEs).
b	🟢	Cabinet decisions on preferred policy options to be made, as soon as possible but no later than 31 December 2022, on accelerating EV uptake.
c	🟢	Government to have implemented regulations on improving the fuel efficiency by 30 June 2022.

Necessary action 3 - Accelerate light electric vehicle uptake		
		We recommend that, in the first budget period the Government make progress on the following:
a	🟢	As part of a policy package introduce a fiscal incentive, such as a feebate or subsidy, to reduce the upfront cost of EVs until such time as there is price parity with ICEs.
b	🟢	As part of an equitable transition, evaluate and support interventions such as leasing, hire and sharing schemes to remove barriers and address some of the upfront capital costs of EVs.
c	🟢	Investigate ways to bulk procure and ensure the supply of EVs into Aotearoa and work with the private sector to do so.
d	🟢	Evaluate how to use the tax system to incentivise EV uptake and discourage the purchase and continued operation of ICE vehicles.
e	🟢	Work with the private sector to roll out EV battery refurbishment, collection and recycling systems to support sustainable electrification of light vehicle fleet.
f	🟢	Evaluate the role of other pricing mechanisms beyond the NZ ETS, such as road pricing, can play in supporting the change to a low emissions and equitable transport system.
g	🟢	In setting these policies the Government needs to mitigate impacts for low-income households and people with disabilities, regional and remote access, and with limited access to electricity.
Necessary action 4 - Increase the use of low carbon fuels for trains, ships, heavy trucks and planes		
		We recommend that, in the first budget period the Government take the following steps to support the use of low carbon fuels for heavy vehicles such as trucks, planes, ships, and off-road vehicles to meet emissions budgets:
a	🔴	Set a target and introduce polices so that at least 140 million litres of low carbon liquid fuels are sold in Aotearoa by 31 December 2035.
b	🟢	Introduce low carbon fuel standards or mandates to increase demand for low carbon fuels, with specific consideration given to aviation.
c	🔴	Introduce incentives to establish low emissions fuel plants, such as biofuel sustainable aviation fuel, and make those fuels more competitive with traditional fossil fuels.
d	🟢	Place further emphasis on decarbonising the rail system, and establish an investment strategy and clear targets to increase the share of rail and coastal shipping.

Heat, Industry & Power

Time-critical necessary action 3 - Target 60% renewable energy no later than 2035		
		Setting a target for renewable energy enables the Government to signal the required emissions reductions across the full energy system. Within that context, the 100% renewable electricity target should be treated as aspirational and considered in the broader context of the energy system that includes electricity, process and building heat and transport. We recommend the Government:
a	🟢	Develop a long-term national energy strategy that provides clear objectives and a predictable pathway away from fossil fuels and towards low emissions fuels, and the infrastructure to support delivery.
b	🟡	Under the framework of the national energy strategy, set a renewable energy target to increase renewable energy to at least 60% by 31 December 2035.
Progress indicator		

	🟡	The Government to have, by 30 June 2023, set a renewable energy target of at least 60% by 31 December 2035, set milestones for 2025 and 2030, and released an energy strategy to deliver this target.
Necessary action 5 - Maximise the use of electricity as a low emissions fuel		
		We recommend that, in the first budget period the Government take steps to ensure a low emissions, reliable and affordable electricity system to support electrifying transport and industry through progress on the following:
a	🟡	Under the framework of a national energy strategy, set a date by which coal electricity generation assets must be retired.
b	🟢	Under the framework of a national energy strategy, decide how to progress solutions to the dry year problem, when this should happen, and at what cost.
c	🟢	Introduce measures, such as a disclosure regime, to reduce wholesale electricity market uncertainty over Emissions Budgets 1 and 2, to encourage investment in new renewable generation.
d	🟢	Assess whether electricity distributors are equipped, resourced and incentivised to innovate and support the adoption on their networks of new technologies, platforms and business models, including the successful integration of EVs.
e	🟢	Enable more independent generation and distributed generation, especially for remote rural and Māori communities, and ensure access to capital for this purpose.
f	🟢	Monitor and review to ensure electricity remains affordable and accessible, and measures are in place to keep system costs down, such as demand response management.
Necessary action 6 - Scale up provision of low emissions energy sources		
		We recommend that, in the first budget period the Government make progress in scaling up the provision of new low emissions fuels by:
a	🟢	Developing a plan for the bioeconomy alongside the new national energy strategy, across transport, buildings, energy, waste, land use and industry.
b	🟢	Assessing the place that hydrogen has in the new national energy strategy.
Necessary action 7 - Reduce emissions from process heat		
		We recommend that, in the first budget period the Government take steps to reduce carbon emissions from fossil fuelled boilers by:
a	🟢	Urgently introducing regulation to ensure no new coal boilers are installed.
b	🟡	Introducing measures to help reduce process heat emissions from boilers by 1.4 Mt CO_2e over 2018 levels by 2030 and by 2 Mt CO_2e by 2035.
c	🟡	Increasing support for identifying and reporting on emissions reduction opportunities in industry, including energy efficiency, process optimisation, and fuel switching.
d	🟡	Helping people to access capital to reduce barriers to the uptake of technology or infrastructure upgrades such as boiler conversions, energy efficiency technologies, and electricity network upgrades.
Necessary action 8 - Support innovation to reduce emissions from industrial processes		
		We recommend that, in the first budget period the Government take steps to support innovation in hard-to-abate industrial processes, including by:
a	🟡	Developing a long-term strategy for the future of hard-to-abate industries, including iron, steel making, cement and lime production and petrochemical production. This strategy should be developed alongside the national energy strategy, future Economic Plans and strategies for an equitable transition (see time-critical necessary actions 1 and 3).

b	🟢	Based on the outcome of the strategy, investigating whether bespoke solutions requiring research and development specific to Aotearoa will be required.

Buildings

Necessary action 9 - Increase energy efficiency in buildings		
		We recommend that, in the first budget period the Government introduce measures to transform, transition and reduce energy use in buildings. Measures should include:
a	🟢	Continuing to improve energy efficiency standards for all buildings, new and existing stock, through measures like improving insulation requirements. Expand assistance which targets low-income households.
b	🟢	Introducing mandatory measures to improve the operational energy performance of commercial and public buildings.
c	🟡	Setting a date by when no new natural gas connections are permitted, and where feasible, all new or replacement heating systems installed are electric or bioenergy. This should be no later than 2025 and earlier if possible.
Necessary action 10 – Reduce emissions from urban form		
		We recommend that, in the first budget period the Government promote the evolution of urban form to enable low emissions transport and buildings through ongoing legislative reform:
a	🟢	Develop a consistent approach to estimate the long-term emissions impacts of urban development decisions and continually improve the way emissions consequences are integrated into decision making on land use, transport and infrastructure investments.
b	🟢	Ensure a coordinated approach to decision making is used across Government agencies and local councils to embed a strong relationship between urban planning, design, and transport so that communities are well designed, supported by integrated, accessible transport options, including safe cycleways between home, work and education.

Multisector

Necessary action 16 - Support behaviour change		
	🟢	We recommend that, in the first budget period the Government embed behaviour change as a desired outcome in its climate change policies and programmes in order to enable New Zealanders to make choices that support low emissions outcomes.
Time-critical necessary action 6 - Align investments for climate outcomes		
		To meet emissions budgets and achieve the 2050 target, it is important that policy decisions and investments made now do not lock Aotearoa into a high emissions development pathway. Safeguards and signals will be needed to prevent this, including a specific focus on ensuring long-lived assets such as infrastructure are net-zero compatible. To achieve this, we recommend in the first budget period the Government:
a	🟢	Immediately start to factor target-consistent long-term abatement cost values into policy and investment analysis in central government. These values should be informed by the Commission's analysis which suggests values of at least $140 per tonne by 2030 and $250 by 2050 in real prices.
b	🟢	Encourage local government and the private sector to also use these values in policy and investment analysis.
c	🟢	Ensure that economic stimulus to support post-COVID-19 recovery helps to bring forward the transformational investment that needs to happen anyway to reach our joint climate and economic goals.
d	🟢	Investigate and develop a plan for potential incentives for businesses to retire emissions intensive assets early.

e	●	Require the Infrastructure Commission to include climate change as part of its decision- and investment-making framework, including embedded emissions and climate resilience
f	●	Investigate and develop plans to mobilise private sector finance for low emissions and climate-resilient investments.
Progress indicators		
a	●	Government to start, as soon as possible and by no later than 31 March 2022, factoring target-consistent long-term abatement cost values into policy and investment analysis.
b	●	Government to publish, as soon as possible and by no later than 31 March 2022, how the COVID-19 economic stimulus is helping to accelerate the climate transition.
Time-critical necessary action 7 - Driving low emissions choices through the NZ ETS		
		The Emissions Trading Scheme (NZ ETS) needs to drive low emissions choices consistent with emissions reduction targets in Aotearoa, including a focus on gross emissions reductions. In the first budget period the Government should:
a		In the next annual update to NZ ETS settings:
i	●	Align unit volumes with emissions budgets, taking into account the need to reduce the NZU stockpile.
ii	●	Increase the cost containment reserve trigger price to $70 as soon as practical and then every year by at least 10% plus inflation.
iii	●	To maintain continuity with recent prices, immediately increase the auction reserve trigger price to $30 as soon as practical, followed by annual increases of 5% plus inflation per year.
b	●	Amend the NZ ETS so that it contributes, as part of a package of policies (see time-critical necessary action 5), to delivering the amount of afforestation aligned with our advice on the proportion of emissions reductions and removals, consistent with budget recommendation 2.
c	●	Establish a sound market governance regime for the NZ ETS as soon as possible to mitigate risks to market function, as some of these risks are potentially catastrophic for the scheme's effectiveness. This work should be advanced through an interagency team including MBIE for its financial markets expertise.
Progress indicators		
a	●	Government ensure that, in the next annual update to the NZ ETS settings, unit volumes are aligned with emissions budgets and price control settings are increased.
b	●	Government to develop proposals as soon as possible to establish a sound market governance regime for the NZ ETS, and to have legislated to address the most significant risks by no later than 30 June 2023.
Necessary action 19 - Continued ETS improvements		
		We recommend that, in the first budget period the Government make progress on:
a	●	Developing options and implementing a plan for recycling some or all of the proceeds from NZ ETS unit auctions into emissions reductions, adaptation, equitable transitions and meeting international climate change obligations.
b	●	Undertaking a first principles review of industrial allocation policy.
c	●	Continuing to phase out industrial allocation.
d	●	Exploring alternative policy instruments that could address the risk of emissions leakage.
e	●	

		Providing more information to reduce uncertainty about adjustments to NZ ETS settings, particularly how it intends to manage unit volumes in light of the split-gas 2050 target.
f	🟡	Clarifying the role and avenues for voluntary mitigation in Aotearoa.

Detailed response to the CCC's consultation questions

Consultation question 1: Principles to guide our advice (p. 30)

Do you support the principles we have used to guide our analysis? Is there anything we should change, and why?

EECA supports the principles as proposed. In particular:

- **Principle 3: Create options –** EECA's *Energy Efficiency First* report shows how nationwide uptake of energy efficient technology – the 'first fuel' – could lower the system cost of decarbonisation, thereby preserving and unlocking investment options in the future.

- **Principle 4: Avoid unnecessary cost –** EECA recognises the need to decarbonise our sectors on as natural an investment cycle as possible in order to reduce the overall costs of the transition, while identifying areas where we can move faster and the barriers that need to be overcome.

  The challenges and costs associated with transitioning existing infrastructure and fleets means that significant attention should be placed on interventions that restrict the adoption of new high emission technologies and processes. This needs to be done with urgency to avoid locking in emissions and future cost associated with stranded assets. The Commission seems to take this approach in several areas, as demonstrated by recommendations related to stopping the import of internal combustion engine vehicles, banning coal boilers etc. We suggest that this could be reflected in Principle 4 or included as a separate principle.

- **Principle 7: Leverage co-benefits –** EECA has long advocated the co-benefits of energy efficiency, conservation and renewable energy. These range from the health and wellbeing benefits of warmer, dryer, more energy efficient homes, to the potential of energy efficiency to act as a 'jobs machine'. According to the International Energy Agency, every $1 invested in energy efficiency retrofits for houses and small business internationally, $0.60 goes to labour costs.[1]

[1] https://www.iea.org/articles/energy-efficiency-and-economic-stimulus

Consultation question 4: Limit on offshore mitigation for emissions budgets and circumstances justifying its use (p. 38)

Do you support budget recommendation 4? Is there anything we should change, and why?

EECA supports the recommendation to limit offshore mitigation for the first emissions budgets. EECA's work has identified there is a significant pool of emissions reductions opportunities that could be unlocked domestically at a cost for government and taxpayers below the cost of offshore mitigation (particularly if you only accept high quality credits from credible markets). Energy efficiency also has well-documented co-benefits[2] that can be realised within New Zealand if we pursue domestic mitigation.

[2] Capturing the Multiple Benefits of Energy Efficiency – Analysis - IEA (2015)

Consultation question 9: Establish processes for incorporating the views of all New Zealanders (p. 44)

Do you support enabling recommendation 5? Is there anything we should change, and why?

EECA supports the intent to make New Zealanders' views front and centre of the discussions that need to happen to balance the fairness of the transition. We do not suggest change to this recommendation but we see an opportunity to use EECA's existing *Gen Less* platform to further these objectives.

EECA's own research into perceptions about climate change and energy emissions shows that New Zealanders understand the need to take climate action, but are seeking direction on how this should occur and what role they need to play. With the right level of effort and investment we can address this through public education, awareness and communication.

A majority of New Zealanders want others to do more to reduce our climate change impact. EECA research (January 2019) found that 88% of people want companies to do more, 76% want government to do more and 76% want other people to do more. It also found that there are some important information gaps or linkages that need to be made in the minds of consumers, such as strengthening the link between transport and consumers overall energy emissions.

If government intends to step proactively into engaging with the public on climate change it will be important to identify shared objectives across relevant agencies, which can guide coordinated action on public awareness, communication and education. As a starting point we have laid out three potential cross-government objectives below:

- ensure the public are **well-informed** and understand government plans and policies
- **engage people in effective consultation and co-development** on plans and policies to help ensure the best decisions are made for New Zealand and New Zealanders as we transition to a low emissions economy
- motivate people to **take action** in their own lives to reduce emissions and make **long-term decisions** that will support the transition.

Any effort to inform and engage New Zealanders should build upon what is already in place. EECA's public *Gen Less* platform, is a well-suited and increasingly well-recognised platform to host a public engagement programme which seeks to increase the public and business' engagement with climate change.

Consultation questions 13: An equitable, inclusive and well-planned climate transition (p. 103)

Do you support the package of recommendations and actions we have proposed to increase the likelihood of an equitable, inclusive and well-planned climate transition? Is there anything we should change, and why?

EECA supports the emphasis placed on ensuring that the climate transition is equitable and inclusive.

Of particular relevance for EECA, the Commission's Necessary Action 1 (d) recommends there is a need to "Assess the Government's current standards and funding programmes for insulation and efficient heating to determine whether they are delivering at an appropriate pace and scale, and how they could impact housing and energy affordability. The Government should give particular consideration to potential flow through costs to tenants, and to government owned housing stock".

EECA's current low-income home retrofit programme *Warmer Kiwi Homes* is one of government's key interventions in alleviating energy hardship in New Zealand. It is the latest iteration of a low-income home retrofit subsidy programme that has been running in various forms since 2009. Since the start of the current programme in July 2018, 53,177 retrofits (39,491 insulation and 13,686 heating respectively) have been completed.

EECA regularly reviews the design and targeting of this programme to ensure that it delivers maximum benefit to low-income households at maximum cost-effectiveness for public money. A recent cost-benefit analysis returned a benefit to cost ratio for this programme of 4.7:1.

EECA is beginning a scheduled outcome evaluation of the WKH programme which is expected by February 2022. This will provide an important source of information for the design of future wellbeing interventions.

Consultation question 14: Transport (p. 110)

Do you support the package of recommendations and actions for the transport sector? Is there anything we should change, and why?

Necessary action 2 - Develop an integrated national transport network to reduce travel by private vehicles and increase walking, cycling, low emissions public and shared transport

EECA supports action to increase the use of low emission transport modes, such as walking, cycling and public and shared transport, as well as optimising or reducing travel.

EECA research shows that only 4 in 10 New Zealanders understand that transport is their single largest contributor to carbon emissions. Behaviour change will be a key enabler to help people to choose low emission transport modes such as walking, cycling and public transport and alternate choices such as working from home. EECA's *Gen Less* campaign has been getting the message out to the public to help people understand the impact of their transport choices on carbon emissions.

Nearly a third of car trips in New Zealand are under 2km[3], and there is opportunity for these "first and last kilometre" trips to be provided by other low emission transport modes and services. EECA agrees that a key challenge to address will be the provision of safe, affordable, convenient and accessible frequent public or shared transport choices. Provision of infrastructure and the design of cities and regions will allow the shift away from private fossil fuel vehicle use and EECA will support the role of government agencies in this important work.

EECA has also supported the demonstration of several electric bus and car share projects through the Low Emission Vehicle Contestable Fund. These technologies and services are now being rolled out in cities around New Zealand, however, there is a need to accelerate their adoption.

Time-critical necessary action 2 - Accelerate light electric vehicle uptake

EECA supports the Commission highlighting the transition of the light vehicle fleet as a time critical necessary action. New Zealand's emissions breakdown makes it clear that the light vehicle fleet provides the greatest opportunity for reducing transport emissions, particularly as there are low emission alternatives already available in the form of battery and plug in hybrid electric vehicles.

The modelling of the Commission's preferred path includes the following forecasts relating to the uptake of electric vehicles (EV):

- 50% of light vehicle imports will be electric by 2027, with 40% of the fleet electric by 2035.
- Of the trucks imported in 2030, 15% of medium trucks and 8% of heavy trucks would be electric. By 2035, these would increase to 84% and 69% respectively.

This modelling appears quite optimistic, however we acknowledge it is dependent on a number of assumptions that represent significant coordinated policy action, as well as overcoming supply constraints and seeing the closing of the significant price gap between EV's and internal combustion engine vehicles.

Below are EECA's comments on the Commission's recommended package of measures for accelerating light electric vehicle uptake.

[3] Ministry of Transport NZ Household Travel Survey Data 2015-2017.

Recommendation A - Place a time limit on light vehicles with internal combustion engines entering, being manufactured, or assembled in Aotearoa, other than in specified exceptional circumstances. The limit should be no later than 2035 and, if possible, as early as 2030

EECA agrees that it will be necessary for New Zealand to set a date from which the importation/manufacture/assembly of light internal combustion engine vehicles will not be allowed. With the target year of the Clean Car Import Standard being 2025, and many of our trading partners adopting similar policies, it seems appropriate to set this date sometime between 2030 and 2035, as suggested by the Commission.

Recommendation B - Introduce a package of measures to ensure there are enough EVs entering Aotearoa, and to reduce the upfront cost of purchasing light electric vehicles until such time as they are cost competitive with the equivalent ICE vehicle

We agree that EV supply constraints and high upfront costs are two of the key barriers that need to be addressed to increase EV uptake.

Constraints to the access of electric vehicle supply from overseas markets could result in a scarcity of vehicle volume and choice, potentially slowing the progress of transitioning the domestic fleet. EECA's work suggests that:

- In the near term (up to 2025) there are expected to be supply constraints because of the limited number of EV models and volumes being produced, which is expected to limit the extent to which all domestic market segments can be supplied. Further compounding this is the limited domestic sales of EV's in Japan, which limits what is available to import into New Zealand particularly as second hand vehicles. This warrants New Zealand looking at emerging EV manufacturing markets to secure EV supply, not just Japan.

- By 2030 it is expected that global production rates of new vehicles increases and there are unlikely to be supply constraints for imports of new EV's. This can be further supported by strategic supplier sourcing strategies with other emerging markets such as China, who is already a major producer and consumer of EV's (although it does not export high volumes currently). Policies will further enable access to the models and volumes of vehicles to be supplied into New Zealand.

Noting the potential short term supply and cost constraints for EV's, it would be valuable if the Commission could include analysis on the uptake of Internal Combustion Engine (ICE) hybrids and the impact this would have on the modelling scenarios and EV uptake in New Zealand, recognising the current dependence (~60% of used vehicles are imported from Japan) and the recent trend of increased hybrid vehicle imports (new and used) from Japan.

We note that the supply of EV's to New Zealand is primarily influenced by the commercial decisions of overseas vehicle manufacturers, and the Government has little ability to change that. However, manufacturers are known to prioritise supply to countries with 'EV-friendly' policies, such as strong vehicle emissions standards and discounts on upfront vehicle cost.

While the upfront cost of electric vehicles is currently acting as a barrier to EV uptake, we note that the lower ongoing costs (such as fuel and maintenance) compared to fossil-fuelled vehicles improves the competitiveness of electric vehicles.[4]

[4] EECA analysis on total cost of ownership of EV and ICE.

The Commission assumes that lifetime price parity between EV's and ICE vehicles will be reached by 2024. This is a realistic assumption, but the timing of upfront capital cost parity may be of more importance to stimulating EV uptake. EECA's work suggests capital price parity between light EV's and ICE vehicles being reached in about 2030.

The assumption of price parity convergence and increase of EV manufacturing to meet supply-demand imbalances by 2030 will support a rapid acceleration of EV uptake from this time. However, we agree that the scale and urgency of the decarbonisation required from the light vehicle fleet means that strong supporting policies are needed immediately to accelerate the fleet transition as much as possible.

Recommendation C - Improve the efficiency of the light vehicle fleet and stop Aotearoa receiving inefficient vehicles by introducing an emissions target for light vehicles new to Aotearoa of 105 grams CO2 per kilometre by 2028

EECA supports the introduction of a vehicle fuel economy standard and welcomes the Government's announcement that the target year for the Clean Car Import Standard will be 2025.

Recommendation D - Develop a charging infrastructure plan for the rapid uptake of EVs to ensure greater coverage, multiple points of access and rapid charging, and continue to support the practical roll out of charging infrastructure

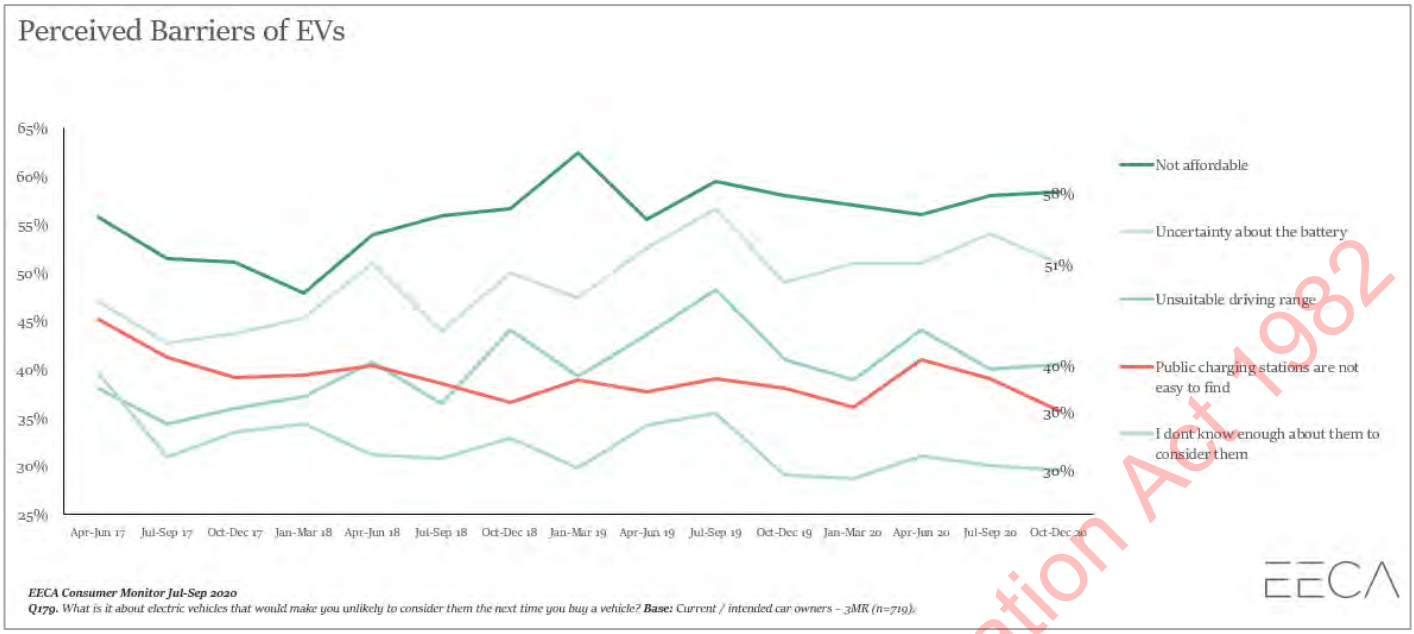
EECA has had an important role in the rollout of New Zealand's electric vehicle charging network. The Low Emission Vehicle Contestable Fund has provided co-funding to over 1,100 EV charging projects (over 600 for public EV chargers). So far, the rollout of New Zealand's EV charging network has started from a low base and is led by a few charging service providers. This has been an appropriate approach up to this point as the number of electric vehicles on the network has been low. However, with the introduction of policies to significantly increase the uptake of EV's, a more coordinated plan for future EV charging infrastructure and investment is required.

EECA supports the recommendation of a national EV charging infrastructure strategy and is working with other government departments to advance this work.

Any charging strategy should go beyond simply setting out the proposed location and level of investment required for public EV charging infrastructure. The strategy should also factor in and be able to respond to the future EV uptake scenarios that influence charging requirements, wider electrification policies and strategies, current government programmes for co-investment and feed into consideration of electricity distribution network upgrades. The factors will vary across the short term and long term, and be influence by the rapidly changing nature of technology and EV owner expectations and needs. The plan should also consider issues such as the asymmetry of information, lack of competition, capability and capacity from charging infrastructure providers, rural gaps, low and middle-income communities, workplace and commercial buildings and residential charging.

Necessary action 3 - Accelerate light electric vehicle uptake

EECA also supports the range of recommended actions for accelerating light electric vehicle uptake under Necessary Action 3. A coordinated package of actions is needed to make the New Zealand vehicle market more supportive of EV's, including reducing the cost and increasing the supply of EVs in New Zealand. EECA's consumer monitoring shows that the upfront cost premium of electric vehicles is the primary barrier to EV uptake in New Zealand.



Necessary action 4 - Increase the use of low carbon fuels for trains, ships, heavy trucks and planes

EECA agrees that a range of low carbon fuels, such as biofuel and hydrogen, will be needed for New Zealand to decarbonise hard to electrify applications such as planes and ships. Our view is technologically agnostic – we anticipate that the 'right' fuel will vary from application to application. It is not clear at this stage whether applications in heavy duty road freight will be better suited for direct electrification or use of low carbon liquid or gaseous fuels, or a combination of both.

Hydrogen

In 2019, EECA jointly commissioned Concept Consulting to undertake research on the cost effectiveness of hydrogen technologies for decarbonising the New Zealand economy relative to alternatives.[5] We also recently assisted Are Ake in their initial study of the economics of using green hydrogen to decarbonise long-distance heavy freight in New Zealand. Through the delivery of our funding programmes, we have also had insight into hydrogen technology and applications.[6]

EECA supports the development of 'green' hydrogen (produced from renewable electricity) that is economic and can cost-effectively reduce emissions compared to alternatives. Growing policy commitment and global investment have the potential to make hydrogen a commercially viable low-carbon alternative to some fossil fuel applications in the future (as New Zealand is a technology taker). Green hydrogen is part of the journey to electrifying the economy and its role should be considered as part of any electrification strategy (or the national energy strategy, as referred to later).

At present, there are significant challenges for the commercial scale deployment of green hydrogen in New Zealand relative to its carbon abatement impact. EECA agrees that there are significant barriers and challenges on both the supply and demand side for hydrogen to become an economically viable alternative.

[5] The research, titled 'H2 in NZ - A study of the potential economics of hydrogen technologies in New Zealand' can be found here: https://www.concept.co.nz/updates.html.

[6] Low Emission Vehicles Contestable Fund (Round 9 Hyundai FCEV trucks project and Round 5 Ports of Auckland Hydrogen Demonstration project).

Deployment of hydrogen in New Zealand still remains in the demonstration phase. Pilot and demonstration projects have the potential to de-risk the technology for first adopters and reduce safety, regulatory and technical barriers.

Biofuel

EECA recently commissioned research regarding liquid biofuels, which covers demand and supply constraints, technology readiness for drop-in biofuels and life-cycle emissions analysis by feedstock.

We have attached this report to this submission as it informs EECA's view on the liquid biofuels opportunity for New Zealand.

Recommendation A - Set a target and introduce polices so that at least 140 million litres of low carbon liquid fuels are sold in Aotearoa by 31 December 2035

From discussion with the Commission, we understand this target was calculated based on liquid biofuels (but is currently worded to also cover other low carbon liquid fuels). Due to the variance in lifecycle emissions of different biofuel types and feedstocks, we suggest that a volumetric target (i.e. in litres) may not be the best approach to achieve emissions reductions. We would support instead an emissions reduction target (i.e. in CO2-e) for low carbon fuels.

The 140ML target appears to be based on production estimates from available wood feedstock rather than on a wider analysis including technical feasibility, demand-supply dynamics or maximising emissions reductions. This raises several points:

- The life-cycle emissions vary a lot from one biofuel to another (mainly depending on feedstock and associated land use change). Therefore, life cycle emissions reduction should be the main driver of any biofuel policy (especially incentives) in order to prevent the use of biofuels with poor emissions benefits (or even increased emissions compared to fossil fuels).
- There might be more valuable (such as chemicals) or efficient (such as direct combustion for process heat) uses of wood than the production of liquid biofuels. A national discussion is needed on what are the priority uses of this limited resource. The Commission's recommendation for the development of a national plan for the bioeconomy (Necessary Action 6) would be an appropriate and valuable opportunity for this discussion to take place.
- So as not to delay action while developing a bioeconomy plan, interventions such as a biofuel mandate or low carbon fuel standards should still be implemented (which prioritise the emissions and sustainability of the biofuel) so long as adequate conditions apply for life cycle emissions of the biofuels supplied into the blended fuels.
- The blending limits for biodiesel and bioethanol suggest that the potential demand for these fuels on an energy basis could be 6% of current demand for diesel fuels by heavy trucks and marine, and 6% of current demand for petrol fuels by light vehicles respectively (biodiesel is not suitable for aviation). This potential could be realised immediately with the import of biofuels, rather than waiting to set up a domestic production industry to provide 3% of demand (as seems to be suggested in the Commission's draft advice). It would be useful if the Commission could be more explicit about if it sees a role for biofuel importation.
- The potential incremental demand for drop-in diesel is much higher assuming a 50% concentration limit, i.e. around 44% of total energy required by diesel heavy trucks, marine and aviation, and 47% of total energy required by light petrol vehicles.
- Our research suggests that, due to technological readiness, production of drop-in biofuel from wood biomass is unlikely to be at scale before 2035.
- Our research includes a progressive scenario where liquid biofuel uptake increases from 0.88 PJ (28.38 million litres) p.a. in 2022 to 8.06 (256.5 million litres) p.a. by 2030, reaching a maximum output of 43.14 PJ (1,287.2 million litres) p.a. by 2043.

Recommendation C - Introduce incentives to establish low emissions fuel plants, such as biofuel sustainable aviation fuel, and make those fuels more competitive with traditional fossil fuels

This recommendation seems to cover incentivising production of biofuels, as well as incentivising demand for biofuels (reducing the cost premium of the fuel).

Demand and production are two different aspects and we feel should be treated separately in the Commission's advice.

The experience with Marsden Point shows that ensuring availability for the domestic market is more complex than building a local production capacity: securing feedstock is a starting point, and ensuring demand is key.

The challenge is that feedstocks are globally tradable commodities, as are biofuels. This can create a complete disconnect between local production and local availability.

We agree that there may be a role for incentives for increasing demand in the short term. However, we are cautious about the proposal to provide incentives for domestic production. The opportunity cost to subsidise domestic production is unlikely to be justified by domestic emissions reduction only, and there is a need to factor in other considerations such as security of supply, economic impact, competing usages for the feedstock and factors that would result in a competitive advantage for production in New Zealand.

The capital cost alone for producing 100 million litres by 2030 would be in the range of $300-$760 million, depending on the conversion technology.[7] Such projects will not take place if investors have low confidence in capital cost recovery and prospects to scale production to reduce costs per unit of energy.

We suggest that the potential for incentives for biofuel production or demand should be considered as part of the wider bioeconomy plan recommended in Necessary Action 6. This would need to consider the risks of government support for biofuel production, including:

- New Zealand subsidising production of biofuels which are then exported to other countries.
- New Zealand developing production capacity which is put in global competition for feedstock.
- New Zealand taking technology development risks in isolation - the scale of investments call for global effort.

Off-road diesel

We would like to draw the Commission's attention to an opportunity not mentioned in the advice and that might have been overlooked: Off-road diesel. This umbrella term refers to the following (non-road) uses of diesel:

Sector	**Application examples**
Aviation	Airport ground service equipment

[7] For FT catalysis and hydro-cracking, the estimate assumes a current capex of $9.12/litre fuel as per (BioPacific Partners, 2020), and a 3% p.a. learning curve to 2030. For pyrolysis oil upgrade, the estimate assumes a capex value of $3.03-$7.6/litre fuel depending on whether the hydrogen is produced or purchased. This cost range is derived from capex estimates by (Wright, et al., 2010) for the n-th plant and a pioneer plant. The pioneer plant is assumed to be built in 2035, and the n-th plant in 2025.

Rail	Rail maintenance equipment
Marine	Recreational boating, personal watercraft, fishing
Agriculture	All-terrain farm vehicles, farm motorcycles, tractors
Construction	Off-road trucks and tractors, generators, machinery
Industrial	Forklifts, generators, other industrial equipment
Mining	Mining equipment, off-road mining trucks
Forestry	Forestry equipment (e.g. haulers) off-road logging trucks
Residential	Residential lawn and garden equipment
Commercial	Commercial lawn and garden equipment, heating, forklifts
Government	Defence, lawn and garden equipment
Recreational	Motorsport, off-road motorbikes

There was about 36PJ of non-transport diesel use in 2019[8] (including an unknown portion for heating). This is equivalent to 2.6 Mt CO2e/year, so the opportunity for emission reduction is likely to be within the range of 1 to 2 Mt CO2e/year.

EECA has commissioned research to increase the understanding of this opportunity, for which solutions such as hybrid and biofuels could be relevant. We will share these insights with the Commission when they are available in mid-2021.

In the meantime, the Commission could mention the opportunity of off-road diesel in the list of potential targets for low-carbon fuels in its advice.

[8] MBIE Energy Balance Tables

Consultation question 15: Heat, industry and power sectors (p. 118, p. 111)

Do you support the package of recommendations and actions for the heat, industry and power sectors? Is there anything we should change, and why?

Time-critical necessary action 3: Target 60% renewable energy no later than 2035

Recommendation A - Develop a long-term national energy strategy that provides clear objectives and a predictable pathway away from fossil fuels and towards low emissions fuels, and the infrastructure to support delivery

EECA supports the development and implementation of a long-term national energy strategy to transition away from fossil fuels to renewable fuels. It is essential that this strategy includes strong transition planning to ensure it doesn't create perverse outcomes (such as switching away from one energy source too soon leading to overall increased emissions or impacting the affordability of consumer electricity etc).

We note we are in the final year of the existing New Zealand Energy Strategy 2011-2021. Any energy strategy should be complementary to and aligned with the New Zealand Energy Efficiency and Conservation Strategy (NZEECS) which is to be updated in 2022.

Recommendation B - Under the framework of the national energy strategy, set a renewable energy target to increase renewable energy to at least 60% by 31 December 2035

EECA agrees there is technical and economic potential for New Zealand to significantly increase its use of renewable energy, and that doing so will be critical to achieving New Zealand's climate change goals.

Under the NZEECS, New Zealand has an existing target of 90 per cent of electricity generation from renewable sources by 2025. EECA agrees there is good rationale for expanding New Zealand's policy focus beyond the electricity generation mix to encompass renewable energy use more broadly and potentially framed as an emissions reduction target. This approach aligns with the overall goal of reducing economy-wide emissions. An appropriate energy target should be developed as part of any long-term energy strategy, with emissions reduction prioritised as the outcome.

The development of a target should be based on an accurate evidence base. We note the current 40% renewable energy figure, and presumably 60% target, is based on Total Primary Energy Supply (TPES). We note that TPES is significantly impacted by the treatment of geothermal electricity generation[9] and consequently a TPES renewable energy target may not be the most appropriate.

[9] This occurs because International Energy Agency (IEA) rules for calculating TPES treats geothermal electricity generation differently to hydro, solar or wind electricity generation. In essence, all the energy extracted from geothermal fluid is added to the TPES rather than the net electricity generation. As the thermodynamic potential of low temperature heat is low, only about 15% of this extracted geothermal heat becomes electricity that is available for use. If geothermal electricity generation was accounted for the same way as hydro generation, i.e. electricity exported from the power station, then New Zealand's renewable energy percentage would fall to around 26%.

Necessary Action 5: Maximise the use of electricity as a low-emission fuel

EECA agrees electrification will be critical to achieving New Zealand's climate change objectives. Optimising electricity demand through efficiency improvements will be a critical enabler to transport and process heat electrification. EECA's 2019 *Energy Efficiency First* report found potential for cost-effective efficiency measures that collectively comprise an estimated 10-12% of electricity demand. At costs between $15-$50/MWh, this efficiency potential is significantly cheaper than even the lowest-cost new renewable generation currently available.[10]

EECA has a range of existing policies that contribute to this, including energy product regulations under the trans-Tasman Equipment Energy Efficiency (E3) Programme. The 86 million products sold under the programme since 2002 have saved 59.55 PJ of electricity, equating to $1.45 billion of national benefit, and 2.33 Mt of CO2-e. It will also be critical to ensure market and regulatory settings enable and encourage the integration of new innovative technologies, such as demand response / flexibility and battery storage, to improve power system flexibility and security as the percentage of electricity supplied by intermittent renewables increases.

EECA supports the Commission's recommendations below, as they will contribute to achieving a fit-for-purpose electricity system that enables decarbonisation via electrification. However, given the scale and complexity of the challenge they are unlikely to be sufficient to overcome the barriers to achieving rapid, economy-wide electrification that is optimal and equitable. EECA therefore suggests a similar approach to electrification to that recommended elsewhere, for example for the bioeconomy. An 'electrification strategy' (or 'roadmap') will be a critical component of any national energy strategy, to ensure an optimal and coordinated increase in electricity demand and supply across the economy while managing the many barriers and issues that are likely to arise, in particular:

- Security and predictability of demand: major new sources and locations of electricity demand (new connections) need to be signalled early enough to allow infrastructure investment to keep pace, and to ensure price 'stability'
- Ensuring the cost of upgrading transmission and distribution infrastructure is spread equitably and rationally across the electricity system
- Ensuring the regulatory framework and consent and planning rules do not unduly dis-incentivise new generation or use of electricity as an energy source
- Energy Efficiency First: by optimising electricity demand, energy efficiency will be a critical enabler to electrification across the economy
- Future proofing: ensuring New Zealand's electricity system enables (and does not unnecessarily dis-incentivise) the adoption of new technologies and innovations will be critical to optimising the transition to an electrified economy.

Such an electrification strategy will require input from a range of public and private stakeholders across the electricity system.

The Commission provides a number of recommendations under this action covering a wide range of areas. It would be useful if these recommendations could more explicitly provide a sense of priority, to assist consideration of where resource is best focussed.

[10] https://www.eeca.govt.nz/our-work/research/research-papers-and-guides/energy-efficiency-first/

Recommendation A - Under the framework of a national energy strategy, set a date by which coal electricity generation assets must be retired

Any regulation to mandate the phase-out of coal or other fossil fuel electricity generation assets should be considered carefully under the framework of a national energy strategy and balance the energy trilemma of affordability, sustainability and security.

Whether mandating the phase-out of coal electricity generation is necessary to achieve a highly renewable electricity system that enables electrification while balancing the trilemma will need to be carefully considered in the context of New Zealand's climate goals and existing market and policy settings. Mandating the retirement of plant is just one option among other options that could be explored, for example:

- setting a mean-year coal generation target of zero
- setting grid emissions factor targets/pathways
- requiring thermal generation usage to be tied to new renewable build.

Recommendation B - Under the framework of a national energy strategy, decide how to progress solutions to the dry year problem, when this should happen, and at what cost

As noted above, efficiency measures to optimise demand will be critical to integrating a higher percentage of intermittent renewable generation while mitigating against dry year risk.

This recommendation could be strengthened to require dry year solutions to be optimised for cost and carbon reduction impact. The current recommendation relies on a national energy strategy putting these in place, however this cannot be guaranteed without more direct guidance.

Recommendation C - Introduce measures, such as a disclosure regime, to reduce wholesale electricity market uncertainty over Emissions Budgets 1 and 2, to encourage investment in new renewable generation

Encouraging investment in new renewable generation is desirable and necessary. It is not clear whether a disclosure regime can sufficiently address the prevailing uncertainties. A liquid and long term wholesale contracts market or some other minimum price mechanism may be necessary.

Recommendation D - Assess whether electricity distributors are equipped, resourced and incentivised to innovate and support the adoption on their networks of new technologies, platforms and business models, including the successful integration of EVs

Agree (see above).

This is important, however the Commission should perhaps go further in terms of what needs to happen if the assessment finds distributors are insufficiently equipped to facilitate the transition.

Recommendation E - Enable more independent generation and distributed generation, especially for remote rural and Māori communities, and ensure access to capital for this purpose

Community, independent and distributed generation has a role to play in the electricity system where they support balancing of the energy trilemma (affordability, security, sustainability). It is important to be clear on what problems the different technologies and interventions are trying to solve (e.g. energy affordability, emission reduction, cold damp housing etc). At a time when very large volumes of capital investment are needed, care needs to be taken to ensure that this capital delivers on the desired outcomes.

Another key consideration is that any rules or regulations introduced should be set so that independent generation is not unnecessarily impeded.

It is also important that distributed generation is provided in a coordinated manner, for example under a demand flexibility framework that ties together the different elements in the system (e.g. solar photovoltaics, home energy management systems, storage, electric vehicles and appliances).

Recommendation F - Monitor and review to ensure electricity remains affordable and accessible, and measures are in place to keep system costs down, such as demand response management

This recommendation could be interpreted as suggesting price controls. It is important not to conflate system efficiency with affordability. Both are important for the transition, however mechanisms to achieve them are different, and potentially operate in conflict with one another. Preventing electricity from becoming uncompetitive when priced against fossil alternatives is a key element of the transition, and an efficient system will be needed to enable this. However, an efficient system also relies on cost-reflective pricing and effective cost recovery. Where measures are needed to address affordability issues related to poverty, these should be implemented by the appropriate social agencies.

As noted above, energy efficiency, and demand response / flexibility will be critical to enabling a highly renewable electricity system that supports decarbonisation through electrification.

Necessary Action 6: Scale up the provision of low-emission energy sources

Recommendation A - Developing a plan for the bioeconomy alongside the new national energy strategy, across transport, buildings, energy, waste, land use and industry

EECA agrees there is a need for long-term planning on bio-resources, including prioritisation of use. This is required to optimise the balance between value added and energy security. It is an important aspect of an orderly transition avoiding unnecessary costs. Hence, any plan will need to address trade-offs for using limited bio-resources, particularly between liquid biofuels for transport and biomass for process heat but also for traditional wood product uses. It will also need to balance the costs and benefits of both domestic and imported bio-resources.

The barriers to developing bio-resource supply-chains are unlikely to be uniform across sectors. For example, process heat usage is diffused across multiple sites through the country, while any biofuel production site will likely be concentrated in one region. The coordination challenge of matching process heat demand with bioenergy supply is much less complex than for matching fuel demand with biofuel production which is assumed to have a much larger 'minimum viable quantity required' to enable plants to achieve economies of scale. These dynamics have important implications for supply-chains and distribution of costs.

As noted by the Commission, there are significant opportunities to replace fossil fuels for process heat with biomass. However, many process heat users face significant financial and non-financial barriers to implementing these opportunities, and policy to help overcome these barriers can catalyse deepening and broadening of bio-resource supply-chains. The Government Investment to Decarbonise Industry (GIDI) Fund has funding available for projects to convert process heat boilers to biomass.

We also note there will be challenges meeting fuel demand for some large process heat sites currently using coal – particularly in Southland and Canterbury – from biomass due to concentration

of demand and insufficient supply in those regions, and competition from wood processors for this resource.

Recommendation B - Assessing the place that hydrogen has in the new national energy strategy

As noted in our comments on Necessary Action 4 in the transport section, green hydrogen is part of the journey to electrifying the economy. EECA agrees that the role of hydrogen should be considered as part of any electrification strategy (such as through the national energy strategy).

Necessary Action 7: Reduce emissions from process heat

Recommendation A - Urgently introducing regulation to ensure no new coal boilers are installed

EECA agrees there is a need for regulation to ensure no new coal boilers are installed, and that such regulatory action is consistent with New Zealand's climate change objectives. EECA also supports investigating regulatory options to optimise process heat efficiency and accelerate the phase-out of existing coal and other fossil fuelled boilers. Regulations can provide an effective mechanism for reducing 'avoidable' emissions, that is, emissions from fossil fuel usage that could be cost-effectively reduced through efficiency and/or replaced by renewables using existing technologies.

Regulations can complement the ETS and complementary measures, such as the GIDI Fund.

Recommendation B - Introducing measures to help reduce process heat emissions from boilers by 1.4 Mt CO2e over 2018 levels by 2030 and by 2 Mt CO2e by 2035

EECA agrees process heat, along with transport, is one of New Zealand's best emissions reduction opportunities. The Commission's proposed level of process heat emissions reduction is technically viable at marginal abatement costs consistent with the Commission's modelling. In EECA's experience working with large emitting businesses, achieving this level of abatement within the emissions budget timeframes will require government to support industry to overcome the financial and non-financial barriers to rapidly transition from fossil fuels to renewables, alongside a combination of higher emissions prices and/or regulations.

The proposed quantum of process heat emissions reductions is technically feasible and, according to the Ministry for the Environment's marginal abatement cost analysis, can be achieved at costs to the economy that are well within the Commission's assumed marginal abatement cost (not to be confused with future ETS price) of around $140 in 2030 needed to achieve the 2050 target. To the extent that process heat abatement opportunities can be achieved at marginal abatement costs to the economy lower than the Commission's expected 'shadow' carbon price pathway (and in some cases below current ETS prices or at negative abatement costs), these abatement opportunities can be considered 'no regrets' and should therefore be prioritised within the next emissions budget period.

Notwithstanding the fact average marginal abatement costs to the economy of reducing process heat emissions may fall within current or future ETS prices, the actual costs and benefits to individual businesses will reflect the highly site-specific nature of process heat fuel switching projects and vary depending on a range of factors. These include decisions by other businesses that can increase or decrease the cost of subsequent businesses decarbonising in that region (i.e. first mover advantages or disadvantages). Achieving the Commission's proposed process heat emissions reductions within the emissions budget timeframes will also require process heat users to act quickly: for some businesses, the challenge of finding upfront capital will be compounded by the

need to replace existing fossil fuel assets before the end of their useful lives. Businesses often require capital investment projects to have payback periods far shorter than the project lifetime (can be as low as two years in some sectors). Moreover, process heat fuel switching projects can take multiple years to implement, and many large process heat users have multiple sites meaning they will need to carefully plan their own long-term transition pathways.

Even where ETS prices make some process heat abatement opportunities economic, financial barriers are often compounded by technical and other non-financial barriers associated with the complexity of large process heat projects. This is borne out by the not insignificant level of unrealised abatement that is already technically available at or below current ETS prices.

Consistent with EECA's response to Necessary Action 5 ('Maximise the use of electricity as a low-emissions fuel') and Necessary Action 6 ('Scale up the provision of low-emission energy sources'), government support for fuel switching projects can ensure a steady and coordinated increase in demand for electricity and biomass, thereby enabling steady and coordinated investment in infrastructure in the electricity system and biomass supply chains.

The new $69 million GIDI Fund, administered by EECA, provides businesses with access to capital co-funding that, alongside EECA's suite of other energy service programmes (including the Energy Transition Accelerator), are supporting businesses to start transitioning away from fossil fuels to renewables.

Clarity on the phasing out of coal

It would be useful if the Commission's advice relating to recommendations A and B could be a bit clearer and consistent with the preferred pathway for coal, as outlined in other parts of the Commission's advice. For example:

- In table 3.1, the "process heat" line states "Replace coal with biomass and electricity" during the first two budgets (with the third budget focussing on replacement of gas by biomass and electricity).
- In Part 3.8.5 Industry and Heat, figure 3.15 (page 64), the graph shows that almost all coal use disappears by 2035 and just a third of it remains in 2030.
- On page 76, it is stated that "Deep cuts in coal use between 2020 and 2030 (by about ~75% from 2010 levels)" are required to be consistent with a 1.5C trajectory.

The wording of the advice under Necessary Action 7 is not explicit that coal use in process heat should be largely phased out within the next decade. It is important to be clear about this as it has implications for existing consents under the Resource Management Act.

Potential wording to make this recommendation explicit could be "Introducing measures to help reduce process heat emissions from boilers by 1.4 Mt CO2e over 2018 levels by 2030 and by 2 Mt CO2e by 2035. *This means the phasing out of coal in process heat use needs to start now and be mostly achieved during the first two budgets*."

Recommendation C - Increasing support for identifying and reporting on emissions reduction opportunities in industry, including energy efficiency, process optimisation, and fuel switching

EECA agrees, and we note MBIE's 2019 discussion document 'Accelerating Renewable Energy and Energy Efficiency' included options under section 1 to address information failures, including requiring large energy users to publish Corporate Energy Transition Plans (including reporting emissions annually) and conducting energy audits every four years.

Businesses face a range of information barriers with the result that many existing cost-effective opportunities to improve energy efficiency and reduce emissions (including at or below current ETS prices) remain unrealised. Moreover, requiring businesses to report on emissions reduction opportunities will improve transparency and data inputs to guide policy and long-term transition planning.

EECA has been increasingly active in this space in the past few years, with the roll out of our Energy Transition Accelerator programme, which offers bespoke technical support to large emitters to develop long-term transition plans. EECA also offers a range of support to help large energy users and other businesses overcome information barriers to improving energy efficiency and identifying fuel switching opportunities, including energy audits, feasibility studies, support for energy graduates, and technology demonstration funding.

We would like to highlight that support is only one part of the equation, and not necessarily the main barrier to wider and faster uptake. Other barriers that need to be addressed include:

- EECA's mandate is limited to energy related emissions, while businesses logically want to assess their emissions as a whole.
- While some businesses are thinking about the transition and are willing to work with and be supported by EECA, others lack the incentives to address this long-term challenge.
- Triggering a review of existing consents and mandating transition plans would create the required incentive.

Based on the above points, we suggest tweaking the recommendation to *"Increasing identification and reporting on emissions reduction opportunities in industry, including energy efficiency, process optimisation, and fuel switching"*

Recommendation D - Helping people to access capital to reduce barriers to the uptake of technology or infrastructure upgrades such as boiler conversions, energy efficiency technologies, and electricity network upgrades.

As noted above there is technical potential to accelerate emissions reduction consistent with the Commission's draft process heat emissions reduction targets. EECA's GIDI Fund is an existing mechanism for achieving this.

Any increased government funding should be complementary to the ETS, and carefully considered alongside both regulatory and non-regulatory options.

EECA is experienced in working with industry to address barriers to uptake of technology, energy efficiency and renewable energy. While some can struggle to access capital (because they are over-indebted for example), it is not our experience that access to capital is the main issue.

Overall, in a context of low regulatory incentives, the challenge is mostly about improving the return on investment of the transition projects so they can be attractive enough for decision makers and become a priority for their organisation. The Commission may want to reflect this in its advice.

Necessary Action 8: Support innovation to reduce emissions from industrial processes

Recommendation A - Developing a long-term strategy for the future of hard-to-abate industries, including iron, steel making, cement and lime production and petrochemical production. This strategy should be developed alongside the national energy strategy, future Economic Plans and strategies for an equitable transition (see time-critical necessary actions 1 and 3).

Recommendation B - Based on the outcome of the strategy, investigating whether bespoke solutions requiring research and development specific to Aotearoa will be required.

EECA agrees with the intent to support innovation to reduce emissions from industrial processes, however, this does not necessarily extend to specifically supporting innovation in the hard-to-abate industries.

In New Zealand, hard-to-abate industrial processes consist of "one-plant sectors". Most innovation in these globalised sectors are likely to come from abroad, especially to reduce emissions, which involves significant rethinking of these processes (hence the name "hard-to-abate").

Therefore, the required investments would be very expensive for a small country alone.

In addition, these plants are mostly controlled by international owners, which can decide to move their plant at will. So there is a real risk at investing significant amount of taxpayer money in these assets.

However, there is a need to support a wider adoption of innovations reducing emissions in a wide range of sectors of New Zealand economy.

EECA published an international technology scan[11] listing some of the innovation which wider use would help the transition, with a range of co-benefits.

Necessary Action 9: Increase energy efficiency in buildings

EECA strongly supports measures to increase the energy efficiency of buildings, and also notes the significant co-benefits of improved buildings in terms of health and wellbeing.

The Commission's *Evidence Report Chapter 9: Which path could we take?* includes some assumed levels of energy efficiency and energy intensity improvement. EECA's view on these assumptions is included below:

- **Residential / existing:** The Commission assumes that existing homes' energy intensity improves by 6% by 2035. We feel that this level of improvement is eminently achievable, particularly if you consider that this level of improvement would be achieved with a conversion to heat pump water heating alone.
- **Residential / new build:** The Commission assumes that by 2035, new builds are 35% more energy efficient compared to today's performance. While it is unclear if the Commission is comparing to today's new builds or today's average house, either way it should be achievable. This seems to align with the timeline of the "final step" of the Ministry of Business, Innovation and Employment's (MBIE) Building for Climate Change programme in terms of timeline and probably energy use, which we support.

[11] https://genless.govt.nz/assets/Business-Resources/International-technology-scan.pdf

- **Commercial:** The Commission assumes a 30% improvement in commercial and public buildings' energy intensity is possible by 2035 compared to today's performance. Based on experience with the NABERSNZ building energy efficiency rating system, we feel that this level of improvement is achievable.

Recommendation A - Continuing to improve energy efficiency standards for all buildings, new and existing stock, through measures like improving insulation requirements. Expand assistance which targets low-income households

The Warmer Kiwi Homes programme, administered by EECA and targeting low-income households, supports insulation and clean, efficient heating to improve the energy efficiency of homes. Support for this programme should continue until all target homes have received retrofits.

EECA is also strongly supportive of the Building for Climate Change programme, administered by MBIE, which will initially focus on improved standards for new builds.

Recommendation B - Introducing mandatory measures to improve the operational energy performance of commercial and public buildings

EECA continues to support the use of the NABERSNZ tool, a system for rating the energy efficiency of office buildings. There are already a number of public and private sector organisation that use NABERSNZ as a straightforward means of helping to make their building more efficient.

The use of this tool could be expanded as a means of delivering on the Commission's budget of a 30% improvement in commercial and public buildings' energy intensity by 2035. For example, the tool could be used to drive energy efficiency improvements in apartment buildings, shopping centres, data centres, hotels and public hospitals.

Recommendation C - Setting a date by when no new natural gas connections are permitted, and where feasible, all new or replacement heating systems installed are electric or bioenergy. This should be no later than 2025 and earlier if possible

EECA strongly endorses a strategic view being taken of New Zealand's future energy systems. A number of overseas jurisdictions are moving to 'all-electric' homes and commercial buildings as a low-cost decarbonisation pathway, and to avoid stranded assets in gas distribution infrastructure. The national energy strategy should therefore consider the best timing of a potential ban on new gas connections, and the role of biofuels. However, any such timeframe for a ban on new gas connections must strike a balance between decarbonisation, energy security, and replacement energy sources affordability.

Necessary action 10 – Reduce emissions from urban form

EECA strongly endorses the Commission's messaging about the importance of understanding the emission impacts of urban form and the need for coordinated decision-making across local and central government.

We recognise that the Commission was unable to go into much detail on the issues and opportunities in this area. We agree that the interrelationship between land use, transport and infrastructure justifies significant attention from Government and that emission reduction needs to be prioritised in decision making.

Consultation question 19: Multisector strategy (p. 134)

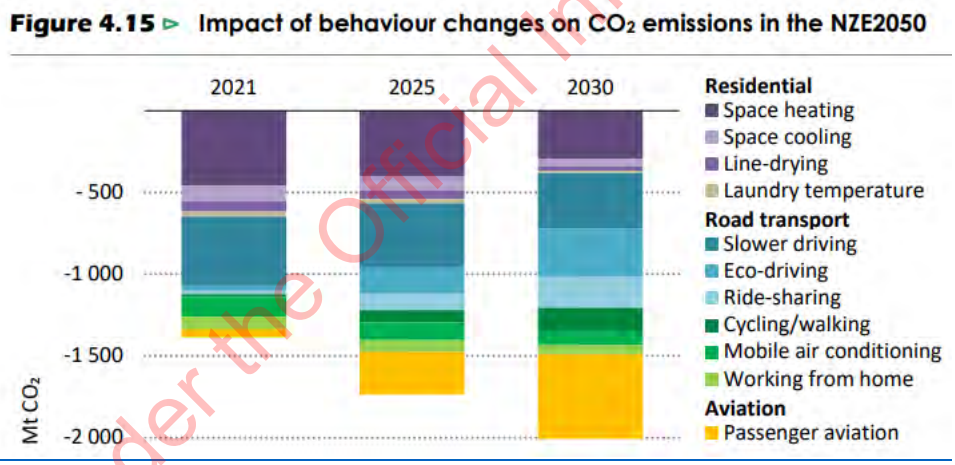
Do you support the package of recommendations and actions to create a multisector strategy? Is there anything we should change, and why?

General comments on the multi-sector approach

A combination of policies and market interventions will be necessary the meet the emissions targets. Although the introduction to chapter 6 accurately describes the types of measures needed to reach these targets, the multisector section is quite limited in what it considers. The Commission's advice does not refer to areas such as innovation, research, and training, which all seem to be critical multi-sector aspects of delivering the emissions budgets, but are not apparent in the Commission's multisector strategy. We are interested to understand if this is based on the Commission's perception of priority or need.

Necessary action 16 - Support behaviour change

EECA agrees that behaviour change is a key component of any plan to escape carbon lock-in. We strongly support the proposal that behaviour change at organisational and business level, as well as an individual level, is critical to achieving net zero. IEA modelling in the World Energy Outlook 2020 highlighted the critical role of behaviour change in reaching New Zealand's net-zero target, and the scale of the behaviour change activity that is needed.



Source: IEA, World Energy Outlook 2020

EECA advises caution, however, against limiting the discussion to specific, small-scale changes. Ad-hoc behaviour change efforts risk creating only short-lived impact – we must pursue deep and long-term systemic change to lock-in behaviour change at the scale required. Identifying the role of government in driving this systemic change will be a key challenge.

Since our formation in 2000, EECA has successfully run programmes promoting energy and climate-related behaviour change, most recently through the *Gen Less* public engagement platform.

Gen Less is aimed at influencing energy-related purchasing, consumption and other behavioural choices at the individual level. It has been informed by ongoing market research and monitoring of individuals' and businesses' values and actions related to climate change. Noting the importance of building upon what is already in place, we would reiterate the opportunity to harness the Gen Less

platform as a channel for increased behaviour change efforts by government (see our comments on consultation question 9 above).

EECA has a strategic process underway to develop better ways of influencing values and addressing the value-action gap through effective communications and behaviour change – our *Hearts and Minds* strategy. By combining bottom up individual behaviour change with top down systemic influencing actions, the *Hearts and Minds* strategy aims to create fertile ground for systemic change.

EECA also intends to measure the gap between what people and businesses will need to do in a net-zero world, and what they are doing today. This will inform our progress towards our objectives and the evolution from year to year.

We agree that meaningful behaviour change action will require a collaborative, focused and multi-agency approach, but suggest dedicated funding with a discrete structure is necessary to convert collaboration into action.

Discussion between government agencies with relevant activities around public engagement (and behaviour change) on climate change has already begun in the context of the Government's Emissions Reduction Plan. Given coordination groups already exist, next steps need to move current activities from simple information sharing to meaningful coordinated action.

There is precedent for creating a distinct team focused on behaviour change internationally. Dedicated agencies have been established at the highest level, as with Australia's Behavioural Economics Team, and dedicated teams have been nested within a ministry or regulatory agency, such as in Japan and the UK.

It is worth noting that EECA currently occupies analogous role to that of Waka Kotahi New Zealand Transport Agency, performing our role as the operations arm of the energy system, implementing MBIE's energy policy function. With additional resourcing, EECA is well placed to lead delivery of future cross government coordinated behaviour change activities in climate change.

We agree that piloting, testing and evaluation of behavioural interventions will be a key activity.

While continuous monitoring can shed light on the long-term impacts of behavioural interventions, evaluation remains the responsibility of individual agencies, which generally lack resource to monitor these effects over long-enough time periods. A stronger direction from central government requiring periodic, rigorous and systematic policy and programme evaluation is needed to support this in practice.

There is an opportunity to support the continuous improvement of climate change related interventions through improved coordination and knowledge sharing among groups conducting research and evaluation. This function could be delivered by a behavioural insights body or by another centralised monitoring and evaluation team.

Time-critical necessary action 6 - Align investments with climate outcomes

EECA strongly agrees with this recommendation and the priority given to it.

We would like to offer some comment and questions that may assist the commission in clarifying its advice for maximum impact.

Recommendation A - Immediately start to factor target-consistent long-term abatement cost values into policy and investment analysis in central government. These values should be informed by the Commission's analysis which suggests values of at least $140 per tonne by 2030 and $250 by 2050 in real prices

EECA notes that Treasury has recently published shadow-pricing guidance for use in government investment decision-making[12]. Establishing appropriate shadow carbon prices is a complex task with a wide range of uncertainty. It would be helpful if the Commission could clarify the recommendation in terms of the process it recommends be used to establish 'target-consistent prices' (a term which will be a key component of implementing this recommendation). We agree that the Commission's own modelling will be a useful resource, however there are other potential sources, such as the Carbon Pricing Leadership Coalition's High-Level Commission on Carbon Pricing and Competitiveness, that may give different or more nuanced results.

Recommendation B - Encourage local government and the private sector to also use these values in policy and investment analysis

EECA supports this recommendation. The use of consistent long-term abatement cost values by all levels of government and the private sector would help future-proof investments.

Recommendation C - Ensure that economic stimulus to support post-COVID-19 recovery helps to bring forward the transformational investment that needs to happen anyway to reach our joint climate and economic goals

EECA agrees with this recommendation and has made resources available to help out with this where appropriate (for example feeding in to consideration of Infrastructure Reference Group projects and the Government Investment to Decarbonise Industry (GIDI) Fund).

Recommendation D - Investigate and develop a plan for potential incentives for businesses to retire emissions intensive assets early

EECA agrees that some additional incentives may need to be made available to businesses if some assets are to be retired early. However, we would urge caution in developing a specific plan for this component. Any scheme will have the risk of being manipulated and the asset retirement barrier will need to be addressed in the wider context of barriers. One role for voluntary carbon markets could be to bring forward replacement of high emissions assets, thus addressing the 'time gap' problem.

Recommendation F - Investigate and develop plans to mobilise private sector finance for low emissions and climate-resilient investments

EECA is exploring options around the growing demand for ways to accelerate climate action and address climate related risk in the private sector. Driven by risk management, new participants are increasingly channelling capital in directions that contribute to climate mitigation and adaption. We support this action and we would like to highlight the potential of the voluntary carbon market (VCM) as a vehicle for private sector finance investments. Today, the existing VCM is niche and could be scaled up significantly.

[12] Appendix 4 of the CBAx User Tool Guidance: https://www.treasury.govt.nz/sites/default/files/2020-12/cbax-guide-dec20.pdf

EECA has been working with Motu and a wide range of stakeholders to address this challenge using the voluntary carbon market opportunity arising from the beginning of the Paris Agreement period.

Motu and EECA will soon publish a summary report outlining the problems, the opportunities and the current thinking in term of solutions. This report also addresses the waterbed effects[13] with the ETS.

Voluntary mitigation can help to bridge current gaps in mitigation ambition, financing, and speed that could undermine the long-term goals of the Paris Agreement.

Through our work, EECA identified a convergence of trends, barriers and opportunities and concluded that the VCM has the potential to be a vehicle for private finance to help unlock emissions reduction by funding domestic energy transition.

There are domestic emission reduction opportunities in New Zealand that are cost effective compared to alternatives such as forestry or offshore credits. These opportunities (energy efficiency and renewable energy projects) are not responsive to energy (and therefore carbon) prices because they face non-price barriers or the price signal is not yet sufficient to trigger investments.

As demonstrated with the GIDI Fund, an injection of capital could unlock some of these opportunities by improving the return on investment of the projects. The VCM could be a source of private funding for these projects.

Additionally, there is an incentive mismatch between businesses with cost-effective opportunities but low incentives/willingness to act and businesses with willingness to transition but few opportunities (overly expensive or not technically mature). Enabling these businesses to split the value and the claims for these projects would enable a shift from the zero-sum game status quo to a collaborative environment.

Shortcomings of the Kyoto period offsetting and carbon neutral approach have resulted in relatively low uptake and low trust in this market. Fixing the accounting issue by increasing transparency is key to increase trust and fix the behaviour issues related to past and current offsetting practices.

Allowing the VCM to fund domestic projects could also improve trust by bringing the outcomes of the spending closer to New Zealanders.

Time Critical necessary action 7 - Driving low emissions choices through the NZ ETS	
Recommendation A - In the next annual update to NZ ETS settings:	
(i)	*Align unit volumes with emissions budgets, taking into account the need to reduce the NZU stockpile*
(ii)	*Increase the cost containment reserve trigger price to $70 as soon as practical and then every year by at least 10% plus inflation*

EECA agrees with the general strengthening of ETS settings and the intent behind these.

[13] The 'waterbed effect' describes a situation where action taken by one party (pushing down) is cancelled out by increases from other parties due to the reduced pressure under the overall unit cap.

The specific wording in the advice could potentially be enhanced and clarified.

Specifically:

Recommendation A(i) - This recommendation could be more specific about the expected change in unit auction volumes. The current recommendation specifies a principle for adjustment (i.e. alignment with budgets) but stops short of identifying the quantum of adjustment the Commission expects to see. This means that if government adjusts the auction volumes at all, this could be claimed to be complying with this recommendation, when actually it is not a sufficient adjustment. A specific range of auction volumes "i.e. Commission analysis suggests that the appropriate range of auction volumes is X to Y million units per year" would be a more effective recommendation.

Recommendation A (i) and (ii) - A fundamental principle of the ETS is that it makes use of a market mechanism to determine the price. While having well signalled price corridors is a useful feature of the ETS, as it provided a degree of confidence about price levels, care should be taken that the ETS is not over-constrained.

The recommendations are set at specific prices, with specific escalation rates. Given the timeframe, the starting price is unlikely to be problematic, however the escalation rates may need to be revisited over time. A more useful approach would be to reference the price setting to ETS market outcomes from a preceding period. For example, "The auction reserve trigger price will be set at the average of the previous 3 months published ETS price".

The justifying comment "these changes are needed because maintaining current settings will lead to failure to meet emissions budgets" could be rephrased for clarity and accuracy. At present it implies a direct link between the ETS settings and New Zealand's emissions. While the ETS is a key tool in managing emissions, it is neither fully effective, nor the only measure being applied to the emissions problem.

Recommendation B - Amend the NZ ETS so that it contributes, as part of a package of policies (see time-critical necessary action 5), to delivering the amount of afforestation aligned with our advice on the proportion of emissions reductions and removals, consistent with budget recommendation 2

This recommendation would benefit from improved clarity and further explanation. It implies some sort of differentiation between forest types, but it is not easy to determine how this would work in practice. While the detail will be developed in consultation with affected parties, a more tangible strawperson example would provide affected parties with a better basis for discussion.

Recommendation C - Establish a sound market governance regime for the NZ ETS as soon as possible to mitigate risks to market function, as some of these risks are potentially catastrophic for the scheme's effectiveness. This work should be advanced through an interagency team including MBIE for its financial markets expertise

Our understanding is that the intent of this recommendation is for the Government to speed up implementation of the market governance work programme already identified. The progress indicator refers to 'the most significant risks' however it is not clear from the advice what the Commission believes these to be.

Necessary action 19 - Continued ETS improvements

Recommendation A - Developing options and implementing a plan for recycling some or all of the proceeds from NZ ETS unit auctions into emissions reductions, adaptation, equitable transitions and meeting international climate change obligations

Recycling of ETS revenue is one among many options to increase government funding for emissions reductions, adaptation, equitable transitions and meeting international climate change obligations. We strongly support the need to investigate this opportunity, alongside the range of other potential funding mechanisms. The benefit of hypothecating ETS revenues is it could make the increasing cost implications of the ETS more palatable to society as they see a direct correlation between the cost to consumers of an ETS and the direct investment from ETS revenues recycled into emission reduction efforts. Much in the same way the dedicated National Land Transport Fund has sought to do this with fuel excise duty and road user charges. However, direct hypothecation may also have downsides, in terms of being unable to provide certainty of forward funding.

Recommendation B - Undertaking a first principles review of industrial allocation policy

EECA supports a first-principles review of industrial allocation policy to ensure it is fit for purpose.

Recommendation C - Continuing to phase out industrial allocation

The Government has put in place a policy to phase out industrial allocation slowly and over a long timeframe. It would be useful to understand if the Commission recommends maintaining this policy or accelerating the phase-out of industrial allocation to be consistent with targets and budgets and ensuring a fair and equitable burden of action across the economy.

Recommendation D - Exploring alternative policy instruments that could address the risk of emissions leakage

Emissions leakage can occur from all sectors of the economy. It would be useful if the Commission can clarify whether this recommendation relates to industrial allocation to Emission Intensive and Trade Exposed (EITE) sectors, or more broadly (i.e. including agriculture). If the recommendation does not include primary production then perhaps the Commission could consider merging recommendation b, c, and d into a single recommendation that says “Adjust the industrial allocation regime and related policies to be consistent with targets and budgets while managing risks of carbon leakage”.

Recommendation E - Providing more information to reduce uncertainty about adjustments to NZ ETS settings, particularly how it intends to manage unit volumes in light of the split-gas 2050 target

Reducing uncertainty in the ETS settings is important for encouraging long-term investment activity in emissions reduction. However, the need to reduce uncertainty is somewhat inconsistent with discussions in the advice about managing ‘the waterbed effect’ (Evidence report Chapter 16, page 8), which suggests fluidly adjusting auction volumes to account for actual emissions reductions both inside and outside the ETS. It would be helpful if the Commission could clarify how these competing objectives would best be managed.

Recommendation F - Clarifying the role and avenues for voluntary mitigation in Aotearoa

We do not share the Commission's view that, providing an adjustment, when a NZU is cancelled, it is equivalent to removing a tonne of emissions from the atmosphere. This theoretical reasoning does not seem to take into account the significant amount of NZUs stockpiled by some businesses, most of which were received for free as a result of over allocation.

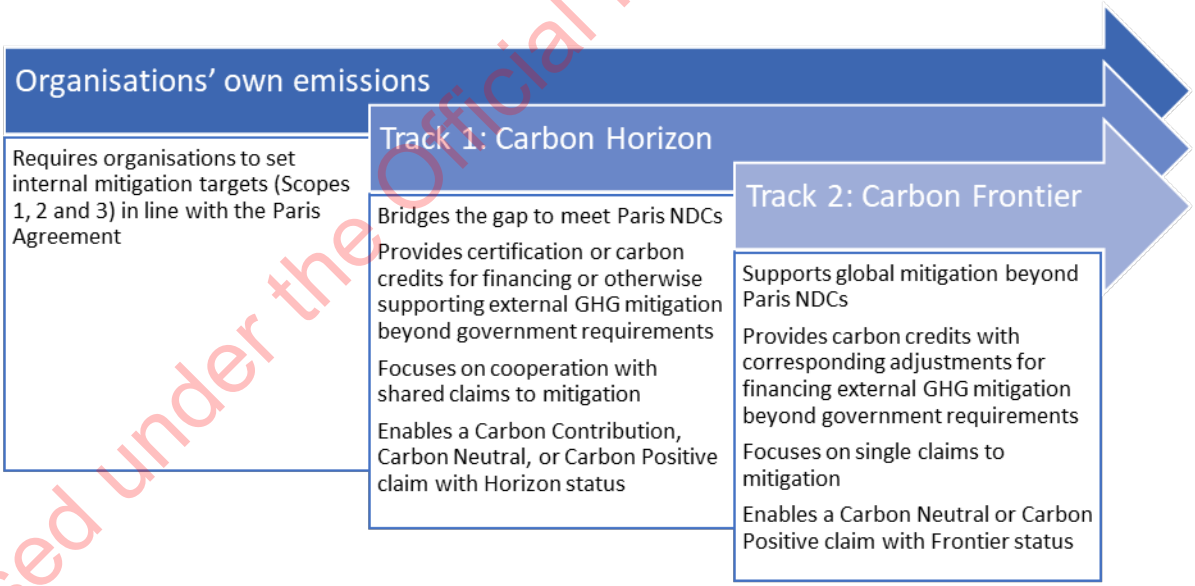
We do support the general recommendation, although it would be helpful if the Commission could provide a clearer position. This could be used as a starting point for inter-agency discussion on the matter.

As mentioned in Recommendation F of Time Critical Necessary Action 7, EECA has been working on this topic with Motu and a wide range of stakeholders.

We think that the voluntary carbon market (VCM) has a key role to play to unlock domestic transition projects facing non-price barriers, or for which the price signal is not yet sufficient to trigger investments when the opportunities arise (e.g. asset replacement).

From the joint work with Motu and the workshops participants, we suggest potential solutions, including:

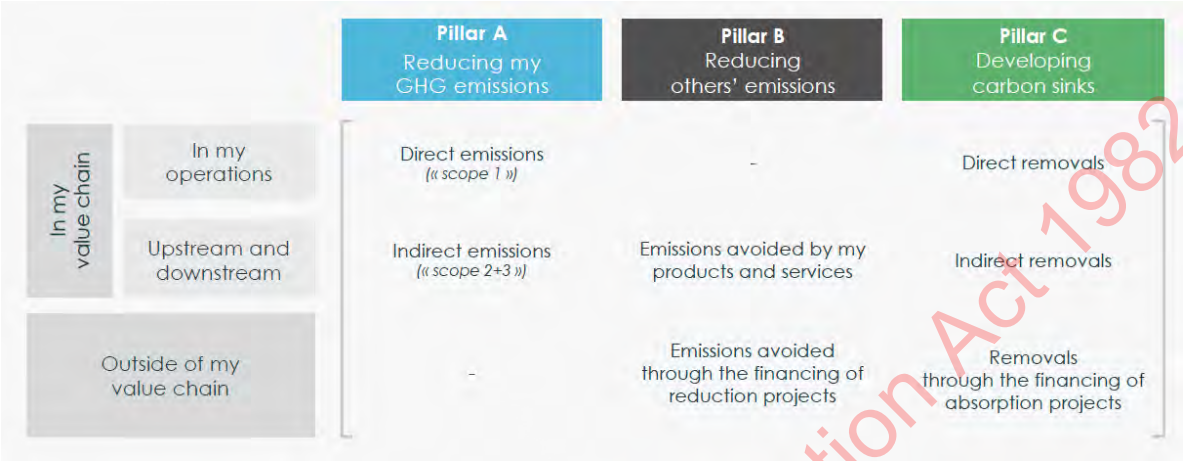
a) A strawperson proposal for a two-track system intended to boost voluntary mitigation at scale with benefits for both organisations and government.



In the past, voluntary mitigation typically focused on generating and trading voluntary carbon credits (VCCs) eligible for carbon-neutral offsetting claims. While retaining that option with new features to make it Paris-compatible, this proposal expands the scope of eligible voluntary mitigation to include recognition for more diverse forms of cooperation with shared gains and greater valuation of environmental, social, cultural, and economic co-benefits. It is scalable for the global transition toward net-zero emissions.

b) An alternative is a "dashboard" approach to carbon accountability for organisations, which increases transparency and allows shared claims to favour collaboration.

With this approach, an organisation's performance would be distinct from helping others, and the gross emissions would be distinct from removals. It would result in a clearer risk exposure for investors and shareholders.
An example of such approach has been developed by the Net Zero Initiative:



Adoption of such reporting would unlock better outcomes such as:

- Allowing an increase of gross emissions from a company producing goods or services that unlock greater emissions reductions for their customers (such as energy providers).
- For the state sector, it would highlight investments in domestic reduction projects as a valid option compared to purchasing offshore credits to cancel.