

# Chapter 7:

# Where are we currently heading?

*This chapter provides a glimpse of what future emissions in Aotearoa could look like if we keep progressing as we are now – with no policy changes or new regulations. It does this through the Current Policy Reference case, which provides the platform that allows us to test and adjust our thinking to create alternate scenarios which form the basis of our advice.*

*We dive deep into each sector and explore how the future might play out if policies continue as they are. This chapter also introduces our ENZ modelling tool and discusses the possible impacts of COVID-19 on our future emissions.*

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*We dive deep into each sector and explore how the future might play out if policies continue as they are. This chapter also introduces our ENZ modelling tool and discusses the possible impacts of COVID-19 on our future emissions.*

## 7.1 Introduction

This chapter introduces the Current Policy Reference case, which projects how emissions and activities could change in the future assuming no changes to current Government policy. It provides a point of reference for comparing our recommended budgets and pathway. The first section of this chapter describes the Current Policy Reference case in more detail and how it was constructed. The second section presents the reference case with charts and tables for key aspects of each sector. The third section considers comparisons between the Current Policy Reference case and other projections of a similar nature. The fourth section provides a discussion of key sources of uncertainty in the reference case, including the impact of COVID-19.

## 7.2 What is the Current Policy Reference case?

The Current Policy Reference case provides a projection of what our emissions could look like out to 2050 if no additional measures are implemented. This reference case is a scenario, and as such the outcomes described are neither what we consider “will” nor “should” occur. Instead, it serves to paint a picture of the types and amounts of emissions reductions which could occur if we keep to the path we are currently on.

The Current Policy Reference case incorporates, through assumption, anticipated changes which are consistent with a future where there are no further developments in Government climate legislation and regulation. The reference case assumes market conditions, technology cost reductions and policies continue on current trajectories. Government policies already in place and funded as of 17 October 2020 are included but proposed or as-of-yet unfunded policies are not.<sup>1</sup> Policies proposed during the October 2020 election that have not been legislated, for example, are not included. A more detailed discussion of the key recent policy developments included in the reference case is provided below.

The Current Policy Reference case is not designed to necessarily meet the 2050 targets or emissions budgets – it is a starting point for our analysis. We use it to calibrate our models with detailed Government projections and to help us understand what additional effort might be required to meet emissions budgets and targets. The reference case also gives a benchmark against which to test the

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<sup>1</sup> 17 October is chosen as the cut-off point as the day of the 2020 general election to highlight that policies of the newly elected Government are not included in the Current Policy Reference case. All policies and measures included in the reference case were in place prior to this date.

relative impacts of different scenarios and the effectiveness of different interventions in achieving emissions reduction targets.

The emissions trajectory of ‘current’ Government policies will, of course, change as new climate policies are introduced. Through its role in monitoring progress of Aotearoa towards budgets and the 2050 target, we will revise and update the reference case over time. The next advice on emissions budgets, to be delivered in 2024, will be based on a new Current Policy Reference case which reflects action taken and external developments between now and then. Government projections and scenarios will also continue to evolve during this time.

Our Current Policy Reference case is, as such, not a fixed scenario against which we will compare repeatedly until 2050. It is a starting reference case for developing the first emissions budgets and the beginning of an iterative modelling and monitoring process which we will continue moving forward. This underpins the dynamic, adaptive approach we are taking towards our policy advice.

### 7.2.1 Uncertainty and the Current Policy Reference case

There is, inevitably, significant uncertainty within the Current Policy Reference case. We present a single reference case that largely mirrors Government “with existing measures” scenarios. The reference case depends on a set of assumptions which are detailed in the sections that follow. These assumptions, and the resulting emissions trajectories, are subject to uncertainty. This is based on possible actions within Aotearoa, as well as external developments – many of which are international. A discussion of the uncertainties for each sector in the reference case is provided in the final section of this chapter.

The discussion on uncertainty also includes a section dedicated to the potential effects of COVID-19. As we have a long-term planning focus, the key uncertainty is the duration of impacts caused by the pandemic. For reasons described at the end of this chapter, we assume the economic impacts of the pandemic will be relatively short term and do not adjust the Current Policy Reference case to include COVID-19 impacts.

If these uncertainties cause variations for the Current Policy Reference case, a different degree of work would be required to meet emissions budgets and the 2050 target.

We recognise and incorporate the major uncertainties which might affect emissions trajectories through modelling multiple future scenarios in addition to the reference case. With the time and resources available to produce this first set of advice, we are unable to model the entire spectrum of possible future scenarios. We have focused on four plausible scenarios which reflect key sources of variation in the drivers of emissions and potential emissions reductions. These are presented in *Chapter 8: What our future could look like*. The emissions budgets we propose are ones we believe are achievable under a range of possible futures.

The wellbeing of iwi/Māori throughout the transition to low emissions is a central part to this. He Ara Waiora<sup>2</sup> presents a Te Ao Māori approach to wellbeing, sourced in mātauranga Māori, and provides valuable and appropriate framing to understand and assess impacts of climate policy for iwi/Māori. It is also a frame that considers broader wellbeing of people and environment for current and future generations. When developing and implementing the emissions reduction plan, the government

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<sup>2</sup> McMeeking (2019)

should consider how those measures impact the four dimensions of wellbeing identified in the framework.

## 7.2.2 How we built the Current Policy Reference case

The Current Policy Reference case was generated using a purpose-built computer model called ENZ that was originally developed by Concept Consulting. 'ENZ' was originally an acronym for 'Energy Emissions in New Zealand' but is now the complete name of the model. We purchased ENZ and have enhanced it to meet our needs.

ENZ allows us to investigate, from a whole-of-system point of view, which emission reductions might be technically and economically achievable in each sector of the economy. It also allows us to factor in anticipated technological developments. As well as the Current Policy Reference case, we use ENZ to generate other scenarios to investigate alternative possible futures in *Chapter 8: What our future could look like*.

The exact design of the Current Policy Reference case varies across sectors. Inputs were derived through a combination of in-house analysis and external engagement. We examined Government projections, including the October 2020 update; expected future reductions in technology costs; research on international trends and committed policies and industry plans within Aotearoa. We also drew on responses to our call for evidence and engaged widely with industry and sector experts for additional input.

### **Box 7.1: Key policies shaping the Current Policy Reference case**

#### Freshwater policy

The Essential Freshwater policies and regulations that came into force on 3 September 2020 contained two major components:

- 1) **The National Environmental Standards for Freshwater:** these regulate activities deemed to pose risks to the health of freshwater and freshwater ecosystems. The standards include regulations for winter grazing, restrict agricultural intensification until 2024, and a limit for synthetic nitrogen fertiliser use on pastoral land of 190kg per hectare per year.
- 2) **National Policy Statement for Freshwater Management:** this provides direction to local authorities on managing freshwater under the Resource Management Act. It sets national objectives for freshwater management, including on wetland protection and restoration, water quality monitoring and tougher national bottom lines for ammonia and nitrate toxicity.

These freshwater policies and regulations are expected to have implications for land sector activities, particularly pastoral agriculture. The effects have been estimated and incorporated by MPI in their October 2020 updated activity projections, which were fed into ENZ. The main impact on the activity data was a reduction in projected livestock numbers, which flows through into lower projected agricultural emissions.

#### Emissions Trading Scheme

The NZ ETS is one of the Government's main tools for reducing GHG emissions. It does this by placing a price on emissions by requiring certain sectors of the economy to purchase New Zealand

Units (NZUs) equal to their annual emissions. Post-1989 forest owners can also receive NZUs for the emissions removals generated by their forests.

The Current Policy Reference case includes a \$35 carbon price in the NZ ETS in line with the updated all-government assumptions. This is assumed to hold constant in real terms until 2050 and reflects a mid-point between the current upper bound of the cost containment reserve (\$50) and the NZU auction reserve price (\$20).

There is a system of free allocation in the NZ ETS for certain industrial activities determined to be emissions-intensive and trade-exposed. Our analysis assumes changes to industrial allocation do not influence industrial output or incentives to reduce emissions.

Animal agriculture emissions are currently exempt from the emissions price in the NZ ETS, but legislation includes a provision for them to lose this exemption in 2025 unless an alternative pricing mechanism is developed. He Waka Eke Noa is working towards this and we will have a role in assessing its progress in 2022. The legislated pricing for agricultural emissions from 2025 would take place at the processor level and with 95% free allocation – this is factored into MPI's activity data that underpin the current policy reference case. Non-animal agricultural emissions such as on-farm fossil fuel use are already subject to emissions pricing.

The amendments to the NZ ETS passed in June 2020 contained a number of technical changes for forestry in the scheme. These included introducing averaging accounting for post-1989 forests and creating a new permanent forestry activity. These changes will phase in by 2023 and have given more certainty for forestry in the scheme, with the net effect of increasing projected future afforestation in Aotearoa. This has been incorporated into the MPI October 2020 data update which is used in ENZ to generate the Current Policy Reference case.

Waste is included in the NZ ETS with disposal facilities having obligations to purchase NZUs. However, this only applies to landfills that accept household waste, which only account for approximately one third of waste emissions. Higher NZ ETS prices are unlikely to materially impact waste volumes or waste emissions. This is because most municipal landfills are required to collect greenhouse gas emissions under the National Environmental Standards for Air Quality. These landfills are able to apply for a 'Unique Emissions Factor' (UEF) to reduce their NZ ETS obligations. A UEF can be applied for by landfills if they produce less emissions than the 'default emissions factor.' Most household waste goes to landfills that have received a UEF, meaning that they are already at a high rate of capture efficiency.

#### Waste levy

A waste disposal levy also applies to landfills with the current price for municipal sites set to increase from \$10 to \$60 per tonne and for non-municipal sites from \$0 to between \$10-\$30 by 2024. As waste volumes are relatively price inelastic<sup>3</sup> and the increases to the waste levy are quite low, we have been conservative and assumed that the small increase to the waste levy will not substantially affect the current policy reference case.

#### No new offshore oil and gas exploration permits

In 2018, the Government announced that there would be no new oil and gas exploration permits offered, except on land in Taranaki. This policy has been included in the current policy reference

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<sup>3</sup> (Clough, 2019)

case. While this has not affected existing exploration permits or companies' ability to extract oil and gas from known reservoirs, we have assumed that our natural gas reserves do not increase.

#### Kigali phasedown

In October 2016 Aotearoa adopted the Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer. This requires Aotearoa and other signatories to gradually phase down HFC production and use. Aotearoa, as a developed country, is required to phase down HFC production and use by 85% by 2036. The Amendment was brought into force for Aotearoa on 1 January 2020.

We take historic data for the model from New Zealand's Greenhouse Gas Inventory. The most recent data currently available is from 2018, so we use this as the base year in ENZ. The model then projects data for 2019 onwards.

The land and waste sector reference cases draw directly on Government activity projections, so they are almost identical to Government "with existing measures" scenarios. The reference cases for transport, buildings and industry, however, draw more on internally developed assumptions. They are still broadly aligned with Government projections but less so than for the land and waste sectors. Comparisons between the ENZ reference cases and projections from Government and other organisations are provided later in this chapter.

The following sections describe ENZ and the Current Policy Reference case for each sector. First, overall long-lived gas and biogenic methane emissions are presented. This is followed by charts, tables and supporting notes highlight projected emissions and activity data out to 2050 for transport; buildings; heat, industry and power; land; and waste. All figures are presented in real terms.

A more detailed account of the ENZ model is provided in Appendix 1. Detailed Current Policy Reference case assumptions are provided in Appendix 2.

## 7.3 Overall emissions

We first present total long-lived gases and biogenic methane (CH<sub>4</sub>) emissions to give a sense of progress towards the 2050 and 2030 targets. Following that, the sectoral data is largely split by gas in order to more clearly highlight the mix of gases being emitted. This provides a platform for a targeted consideration of the opportunities for reducing emissions to meet our targets in Part 3.

### 7.3.1 Long-lived gases

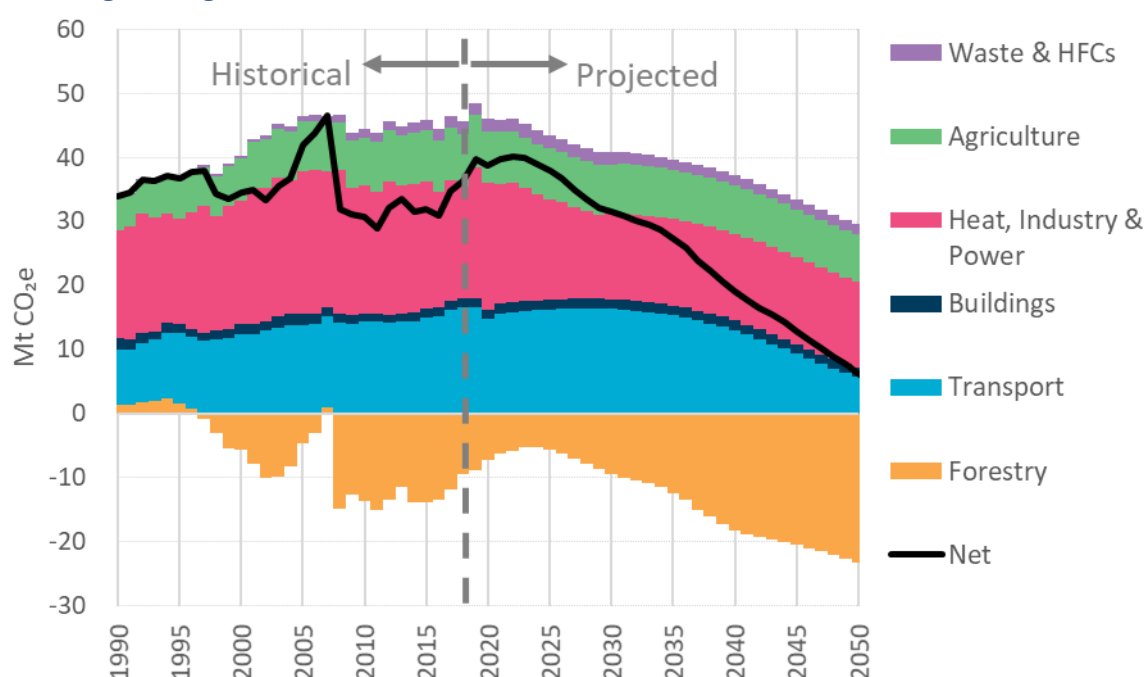


Figure 7.1: Current Policy Reference case total long-lived gases emissions and removals by sector

Source: Commission analysis.

Table 7.1: Current Policy Reference case total long-lived gases emissions and removals by sector (Mt CO<sub>2</sub>e)

	2018	2030	2040	2050
<b>Waste and HFCs</b>	2.0	1.9	1.5	1.5
<b>Agriculture</b>	8.3	7.8	7.6	7.4
<b>Heat, Industry and Power</b>	17.4	13.3	13.6	13.4
<b>Buildings</b>	1.4	1.6	1.5	1.5
<b>Transport</b>	16.6	16.3	13.0	5.7
<b>Forests</b>	-9.5	-9.3	-18.2	-23.2
<b>Net</b>	36.3	31.4	19.0	6.3
<b>Gross</b>	45.7	40.8	37.2	29.5

#### Notes:

- Long-lived gas emissions in Aotearoa come from a range of sources and are comprised of all gases other than biogenic methane. They are largely carbon dioxide (CO<sub>2</sub>) and nitrous oxide (N<sub>2</sub>O), with some much smaller amounts of F-gases and fossil methane. Figure 7.1 presents these alongside emissions removals by forests, which together account for net emissions of long-lived gases.
- Gross long-lived gas emissions increased steadily from 32.5 megatonnes (Mt) CO<sub>2</sub>e in 1990, peaking at 46.8Mt CO<sub>2</sub>e in 2008 and reaching 45.7Mt CO<sub>2</sub>e in 2018. Note that this is distorted due to major underestimation of transport emissions prior to 2001.

- From 2018, gross emissions decline to 40.8Mt CO<sub>2</sub>e in 2030 and 29.5Mt CO<sub>2</sub>e in 2050. This is driven in large part by projected decreases in transport emissions after 2030, which drop from 16.3Mt CO<sub>2</sub>e in 2030 to 5.7Mt CO<sub>2</sub>e in 2050. Other sources of emissions also decline steadily from 2018 to 2050.
- The decrease in transport emissions is largely due to the projected electrification of the light vehicle fleet. This is one area where the ENZ Current Policy Reference case differs significantly from other Government projections. A discussion of these comparisons is provided later in this chapter.
- Emissions removals by forests fluctuated between 1990 and 2018. In the Current Policy Reference case, they are expected to increase steadily from 9.5Mt CO<sub>2</sub>e in 2018 to 23.2Mt CO<sub>2</sub>e in 2050. This results in net emissions of long-lived gases declining from 36.3Mt CO<sub>2</sub>e in 2018 to 6.3Mt CO<sub>2</sub>e in 2050.
- A more detailed discussion of emissions removals by forests in the Current Policy Reference case are discussed in the land subsection below.
- The emission sources which are included under each of the categories in Figure 7.2 and Table 7.2 are detailed in the following sections.

### 7.3.2 Biogenic methane

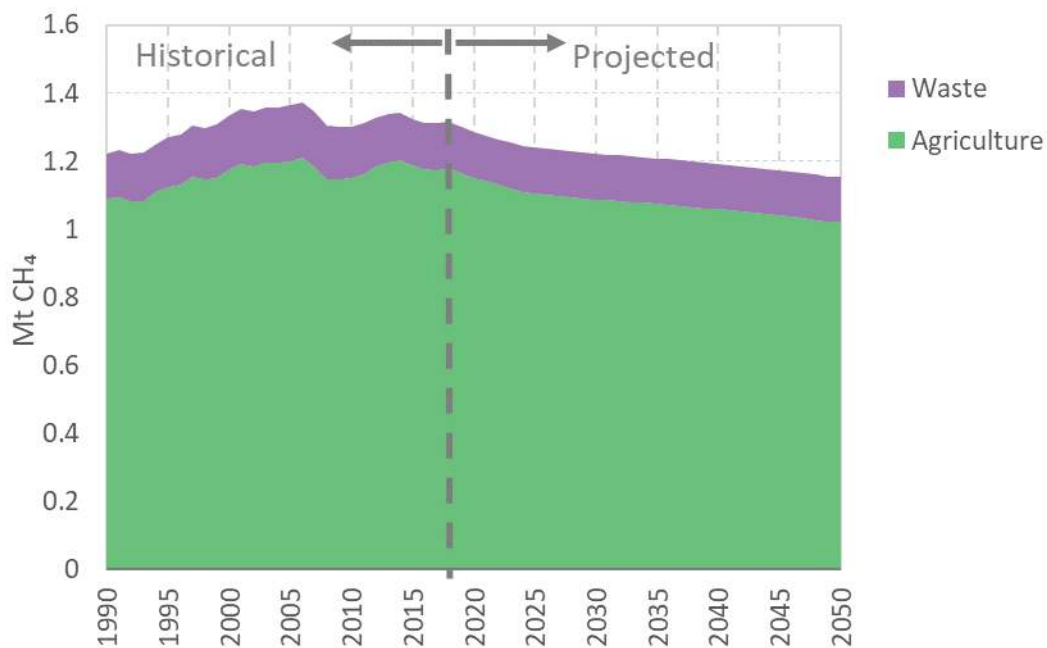


Figure 7.2: Current Policy Reference case total biogenic methane emissions by sector

Source: Commission analysis.

Table 7.2: Current Policy Reference case total biogenic methane emissions by sector (Mt CH<sub>4</sub>)

	2018	2030	2040	2050
<b>Agriculture</b>	1.18	1.09	1.06	1.02
<b>Waste</b>	0.14	0.13	0.13	0.13
<b>Total</b>	1.32	1.22	1.19	1.15

## Notes:

- Biogenic methane emissions largely come from ruminant livestock and organic waste decomposition.
- Agricultural biogenic methane emissions increased steadily from 1.09Mt CH<sub>4</sub> in 1990, peaking at 1.21Mt CH<sub>4</sub> in 2006 before declining to 1.18Mt CH<sub>4</sub> in 2018.
- In the Current Policy Reference case, agricultural biogenic methane emissions decline to 1.09Mt CH<sub>4</sub> in 2030 and 1.02Mt CH<sub>4</sub> in 2050. Details of these emissions are described in the land section of this chapter below.
- Waste emissions are indicative and pending updates. This is discussed further in the waste section below.

## 7.4 Transport

ENZ includes road, rail, shipping and aviation, with the latter two split into domestic and international. It also includes different fuel types: fossil and alternatives. It models the main levers which influence emissions, including the makeup of the vehicle fleet, transport demand and the factors driving them, such as the size of the population. ENZ also takes account of behavioural change, including shifts between travel types, such as more walking or cycling, or reduced demand for travel because of more working from home. In both cases, ENZ responds by reducing the distance travelled by road.

### 7.4.1 Domestic transport carbon dioxide emissions by travel type

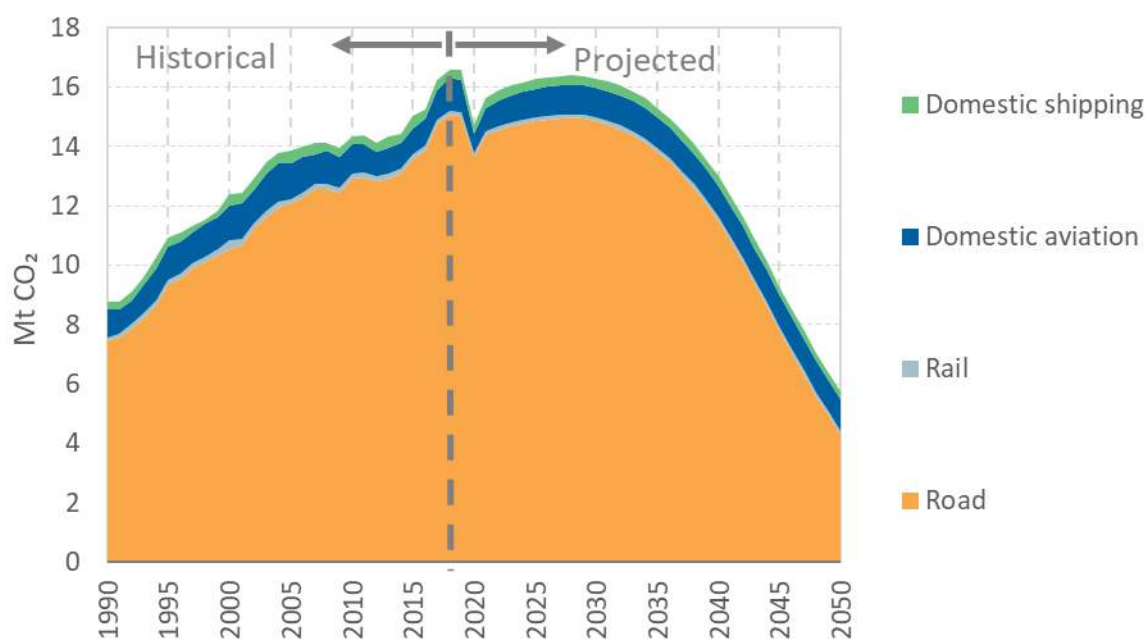


Figure 7.3: Current Policy Reference case domestic transport emissions by travel type

Source: Commission analysis.

Table 7.3: Current Policy Reference case domestic transport emissions by type (Mt CO<sub>2</sub>)

	2018	2020	2030	2040	2050
<b>Road</b>	15.1	13.6	14.8	11.5	4.3
<b>Rail</b>	0.1	0.1	0.1	0.1	0.1
<b>Domestic aviation</b>	1.1	0.6	1.0	1.0	1.1
<b>Domestic shipping</b>	0.3	0.3	0.3	0.3	0.3
<b>Total</b>	16.6	14.7	16.3	13.0	5.7

Notes:

- Figure 7.3 shows transport emissions for the major domestic types of travel. In line with the Commission’s current policy mandate, we have excluded international aviation and international shipping from this graph, however, we do address international transport in Figure 7.7 below.
- Between 1990 and 2018, emissions from road vehicles have dominated domestic transport CO<sub>2</sub> emissions and have nearly doubled. Emissions from other modes (domestic aviation, railways and domestic shipping) are smaller and have not seen much growth.
- After 2018, emissions from road vehicles are projected to rise slowly to the mid-2020s, then decline steadily due mainly to the expected uptake of electric vehicles; emissions from other travel types would not change much.
- Greenhouse gas emissions in the transport sector were more than 99% CO<sub>2</sub> in 2018.<sup>4</sup> We have not modelled other greenhouse gas emissions in transport as they are insignificant.
- Between 1990 and 2018, road vehicle emissions have grown with the population and the economy, with little improvement in vehicle efficiency to offset the growth in traffic.
- In domestic aviation, improvements in fuel efficiency and increases in passenger occupancy have helped to offset growth in aviation traffic. The efficiency improvements are expected to continue, but further increases in passenger occupancy may not be feasible.
- Emissions from railways and domestic shipping are small and expected to remain that way.

<sup>4</sup> Ministry for the Environment (2020).

## 7.4.2 Household transport by transport type

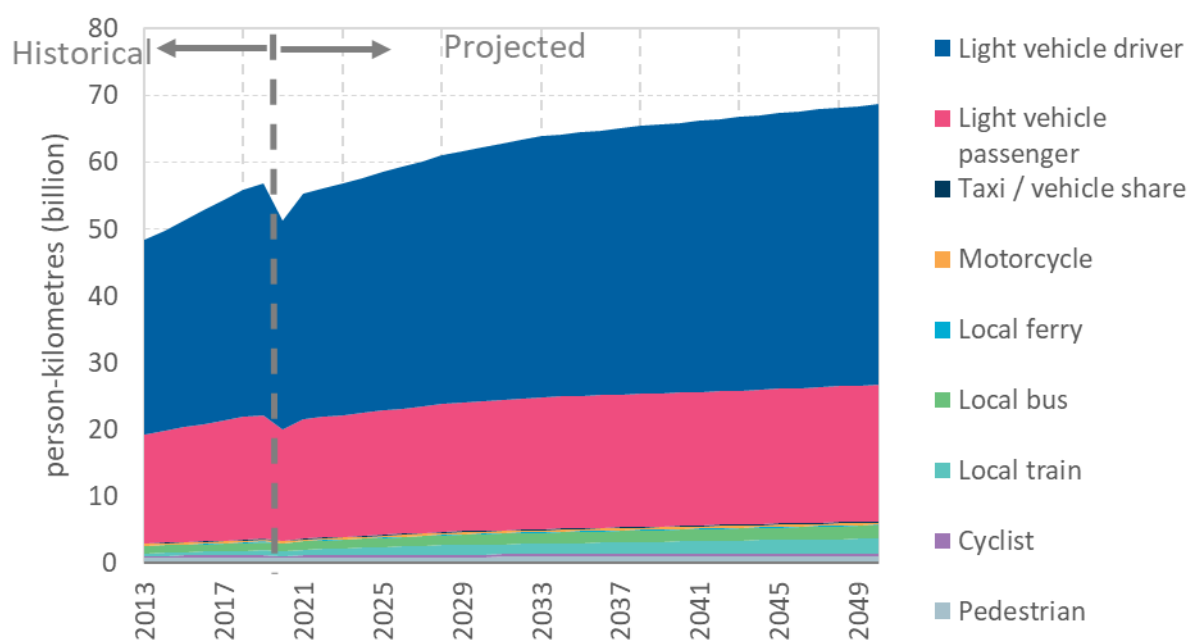


Figure 7.4: Current Policy Reference case household passenger kilometres by travel type

Source: Commission analysis.

Table 7.4: Current Policy Reference case household passenger kilometres by travel type (billions)

	2018	2020	2030	2040	2050
<b>Pedestrian</b>	0.9	0.8	0.9	1.0	1.0
<b>Cyclist</b>	0.3	0.3	0.4	0.4	0.4
<b>Local train</b>	0.6	0.7	1.5	1.9	2.3
<b>Local bus</b>	1.2	1.1	1.5	1.7	2.0
<b>Local ferry</b>	0.1	0.1	0.1	0.1	0.1
<b>Motorcycle</b>	0.3	0.3	0.3	0.3	0.3
<b>Taxi / vehicle share</b>	0.1	0.1	0.2	0.2	0.2
<b>Light vehicle passenger</b>	18.4	16.6	19.4	20.0	20.5
<b>Light vehicle driver</b>	34.1	31.2	38.0	40.4	41.9
<b>Total</b>	56.0	51.2	62.2	66.0	68.7

### Notes:

- Figure 7.4 shows household travel, which includes most local travel other than travel for business purposes. It would, for example, exclude tradespeople travelling to job sites or couriers making deliveries.
- Between 1990 and 2018, household travel was dominated by light vehicle drivers and light vehicle passengers, which accounted for about 95% of person-kilometres travelled.
- After 2018, household travel continues to be dominated by light vehicle drivers and light vehicle passengers; there would be significant percentage growth in public transport (local

train and local bus) due to ongoing improvements in infrastructure and services, but from a small initial base.

- Household travel accounts for about 75% of light vehicle travel and is therefore the major driver of domestic transport emissions; commercial travel accounts for most of the remaining light vehicle travel.
- Cities in Aotearoa generally have a sprawling land-use pattern, which has been difficult to serve with public transport, or walking and cycling. Government transport expenditures have historically focused on roading, accentuating this pattern.
- In the Current Policy Reference case, we do not assume any potential long-term increase in remote working, which could reduce travel demand.

### 7.4.3 Road transport emissions by vehicle class



Figure 7.5: Current Policy Reference case emissions by vehicle class

Source: Commission analysis.

Table 7.5: Current Policy Reference case emissions by vehicle class (Mt CO<sub>2</sub>)

	2018	2020	2030	2040	2050
<b>Light passenger vehicles</b>	8.1	7.3	7.7	5.5	1.5
<b>Light commercial vehicles</b>	2.7	2.5	2.8	2.0	0.5
<b>Motorcycles</b>	0.0	0.0	0.0	0.0	0.0
<b>Medium trucks</b>	2.4	2.1	2.2	1.9	0.8
<b>Heavy trucks</b>	1.5	1.4	1.8	1.8	1.5
<b>Buses</b>	0.3	0.2	0.3	0.2	0.0
<b>Total</b>	15.1	13.6	14.8	11.5	4.3

#### Notes:

- Figure 7.5 shows road transport emissions broken out by the class of vehicle.
- Between 1990 and 2018, emissions grew from all six classes of vehicles. Growth has been especially large for medium and heavy trucks and for light commercial vehicles (vans and utes).
- After 2018, emissions from most vehicle classes are expected to rise until the mid-2020s, then decline as the vehicle fleet becomes increasingly electrified.
- The terms 'light passenger vehicles' and 'light commercial vehicles' refer to the body type of the vehicle, not the use or ownership of the vehicle. The light passenger vehicle class

includes cars and SUVs; the light commercial vehicle class includes vans and utes. Close to 60% of light commercial vehicles are owned by households, not businesses.<sup>5</sup>

- Between 2000 and 2018, light commercial vehicle numbers have gone up about 80% compared to about 54% for light passenger vehicles, reflecting the growing popularity of these large vehicles for both households and businesses.<sup>6</sup>
- Emissions per kilometre for most classes of vehicles have historically gone down very slowly, as efficiency improvements have been offset by growing vehicle size and growing engine size. This pattern is expected to continue for internal combustion engine vehicles.
- While the projected long-term decline in road transport emissions is good news, there are three important caveats to this Current Policy Reference case projection:
  1. As noted, later in this chapter, the continuing decline in battery costs and increasing competitiveness of electric vehicles, which is driving these results, is subject to uncertainty.
  2. Emissions from road transport remains at current high levels for at least another 10 years, before they begin to decline significantly
  3. Even in 2050, there would still be around 4Mt CO<sub>2</sub> emissions from road vehicles.

Taken together, these caveats imply that the long-term decline in road transport emissions in the Current Policy Reference case would almost certainly be insufficient to meet our emission reduction commitments.

#### 7.4.4 Electric vehicle uptake

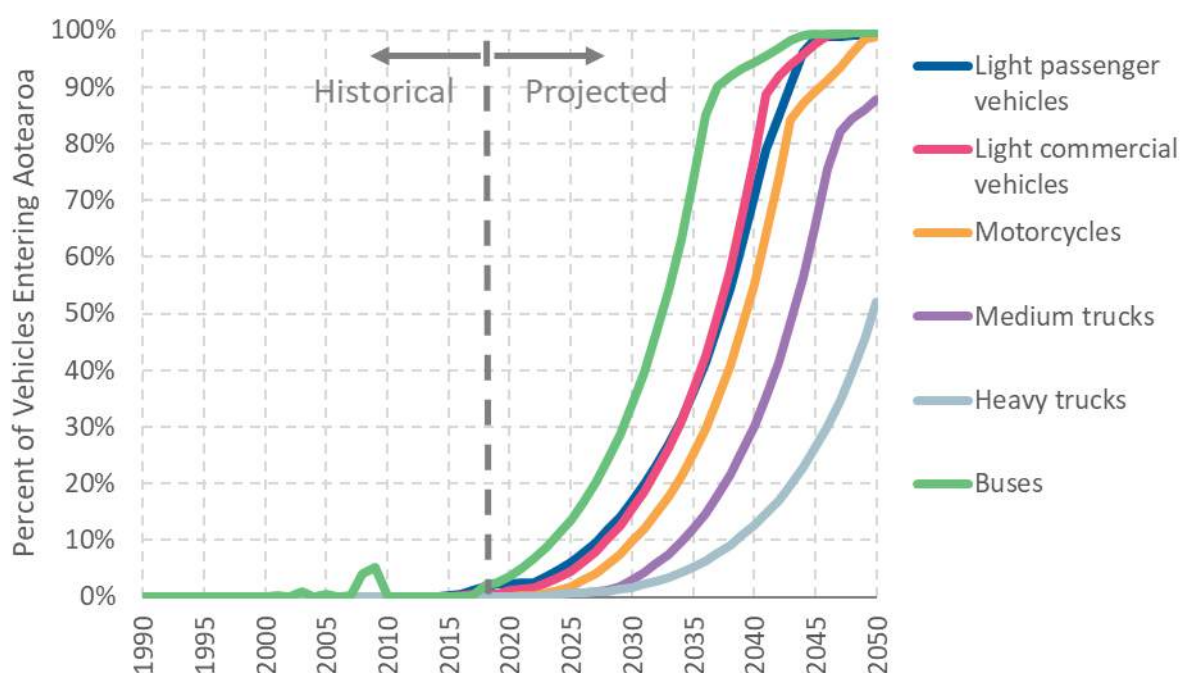


Figure 7.6: Current Policy Reference case percentage of electric vehicles entering the fleet

Source: Commission analysis.

<sup>5</sup> Ministry of Transport (2019c), see the 'All Light Vehicles' sheet.

<sup>6</sup> Ministry of Transport (2019a), see tab '1.1, 1.2'.

Table 7.6: Current Policy Reference case percentage of electric vehicles entering the fleet

	2018	2020	2030	2040	2050
<b>Light passenger vehicles</b>	2%	2%	17%	71%	99%
<b>Light commercial vehicles</b>	0%	1%	15%	78%	100%
<b>Motorcycles</b>	0%	0%	10%	55%	99%
<b>Medium trucks</b>	0%	0%	3%	30%	88%
<b>Heavy trucks</b>	0%	0%	2%	13%	52%
<b>Buses</b>	2%	4%	34%	94%	100%

Notes:

- Figure 7.6 shows the expected uptake of electric vehicles as a percentage of newly registered vehicles (both imported new and imported used) entering the fleet each year. These percentages are not to be confused with the percentage of electric vehicles in the fleet each year, which will lag significantly behind the percentage of electric vehicles entering the fleet.
- See the Appendix 1 for more information on how we model electric vehicles.
- Numbers of electric vehicles entering the fleet in 2018 and previous years were very small—less than 10,000.
- Declining battery costs make it likely that electric vehicles will become increasingly competitive with conventional vehicles, implying that electric vehicle numbers are likely to grow even in the absence of strong Government policies to promote them. As noted in Figure 7.5, the resulting long-term decline in road transport emissions in the Current Policy Reference case would almost certainly be insufficient to meet our emission reduction commitments.
- Given the many uncertainties, projecting the timing of the growth of electric vehicle sales is difficult. The Current Policy Reference case suggests that for light passenger vehicles, the time when more than half the vehicles imported into Aotearoa (both imported new and imported used) would be electric is in the late 2030s, with electric vehicles completely taking over the light passenger vehicle market in the early 2040s.
- Light commercial vehicles switch-over to electric at a similar rate to light passenger vehicles. Buses switch over faster; medium and heavy trucks take longer due to the challenges of using battery power for heavy vehicles travelling long distances.
- The bus fleet is split fairly evenly between local public transport buses and buses designed for longer-distances, which serve mainly tourists. The public transport portion of the bus fleet is amenable to electrification and almost entirely under Government control, so it would likely be an early adopter of electrification.
- Our model is based on battery cost projections from Bloomberg New Energy Finance (BNEF),<sup>7</sup> a well-regarded source for clean technology trends. The battery cost reductions projected by BNEF result in a rapidly falling cost for electric vehicle ownership. However, it is reasonable to expect a lag between the costs of electric vehicles falling and rapid uptake by consumers.
- Reasons for the potentially lagging uptake of electric vehicles in Aotearoa include the small size of our new vehicle market and the fact that we drive on the left. Both of these factors restrict our access to new vehicle models. We are also heavily dependent on used vehicles imported from Japan, which limits us to used vehicles available in the Japanese fleet. Our slow fleet turnover is also a factor. Evidence also suggests that consumer behaviour does not respond only to the relative cost of ownership of electric vehicles versus conventional

<sup>7</sup> BloombergNEF (2020)

vehicles – other factors such as range anxiety or new technology hesitancy may also delay uptake.

#### 7.4.5 Emissions from transport including international transport

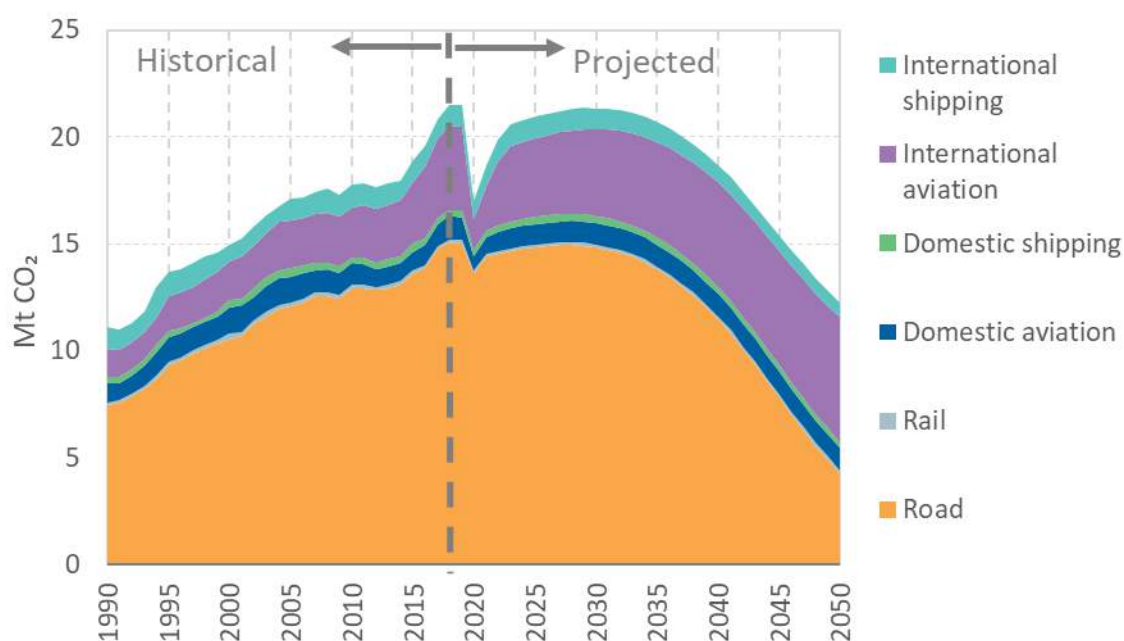


Figure 7.7: Current Policy Reference case emissions from transport including international transport

Source: Commission analysis.

Table 7.7: Current Policy Reference case emissions from transport including international transport (Mt CO<sub>2</sub>)

	2018	2020	2030	2040	2050
<b>Road</b>	15.1	13.6	14.8	11.5	4.3
<b>Rail</b>	0.1	0.1	0.1	0.1	0.1
<b>Domestic aviation</b>	1.1	0.6	1.0	1.0	1.1
<b>Domestic shipping</b>	0.3	0.3	0.3	0.3	0.3
<b>International aviation</b>	3.9	1.4	4.1	4.9	5.8
<b>International shipping</b>	1.0	0.8	1.0	0.8	0.7
<b>Total</b>	21.5	17.0	21.3	18.7	12.3

#### Notes:

- Figure 7.7 shows emissions by travel type, similar to Figure 7.3, but with the two international modes, international aviation and international shipping, added.
- Between 1990 and 2018, emissions from international transport have been a significant and growing portion of transport emissions in Aotearoa. This is mainly due to growth of international aviation emissions.
- After the COVID-19 shock, international aviation emissions are likely to resume their growth, driven by increasing numbers of overseas visitors visiting Aotearoa.

- As noted in *Chapter 3: How to measure progress*, international transport emissions are not within the scope of the first emissions budget, but we may elect to include them in later budgets. International aviation and international shipping are also already subject to specific international agreements to reduce emissions: the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) under the International Civil Aviation Organization and the greenhouse gas reduction provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) under the International Maritime Organisation.
- There is no internationally agreed approach to measuring a country's contribution to international aviation and shipping emissions. These graphs are based on purchases of bunker fuel in Aotearoa by international carriers.
- Historically, growth in international air traffic has outpaced improvements in aviation fuel efficiency, resulting in growing international aviation emissions. Although subject to significant uncertainty due to the potential long-term impacts of COVID-19, this trend is likely to resume in the future.
- International shipping emissions have not grown significantly as ship efficiency has kept pace with the relatively slow growth in international shipments. International shipping emissions are expected to decline modestly by 2050 as improving ship efficiency outpaces growth in shipments.

## 7.5 Buildings

Buildings in ENZ are represented in terms of the energy utilised in their operation. Energy used for space and water heating as well as cooking, lighting and electrical equipment are modelled explicitly within ENZ at an aggregated level for residential, commercial and public buildings.

Greenhouse gas emissions from these uses of energy and are accounted for in ENZ. Whether from gas combusted onsite in a gas boiler or from the plants which generate the electricity used in a hot water cylinder. This means that we can see from a whole energy system point of view the emissions footprint of operating our homes and workplaces.

As population and GDP increase within the model, the number of buildings and requirement for energy increase. Within the model, buildings are split into existing and future builds with varying energy efficiency opportunities, construction rates and retrofit cycles. Energy uses are disaggregated into space heating, water heating, cooking, lighting and other for each fuel type (electricity, gas, LPG, coal and biomass). In the model, consumer choice of heating technology (fossil fuel or electric) at the time of a new build or retrofit is based on relative costs of equipment and fuel. A fossil fuel phaseout profile overrides this economic based selection – this phaseout either reflects societal behavioural changes or a mandated approach.

The energy efficiency of heating in buildings and in appliances are also represented in ENZ. Efficiency measures such as improved insulation or a conversion of lighting to LEDs reduce the operational energy demand for buildings in the model.

## 7.5.1 Emissions from fossil fuel use in buildings

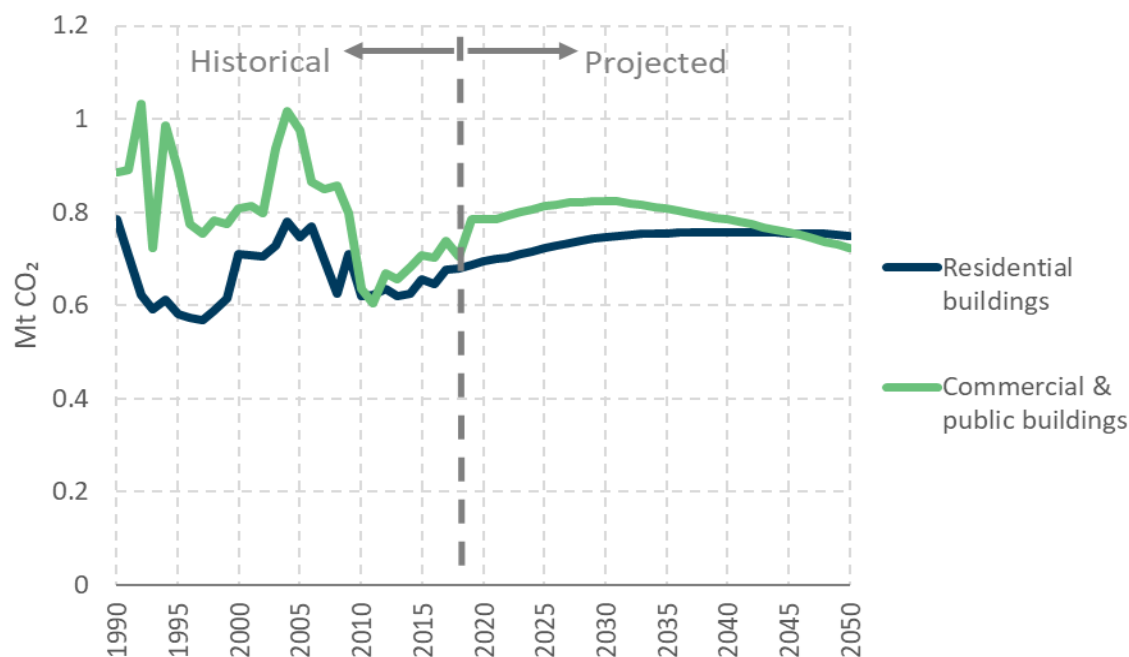


Figure 7.8: Current Policy Reference case emissions from onsite fuel use in buildings

Source: Commission analysis.

Table 7.8: Current Policy Reference case emissions from onsite fuel use in buildings (Mt CO<sub>2</sub>)

	2018	2030	2040	2050
<b>Residential buildings</b>	0.7	0.7	0.8	0.7
<b>Commercial and public buildings</b>	0.7	0.8	0.8	0.7
<b>Total</b>	1.4	1.6	1.5	1.5

### Notes:

- Direct emissions from fossil fuel use in buildings are primarily from the combustion of gas, coal and liquid fossil fuels for cooking and space and water heating in residential, commercial and public buildings.
- The annual total of these emissions has held roughly constant during the period from 1990 to 2018 at an average of 1.5Mt CO<sub>2</sub> despite a 40% increase in population and building stock.
- Figure 7.8 shows that total emissions are projected to remain roughly constant relative to 2018 and are 1.6Mt CO<sub>2</sub> at 2030 and 1.5Mt CO<sub>2</sub> at 2050.
- In this reference projection gas and LPG remain affordable fuels for heating in homes and buildings and the total number of gas connections is assumed to increase as the total building stock increases. However, despite this, combustion emissions hold relatively flat due to efficiency improvements in space and water heating system and improvements in building performance. Coal use contributes about 10% of the total emissions in 2018 and in this projection is continued to be used as there is no targeted phase out.

- Electricity use in buildings can also contribute to periods of peak demand and the usage of fossil fuelled thermal plants for electricity generation. These indirect emissions due to thermal generation are accounted for under the classification of electricity generation in this Current Policy Reference case. Similarly, there are emissions from building construction and from the materials used for construction. Construction activity, energy use and emissions are accounted for under industrial activity as are emissions from domestic industries which produce construction material.
- The buildings categorisation shown in Figure 7.1. This includes only the direct emissions from the on-site fossil fuel use in residential, commercial and public buildings. This convention is continued in the other sections of this report which present emissions totals across all sectors.

## 7.6 Heat, industry and power

Heat, industry and power includes the energy supply sector and other industrial activities which use energy and cause emissions. Within ENZ, it is this module where the supply of energy for transport, buildings and other industrial activities is represented. This includes generating electricity for heating buildings and the refining of oil into petroleum for transport.

ENZ models future industrial activity based on historic trends, assumed growth and known dependencies such as fuel costs, competition for resource and other input drivers. ENZ deploys new emissions reduction technologies when they become technologically ready and economically viable.

Much of our industrial activity which produces emissions is condensed in a small number of plants owned by a small number of firms. Several of these are modelled explicitly, such as the refinery, steel mill and aluminium smelter. Their level of future activity will be a key driver of sector emissions and is also highly uncertain. For example, during 2020, a number of firms undertook strategic reviews and may dramatically change their future operation in Aotearoa.

As it is not possible for ENZ to predict these potential step changes in activity, we conservatively assume most of these activities continue at close to current levels, with existing plants and efficiencies. The exceptions to this are the Tiwai Point aluminium smelter and methanol producing facilities which are assumed to close by the late 2020s. This reflects the signalled exit of the aluminium smelter from Aotearoa by owner Rio Tinto. Methanol production is assumed to stop in 2029, when Methanex's existing natural gas contracts expire. It is assumed Methanex ceases to produce as our largest natural gas fields near the end of their economic life.

Future energy costs and emission pricing will also be key in determining future emissions within the industrial and energy sectors. Energy and emissions pricing drives most of the modelled dynamics around industry decarbonisation in ENZ. Boiler conversion from coal to lower emissions fuels occurs in the model when the continuing operating cost of a coal boiler and paying a carbon charge rises above the costs of replacing the boiler and purchasing an alternative fuel. Practical constraints are built into the model around the regional availability of fuels and the rate at which equipment can be replaced and infrastructure can be built. Changes in rates of industrial allocation in the NZ ETS are assumed to have no effect on industrial output, nor on uptake of mitigation options, where decisions are assumed to be made based on marginal costs.

This Current Policy Reference case largely assumes future energy costs and emissions pricing are similar to current levels. Because of this, there is limited switching to lower emission fuels.

The commodities produced by our industries and consumed by our society are traded globally. For example, we export infant formula which has been produced from local milk to families in China and import televisions from China. ENZ includes assumptions on the future cost of a small number of commodities which can then influence domestic activity and emissions but does not model international trade.

In addition to this, ENZ is based on a production-based accounting of greenhouse gas emissions. This means ENZ does not capture emissions embodied in imported materials or the emissions leakage which would occur if domestic industrial activity was displaced with imported material. These are important issues and dynamics and although they are not captured in the model, they will be addressed in commentary throughout this evidence report.

### 7.6.1 Primary metal production



Figure 7.9: Current Policy Reference case emissions from primary metal production

Source: Commission analysis.

Table 7.9: Current Policy Reference case emissions from primary metal production (Mt CO<sub>2</sub>)

	2018	2030	2040	2050
<b>Iron and Steel</b>	1.8	1.7	1.7	1.7
<b>Aluminium</b>	0.6	0.0	0.0	0.0
<b>Total</b>	2.4	1.7	1.7	1.7

## Notes:

- Domestic emissions from iron and steel production are mostly from the chemical reaction which occurs between iron sand and coal to produce iron metal. From 1990 to 2018 these emissions have remained largely flat at an average of 1.7Mt CO<sub>2</sub>.
- Direct process emissions and fossil fuel use from the production of aluminium have held constant at around 0.6Mt CO<sub>2</sub> since the early 1990s. The operation largely eliminated F-gas emissions at the beginning of the displayed record. Since this time the emissions have been around 90% carbon dioxide and 10% F-gas emissions.
- Aluminium production emissions are projected to reduce from current levels to zero by 2027, where they remain out to 2050.
- This reduction is due to an assumed closure of the Tiwai Point aluminium smelter with production ramping down from 2024 to 2026. There is uncertainty of the timing of this closure – smelter owner Rio Tinto have signalled their intention to close the smelter in 2021 but it is understood they are in discussion with the Government for an extension of a further three to five years.<sup>8</sup>
- Projected emissions for iron and steel production reduce immediately in the projection and then remain constant at 1.7Mt CO<sub>2</sub> out to the end of this period. However, there is considerable uncertainty around the future emission from this activity.
- The steel mill has recently decided to cut 150-200 jobs following a strategic review.<sup>9</sup> The step reduction of 10% of emissions is an assumption around how this restructure will influence emissions in the future. Bluescope Steel (owner of NZ Steel) has signalled potential closure of the mill if restructuring and redundancies do not improve profitability.
- It is assumed that only integrated steel mill will not undergo modernisation or transformation during this period.

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<sup>8</sup> New Zealand Labour Party (2020)

<sup>9</sup> Carroll (2020)

## 7.6.2 Petrochemical production



Figure 7.10: Current Policy Reference case emissions from petrochemical production

Source: Commission analysis.

Table 7.10: Current Policy Reference case emissions from petrochemical production (Mt CO<sub>2</sub>)

	2018	2030	2040	2050
<b>Petrochemical production</b>	1.4	0.3	0.3	0.3

### Notes:

- Emissions from chemical production in Aotearoa are mostly from the combustion of natural gas in steam methane reformers to produce methanol and urea. These industries were enabled following the discovery and production of natural gas from onshore and offshore Taranaki fields. Production and emissions from these industries has closely followed the lifecycle of producing natural gas fields. The Maui field established and sustained the industry until around 2000 and the Pohokura field has ramped up since this time.
- In the reference case, the projected emissions hold at the recent average level of 1.9Mt CO<sub>2</sub> until 2026 and then drop to 0.3Mt CO<sub>2</sub> by 2029. They remain at this level until 2050.
- This step change in emissions between 2026 and 2029 is due to the assumed completion of methanol production which is in line with the end of the producing company's publicly disclosed gas contracts. It is possible that production would cease before or continue after this date, however the current rate of natural gas consumption for methanol production is incompatible with estimates of permitted natural gas reserve. Because of this, for this modelling exercise an assumption around closure date has been required. The residual emissions beyond this date are primarily from the production of urea.
- Because of the uncertainty in the level of future methanol production, there is considerable uncertainty in future emissions in chemical production.

- This projection draws on the analysis of Concept Consulting (2019) in their Long-Term Gas and Supply Reports for the Gas Industry Company.

### 7.6.3 Cement, lime and glass production

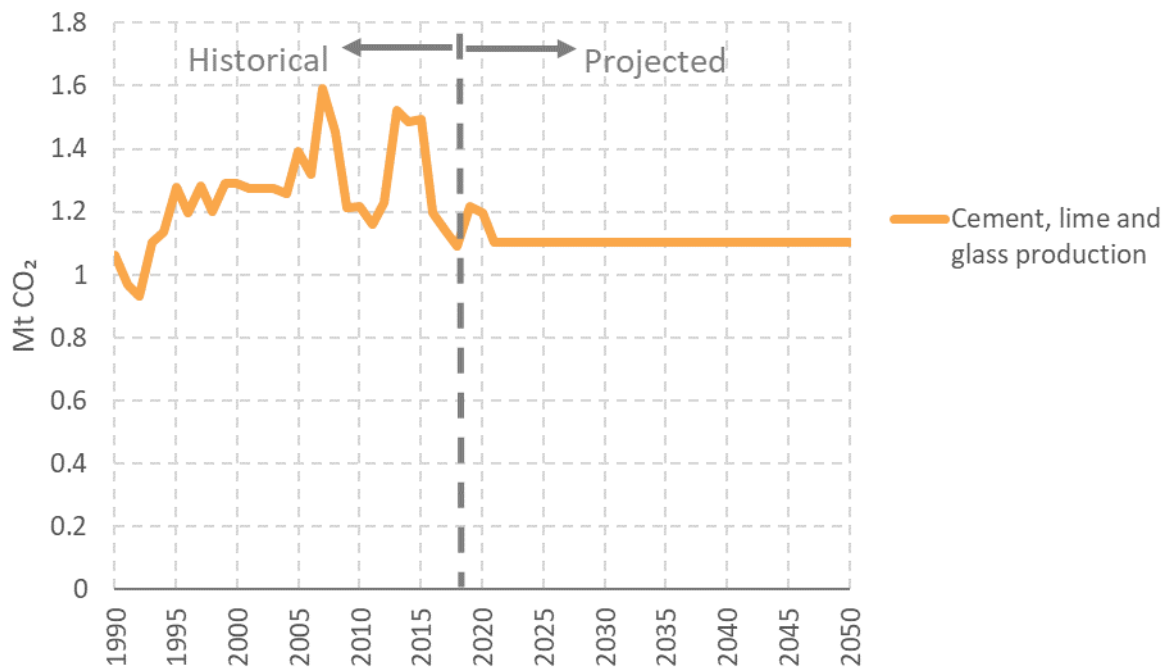


Figure 7.11: Current Policy Reference case emissions from cement, lime and glass production

Source: Commission analysis.

Table 7.11: Current Policy Reference case emissions from cement, lime and glass production (Mt CO<sub>2</sub>)

	2018	2030	2040	2050
<b>Cement, lime and glass production</b>	1.1	1.1	1.1	1.1

#### Notes:

- Carbon dioxide emissions from cement, lime and glass manufacturing are from fuel combustion for process heat and the calcination reaction which converts limestone into the desired products. Historic emissions have fluctuated slightly due to changes in plants and production but have averaged around 1.3Mt CO<sub>2</sub>.
- In the reference case, projected emissions would hold constant at 2018 levels at 1.1Mt CO<sub>2</sub>.
- Under the Current Policy Reference case, small amounts of emission reductions would be achieved in cement manufacturing through increased use of biofuels and waste materials as an alternative to coal for energy.

#### 7.6.4 Food and wood, pulp and paper processing

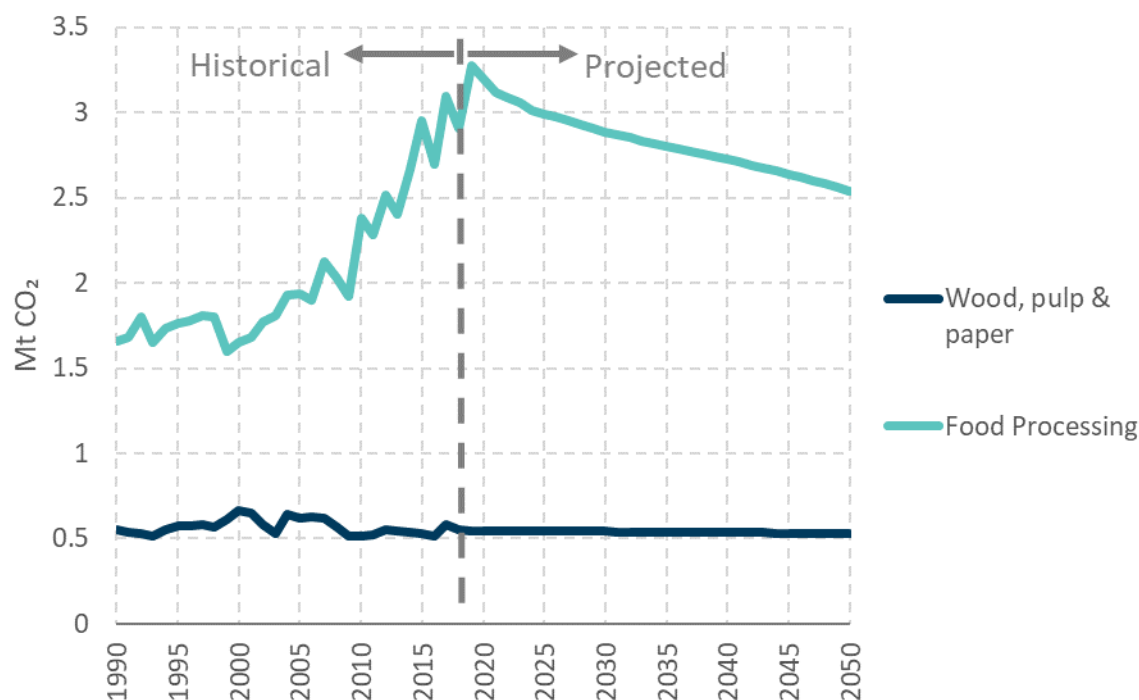


Figure 7.12: Current Policy Reference case emissions from food and wood processing

Source: Commission analysis.

Table 7.12: Current Policy Reference case emissions from food and wood processing (Mt CO<sub>2</sub>)

	2018	2030	2040	2050
<b>Wood, pulp and paper processing</b>	0.6	0.5	0.5	0.5
<b>Food processing</b>	2.9	2.9	2.7	2.5
<b>Total</b>	3.5	3.4	3.3	3.1

#### Notes:

- Emissions in food processing and wood, pulp and paper manufacturing are largely from the combustion of coal, gas and diesel for process heat. Food processing emissions have increased considerably over the historic period largely due to increases in total dairy production. Wood, pulp and paper processing emissions have remained constant over this period despite increases in production of wood products.
- In the reference case, projected emissions in food processing would peak at 3.3Mt CO<sub>2</sub> in 2019 and then would reduce to 2.9Mt CO<sub>2</sub> in 2030 and 2.5Mt CO<sub>2</sub> by 2050.
- This Current Policy Reference projects peak agricultural milk production would occur in 2019 and maximum processing emissions would be concurrent with this. Beyond this, total production would be largely constant, but emissions would reduce at around 0.7% per year due to assumed improvements in energy efficiency and plant modernisation.

- Projected emissions in wood, pulp and paper processing would remain constant at around 0.6Mt CO<sub>2</sub> despite increases in production as increasing energy demand would be offset by greater use of biomass as a fuel.

### 7.6.5 Electricity generation

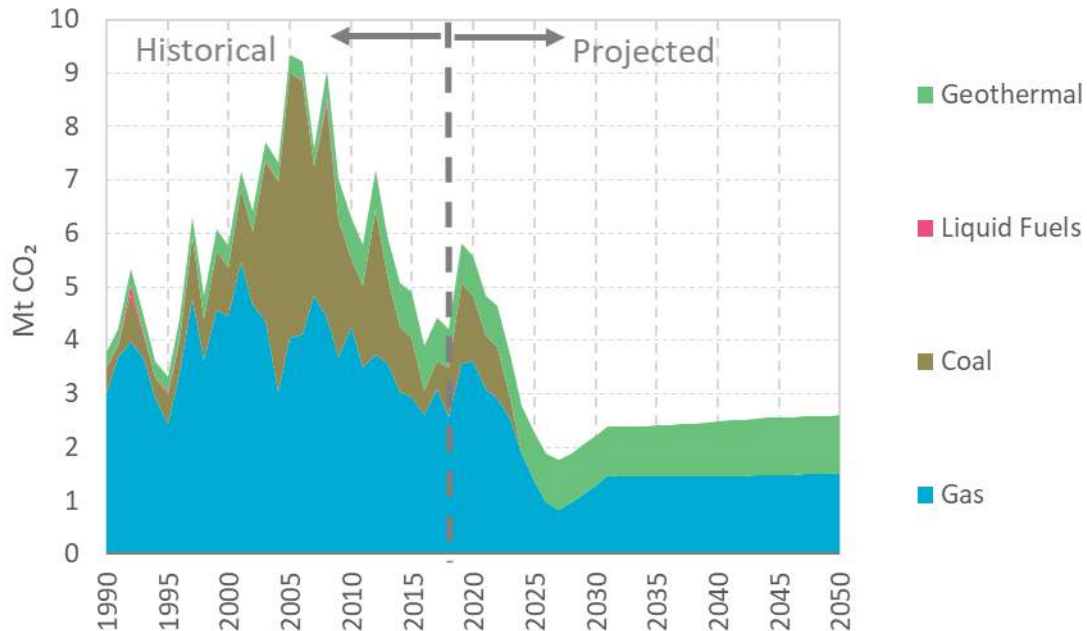


Figure 7.13: Current Policy Reference case emissions from electricity generation by fuel

Source: Commission analysis.

Table 7.13: Current Policy Reference case emissions from electricity generation by fuel (Mt CO<sub>2</sub>)

	2018	2030	2040	2050
<b>Gas</b>	2.5	1.3	1.4	1.5
<b>Coal</b>	0.9	0.0	0.0	0.0
<b>Liquid Fuels</b>	0.0	0.0	0.0	0.0
<b>Geothermal</b>	0.7	0.9	1.0	1.1
<b>Total</b>	4.2	2.2	2.5	2.6

#### Notes:

- Past emissions from electricity generation have been primarily from the use of coal and gas used in thermal generation plants. The amount of coal and natural gas used depends on electricity demand and climatic conditions. Electricity demand changes depending on the time of day, with daily peaks in the morning and evening. Demand also varies with the season and is generally higher in winter than in summer. Electricity emissions tend to be higher in years when hydro storage is low and more fossil fuels are used to meet the shortfall in generation.
- Geothermal electricity generation also contributes to overall electricity emissions, but average emissions per kilowatt-hour are about a quarter that of natural gas, with substantial variation from field to field. Electricity generation emissions peaked at 9.5Mt CO<sub>2</sub> in 2005.

- Under the reference case, emissions would be projected to decrease from 4.2Mt CO<sub>2</sub> in 2018 to 2.2Mt CO<sub>2</sub> in 2030 and 2.6Mt CO<sub>2</sub> in 2050 despite a 40% increase in total electricity generation. The system operates at between 92% and 94% renewables from 2028.
- Projected generation emissions would be at a minimum at around 2027. This is a consequence of the assumed closure of the aluminium smelter which would release a surplus of hydroelectricity to the market and temporarily displaces some use of gas.
- Geothermal, wind and solar generation would provide increases in electricity supply and would also further displace thermal generation as they would become increasingly affordable to build. Residual emissions beyond 2030 would be from the use of gas for dry year firming and peaking, and from geothermal fields. This is shown in Figure 7.14.
- These emissions and electricity generation totals include cogeneration plants.

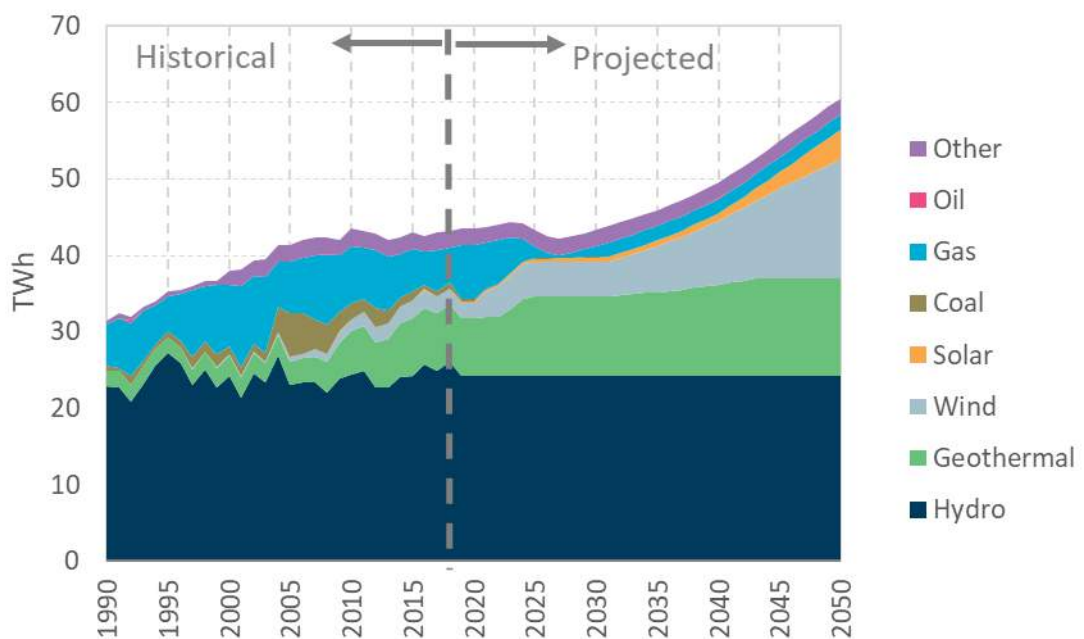


Figure 7.14: Current Policy Reference case electricity generation by fuel type

Source: Commission analysis.

## 7.6.6 Fossil fuel production



Figure 7.15: Current Policy Reference case emissions from fossil fuel production

Source: Commission analysis.

Table 7.14: Current Policy Reference case emissions from fossil fuel production (Mt CO<sub>2</sub>e)

	2018	2030	2040	2050
<b>Refining</b>	1.0	0.8	0.8	0.8
<b>Other fossil fuel production</b>	1.3	0.7	0.7	0.7
<b>Total</b>	2.3	1.7	1.7	1.5

### Notes:

- Emissions from fossil fuel production are mostly from petroleum refining and oil and gas production. Oil and gas production emissions result from operational venting and flaring of carbon dioxide and fugitive emission of methane at wells and in pipelines – these emissions have fluctuated over the historic period. Refining emissions have remained largely constant and have averaged 1Mt CO<sub>2</sub>e per year since 1990.
- Total emissions from these activities are projected to decrease from 2.3Mt CO<sub>2</sub>e in 2018 to 1.7Mt CO<sub>2</sub>e in 2030 and 1.5Mt CO<sub>2</sub>e in 2050.
- The reduction in production emissions out to 2030 is largely due to a 50% downscale in domestic natural gas production due to reduced demand for electricity generation and the assumed completion of methanol production in 2029. Uncertainty around the level of future of domestic methanol production contributes uncertainty to this projection.
- Refining activity and emissions reduced in 2020 to 20% below current levels and then holds constant until the end of the projection.

- The refinery has recently announced it will cut back production volumes to 1995 levels and this initial reduction represents this restructure. Beyond this the emissions remain constant despite a reduction in demand for petroleum for transport because it is assumed that the 40% of current petroleum which is imported refined is displaced before the domestic processing is reduced. The refinery’s future operations is still uncertain and introduces uncertainty in this projection.

### 7.6.7 Motive power - mining, construction and agriculture

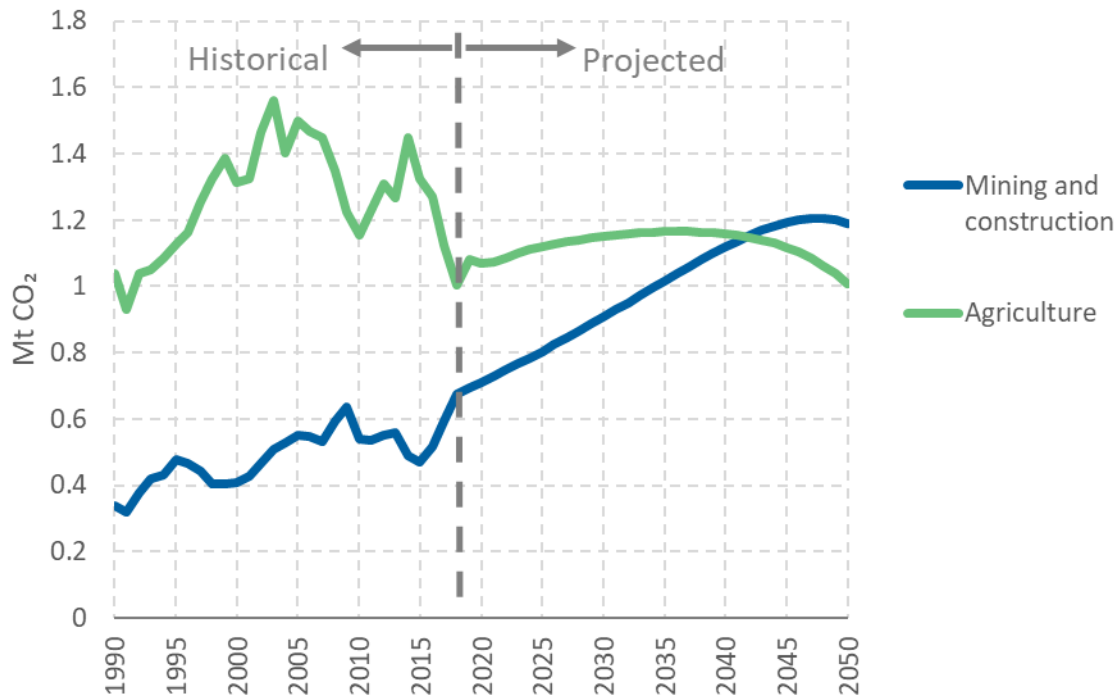


Figure 7.16: Current Policy Reference case motive power emissions

Source: Commission analysis.

Table 7.15: Current Policy Reference case motive power emissions (Mt CO<sub>2</sub>)

	2018	2030	2040	2050
<b>Mining and construction</b>	0.7	0.9	1.1	1.2
<b>Agriculture</b>	1.0	1.2	1.2	1.0
<b>Total</b>	1.7	2.1	2.3	2.2

Notes:

- Motive power emissions are generated by liquid fossil fuel use in the mining, quarrying, construction, agriculture, forestry and fishing sectors. This is primarily diesel for use in machinery and off-road vehicles. There are a diverse set of use cases including mining trucks, farm machinery and fishing vessels. The totals here include the entire share of liquid fuel used in agriculture and the mining and construction sectors.<sup>10</sup>

<sup>10</sup> The Energy Efficiency and Conservation Authority (EECA)’s end use database substantiates that liquid fuel use in these sectors is overwhelmingly for motive power (Energy Efficiency and Conservation Authority, 2020).

- Total emissions have fluctuated over the historic period but with an average of 1.8Mt CO<sub>2</sub> per year.
- Total emissions are projected to increase from 1.8Mt CO<sub>2</sub> in 2018 to 2.0Mt CO<sub>2</sub> in 2030 and to 2.3Mt CO<sub>2</sub> by 2050.
- The increase in emissions is due to an assumed increase in activity in the mining, quarrying and construction sectors at a rate of 2.5% per year. This growth is a continuation of the historic trend and consistent with requirements for infrastructure and building projects to support a growing population. Energy demand in the agricultural and forestry sectors is assumed to be constant at current levels. There is a downwards turn in emissions beyond 2040 as electric vehicles and machinery begin to become available and economic for these use cases.

### 7.6.8 Residual emissions

*Table 7.16: Current Policy Reference case residual emissions (Mt CO<sub>2</sub>)*

	<b>2018</b>	<b>2030</b>	<b>2040</b>	<b>2050</b>
<b>Residual</b>	0.8	0.8	0.8	0.7

#### Notes:

- In addition to the emissions broken out in the above transport, buildings and industry sectors, there is a total of emissions which have not been allocated to a specific sector and activity. Most of this is classified as 'other industry' in New Zealand's Greenhouse Gas Inventory classification. For these emissions we note that:
  - Historical emissions have ranged from 0.7Mt CO<sub>2</sub> to 1.9Mt CO<sub>2</sub>.
  - Projected emissions largely hold at the 2020 value of 0.8Mt CO<sub>2</sub>.
  - For these emissions we coarsely assume that liquid fuel use would decarbonise at the same rate as motive power applications in the mining, construction and ag sectors. Solid and gas fuel use would transition fuel use in the same way as the food processing sector.

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There is, however, sparse data on non-transport uses of liquid fuel. EECA have identified this as an information gap and is targeting improving the evidence base on these energy uses with a project in 2021.

## 7.7 Land

ENZ contains the area and emissions associated with the following land uses. While these are not the only land uses that contribute to emissions or emissions removals, they make the biggest contribution towards emissions budgets and targets.<sup>11</sup>

The land uses included in ENZ are:

- Sheep, beef and deer farming<sup>12</sup>
- Dairy farming
- Horticulture
- Arable farming
- Exotic forest (pre-1990 and post-1989)
- New native forest (Post-1989)
- Other<sup>13</sup>

ENZ models land in Aotearoa at a national level. However, also understanding the uses of Māori collectively-owned land would be a valuable layer in the analysis. Data limitations mean it is not possible to consider specific projections for Māori collectively-owned land out to 2050 but relevant information about Māori collectively-owned land is considered alongside the reference case projections. What is known is that some iwi/Māori-collectives own large tracts of land and could face challenges transitioning land use. The Crown needs to work in partnership with iwi/Māori-collectives to understand their aspirations for land, particularly forestry, and the barriers to achieving these.

We use ENZ to generate our Current Policy Reference case using land areas and livestock numbers from the Ministry for Primary Industries (MPI) October 2020 data update for their “with existing measures” scenario. This input data reflects important recent policy developments, such as the National Policy Statement for Freshwater Management and amendments to the Emissions Trading Scheme (NZ ETS) passed by Government in 2020. The key model underlying this activity data is MPI’s Pastoral Supply Response Model, which projects trends in animal populations, primarily in response to export prices, productivity trends and the returns on agricultural land relative to forestry.

Fertiliser emissions are attributed to the land use where it is applied. In the reference case, the 2017 fertiliser use per hectare for each land use is assumed to be constant until 2050. The percentage of fertiliser used on each farming system is taken from the Fertiliser Association, who draw on the Stats NZ 2017 Agricultural census.<sup>14</sup> The same split among land uses is also applied to emissions from liming and urea on farms.

A level of ongoing productivity gains is also assumed for land uses in the reference case but there is no adoption of new technologies such as methane inhibitors or vaccines for ruminants. The impact of these technologies is investigated in future policy scenarios presented in *Chapter 8: What our future could look like*.

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<sup>11</sup> Pre-1990 native forest area is not modelled as emissions removals from it are not part of emissions accounting for the first set of emissions budgets. Deforestation emissions from these forests are included, however, but do not require a full modelling of the total land area. For a full discussion of forest accounting see *Chapter 3: How to measure progress*.

<sup>12</sup> Area used for production, not whole owned area.

<sup>13</sup> “Other” land is a broad category that includes other types of farming and areas of land on-farm that are not in pasture, crops, or forest.

<sup>14</sup> Fertiliser Association (2019)

Our Current Policy Reference case land emissions projections are similar but not identical those from MPI models, as shown in the 7.9 Comparisons with other projections section later in this chapter.

### 7.7.1 Agriculture emissions - biogenic methane

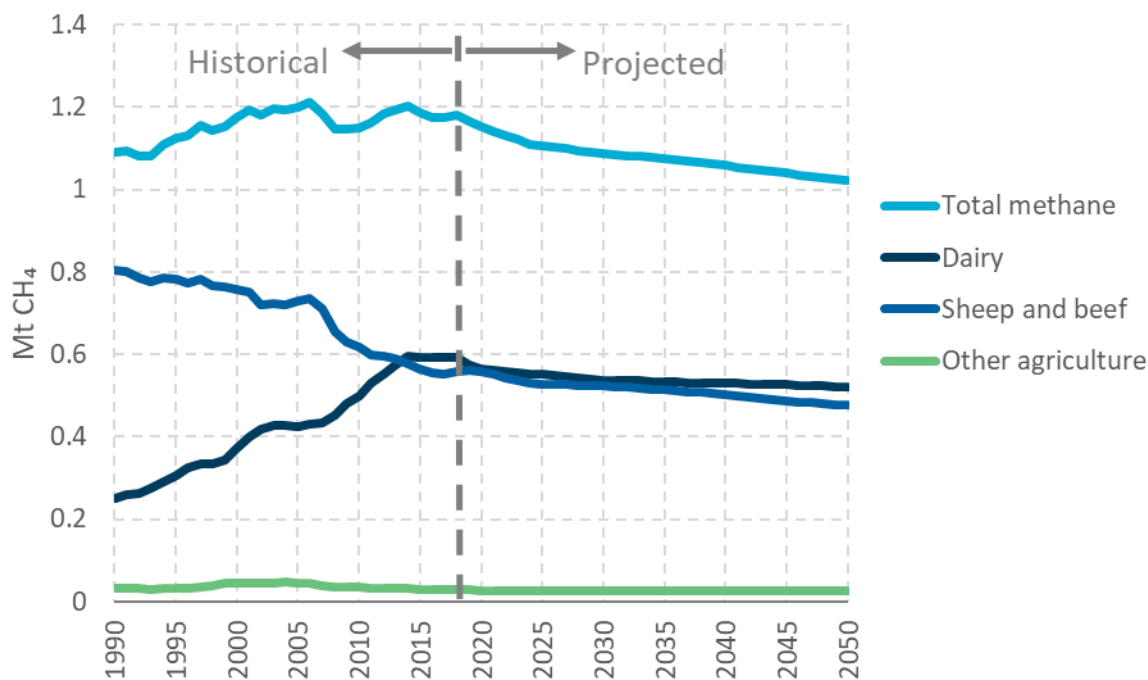


Figure 7.17: Current Policy Reference case biogenic methane emissions from agriculture

Source: Commission analysis.

Table 7.17: Current Policy Reference case biogenic methane emissions from agriculture (Mt CH<sub>4</sub>)

	2018	2030	2040	2050
<b>Dairy</b>	0.59	0.54	0.53	0.52
<b>Sheep and beef</b>	0.56	0.52	0.50	0.48
<b>Other agriculture</b>	0.03	0.03	0.03	0.02
<b>Total</b>	1.18	1.09	1.06	1.02

#### Notes

- Agricultural biogenic methane emissions largely come from dairy and sheep and beef farming.
- From 1990 to 2018, biogenic methane emissions from dairy farming increased significantly from 0.25Mt CH<sub>4</sub> to 0.59Mt CH<sub>4</sub>. Sheep and beef biogenic methane emissions declined from 0.81Mt CH<sub>4</sub> to 0.59Mt CH<sub>4</sub>. Biogenic methane emissions from other agriculture stayed constant at approximately 0.03Mt CH<sub>4</sub> in the same period.
- In the Current Policy Reference case, total agricultural biogenic methane emissions decline steadily from 1.18Mt CH<sub>4</sub> in 2018 to 1.02Mt CH<sub>4</sub> in 2050.
- Within this reference case total, dairy biogenic methane emissions decline to 0.54Mt CH<sub>4</sub> in 2030 and 0.52Mt CH<sub>4</sub> in 2050. Sheep and beef biogenic methane emissions decline from to

0.52Mt CH<sub>4</sub> in 2030 and 0.48Mt CH<sub>4</sub> in 2050. For other types of agriculture, biogenic methane emissions reduce to 0.02Mt CH<sub>4</sub> in 2050. These are mostly from deer farming.

- These reductions are primarily driven by a combination of ongoing emissions intensity improvements and land use change. Biogenic methane emissions per kilogram of milk solids and sheep and beef meat decline by an average annualised rate of 0.6% and 1.0%, respectively. The rate slowly reduces towards 2050. This is in line with or slightly more conservative than historic trends, which have seen methane emissions efficiency improvements of approximately 1.0% per year across both dairy and meat farming since 1990. These improvements are due to a combination of animal genetics, farm management practices and structural changes in the sector such as less efficient producers exiting the market.
- Land use change includes slight decreases in dairy land over time and more substantial decreases in sheep and beef land (although at a much slower rate than historic trends). Details of land use change are provided in the 7.7.4 *Agricultural and forest land area* section below.
- These national trends may be different on Māori collectively-owned land, where governance strategic priorities, management practices and owners' aspirations differ from other farms in Aotearoa. For example, there is some evidence that Māori collectively-owned farms have lower animal stocking rates than the national average<sup>15</sup>.
- This could mean that emissions reductions linked to stocking rates on Māori collectively-owned land might plateau earlier as the potential for further reductions are exhausted.

### 7.7.2 Agriculture emissions - nitrous oxide

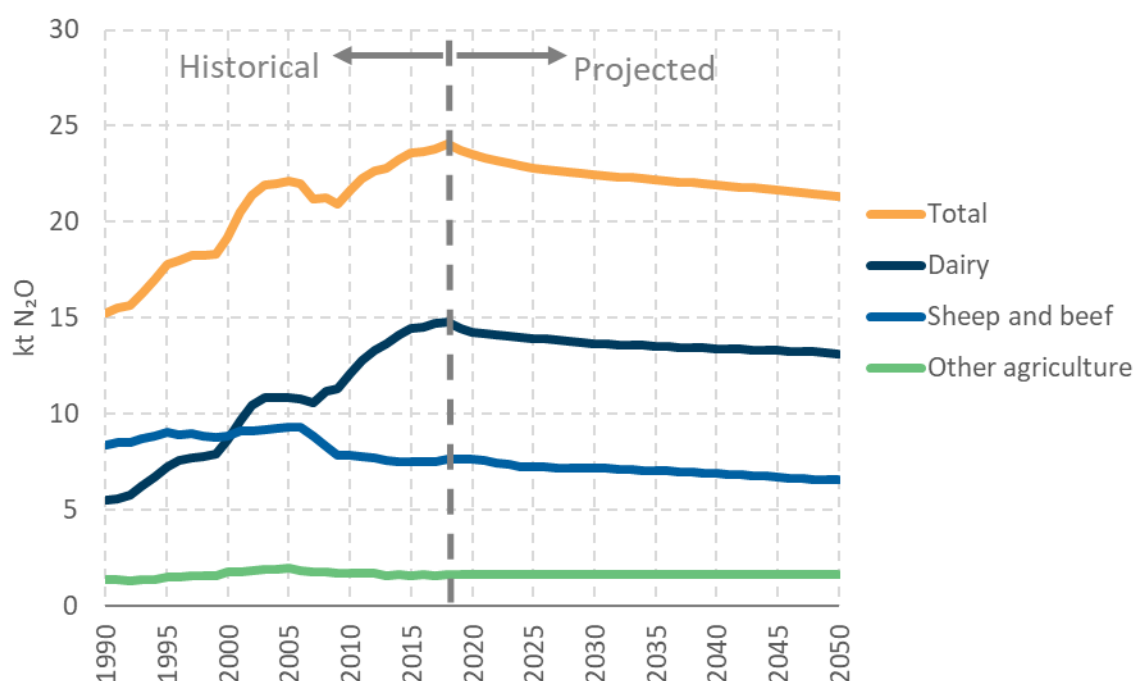


Figure 7.18: Current Policy Reference case nitrous oxide emissions from agriculture

Source: Commission analysis.

<sup>15</sup> Stats NZ (2020)

Table 7.18: Current Policy Reference case nitrous oxide emissions from agriculture (kt N<sub>2</sub>O)

	2018	2030	2040	2050
<b>Dairy</b>	14.8	13.6	13.4	13.1
<b>Sheep and beef</b>	7.6	7.2	6.9	6.6
<b>Other agriculture</b>	1.6	1.6	1.6	1.6
<b>Total</b>	24.1	22.4	21.9	21.3

Notes:

- Agricultural nitrous oxide emissions largely come from animal urine patches and, to a lesser extent, fertiliser use and manure management.
- From 1990 to 2018, nitrous oxide emissions from dairy farming increased significantly from 5.5kt N<sub>2</sub>O to 14.8kt N<sub>2</sub>O. Sheep and beef nitrous oxide emissions declined from 8.4kt N<sub>2</sub>O to 7.6kt N<sub>2</sub>O. Nitrous oxide emissions from other agriculture stayed relatively constant at 1.6kt N<sub>2</sub>O during this period.
- In the Current Policy Reference case, total agricultural nitrous oxide emissions decline from 24.1kt N<sub>2</sub>O in 2018 to 21.3kt N<sub>2</sub>O in 2050. Dairy nitrous oxide emissions decline from 2018 levels to 13.6kt N<sub>2</sub>O in 2030 and 13.1kt N<sub>2</sub>O in 2050. Sheep and beef nitrous oxide emissions decline to 7.2kt N<sub>2</sub>O in 2030 and 6.6kt N<sub>2</sub>O in 2050. Nitrous oxide emissions from other types of stay roughly constant.
- These reductions are primarily driven by a combination of ongoing efficiency gains and land use change. Nitrous oxide emissions per kilogram of milk solids and sheep and beef meat decline between 2018-2050 at an annualised average rate of 0.5% and 0.9%, respectively. The rate slowly reduces towards 2050 and is similar to historic trends. These improvements are due to a combination of animal genetics, farm management practices and structural changes in the sector such as less efficient producers dropping out of the market. Details of land use change are provided in the *Agricultural and forest land area* section below.
- The distinct trends on Māori collectively-owned land, mentioned above, in relation to biogenic methane would also apply to nitrous oxide. For example, Māori collectively-owned farms used an average of 22 tonnes of fertiliser per hectare of grassland in 2018, compared to 28 for farms in Aotearoa as a whole.<sup>16</sup> This suggests fertiliser emissions reductions could be occurring more quickly on Māori collectively-owned land (possibly because of water policies in specific areas) and/or that these reductions could plateau earlier.

<sup>16</sup> Stats NZ (2020)

### 7.7.3 Agriculture emissions - carbon dioxide

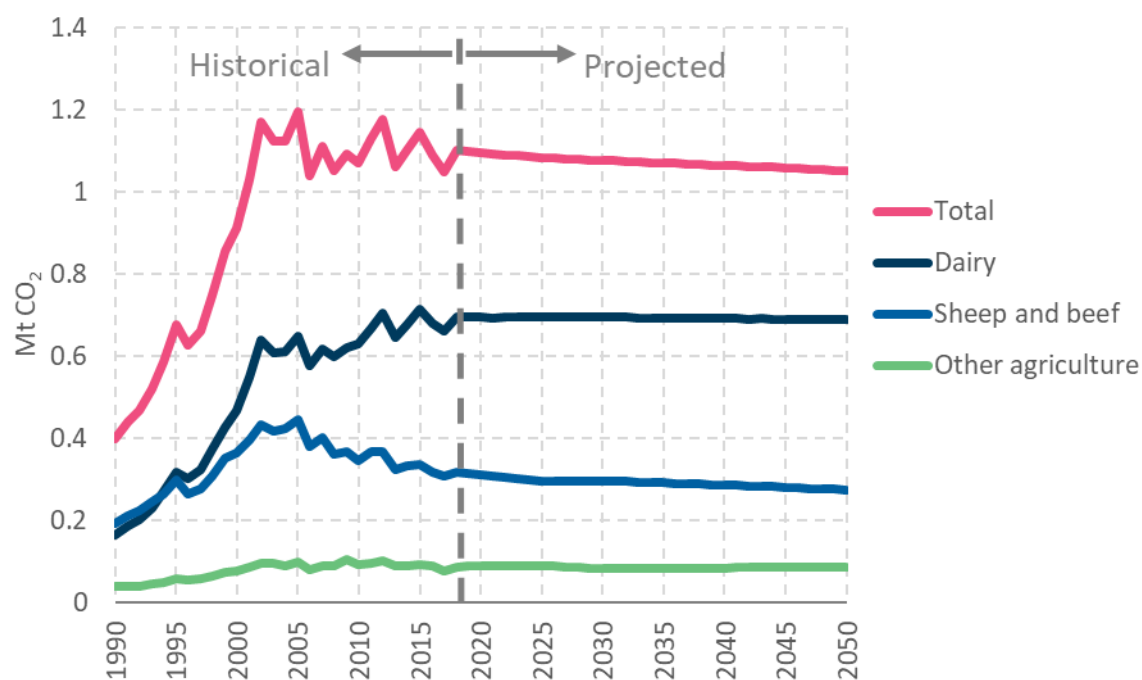


Figure 7.19: Current Policy Reference case carbon dioxide emissions by agriculture

Source: Commission analysis.

Table 7.19: Current Policy Reference case carbon dioxide emissions by agriculture (Mt CO<sub>2</sub>)

	2018	2030	2040	2050
<b>Dairy</b>	0.69	0.70	0.69	0.69
<b>Sheep and beef</b>	0.32	0.30	0.29	0.28
<b>Other agriculture</b>	0.09	0.08	0.09	0.09
<b>Total</b>	1.10	1.08	1.06	1.05

#### Notes:

- Agricultural carbon dioxide emissions come from the use of limestone and urea on soils. Emissions from electricity, transport and other energy uses on farm are not included here but in the relevant non-land sector emissions.
- From 1990 to 2018, carbon dioxide emissions from dairy farming increased significantly from 0.17Mt CO<sub>2</sub> to 0.69Mt CO<sub>2</sub>. Sheep and beef carbon dioxide emissions increased from 0.19Mt CO<sub>2</sub> in 1990 to 0.32Mt CO<sub>2</sub> in 2018. Carbon dioxide emissions from other agriculture increased from 0.04Mt CO<sub>2</sub> to 0.09Mt CO<sub>2</sub> in the same period.
- In the Current Policy Reference case, dairy carbon dioxide emissions stay relatively stable, increasing to 0.70Mt CO<sub>2</sub> in 2030 before dropping to 0.69Mt CO<sub>2</sub> in 2050. Sheep and beef carbon dioxide emissions decline to 0.30Mt CO<sub>2</sub> in 2030 and 0.28Mt CO<sub>2</sub> in 2050. Carbon dioxide emissions from other agriculture stays stable out to 2050.
- The distinct trends on Māori collectively-owned land mentioned above in relation to nitrogen fertiliser could also apply to carbon dioxide from lime and urea.

### 7.7.4 Agricultural and forest land area

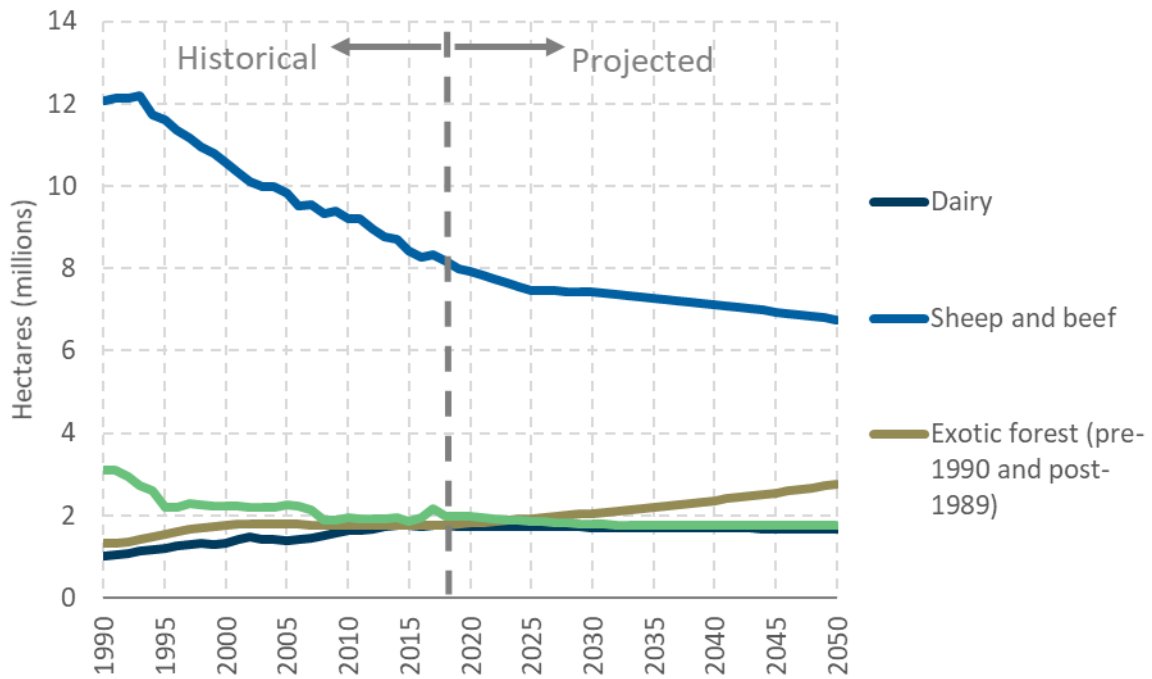


Figure 7.20: Current Policy Reference case agriculture and forest land use (large areas)

Source: Commission analysis.



Figure 7.21: Current Policy Reference case agriculture and forest land use (small areas)

Source: Commission analysis.

Table 7.20: Current Policy Reference case agricultural and forest land areas (Mha)

	2018	2030	2040	2050
Dairy	1.74	1.71	1.69	1.66
Sheep, beef and deer	8.17	7.41	7.12	6.75
Exotic forest (pre-1990 and post-1989)	1.77	2.05	2.36	2.75
New native forest (post-1989)	0.05	0.11	0.15	0.19
Horticulture	0.11	0.12	0.12	0.13
Arable	0.15	0.13	0.13	0.13
Other	1.99	1.80	1.77	1.77

Notes:

- Land use change is a key driver of emissions and removals by agriculture and forests. Different land uses make different contributions and change between them is driven by a complex set of economic, environmental, cultural and social factors.
- Between 1990 and 2018, the biggest land use change was the significant decrease in sheep and beef farming area, from 12 million hectares (Mha) to 8.15Mha. This was in large part due to the economic restructuring of the late 1980s and early 1990s and the development of more lucrative markets for dairy and forestry. Dairy farming area increased from 1Mha in 1990 to 1.74Mha in 2018. Exotic forest area increased from 1Mha in 1990 to 1.77Mha in 2018.
- Areas of horticulture and arable farming as well as new native forest did not change significantly between 1990 and 2018.
- In the Current Policy Reference case, sheep and beef farming area decreases to 7.4Mha in 2030 and 6.75Mha in 2050. This is a significantly slower rate of decrease than the historic trend. Dairy farm area decreases to 1.71Ma in 2030 and 1.66Mha in 2050. Exotic forest area increases to 2.05Mha in 2030 and 2.75Mha in 2050. New native forest area increases to 0.11Mha in 2030 and 0.19Mha in 2050
- These land use changes are likely driven by a combination of sheep and beef farms retiring unproductive land, stricter freshwater policies limiting dairy area and a higher emissions price driving more afforestation.
- The total area of exotic forest on Māori collectively-owned land would also likely increase as Treaty settlements return the remaining Crown forest licensed lands to iwi. Strategically, if there is alignment with iwi/Māori aspirations, the Crown could work in partnership with iwi and other relevant Māori-collectives to increase afforestation in the short to medium term. This approach is particularly relevant given Māori-collectives own reasonably large areas of land with potential for afforestation or optimised afforestation.
- Additionally, there are opportunities associated with forestry that would support iwi/Māori cultural drivers iwi/Māori aspirations, as increased cover of indigenous forestry would support revitalisation and preservation of indigenous biodiversity, mahinga kai species and rongoā.
- Horticulture and arable farming both occupy relatively small land areas and change slightly in the current policy reference case. Arable farming decreases in area from 0.15Mha in 2018 to 0.13Mha in 2050. Horticulture area expands slightly from 0.11Mha in 2018 to 0.13Mha in 2050.

## 7.7.5 Afforestation

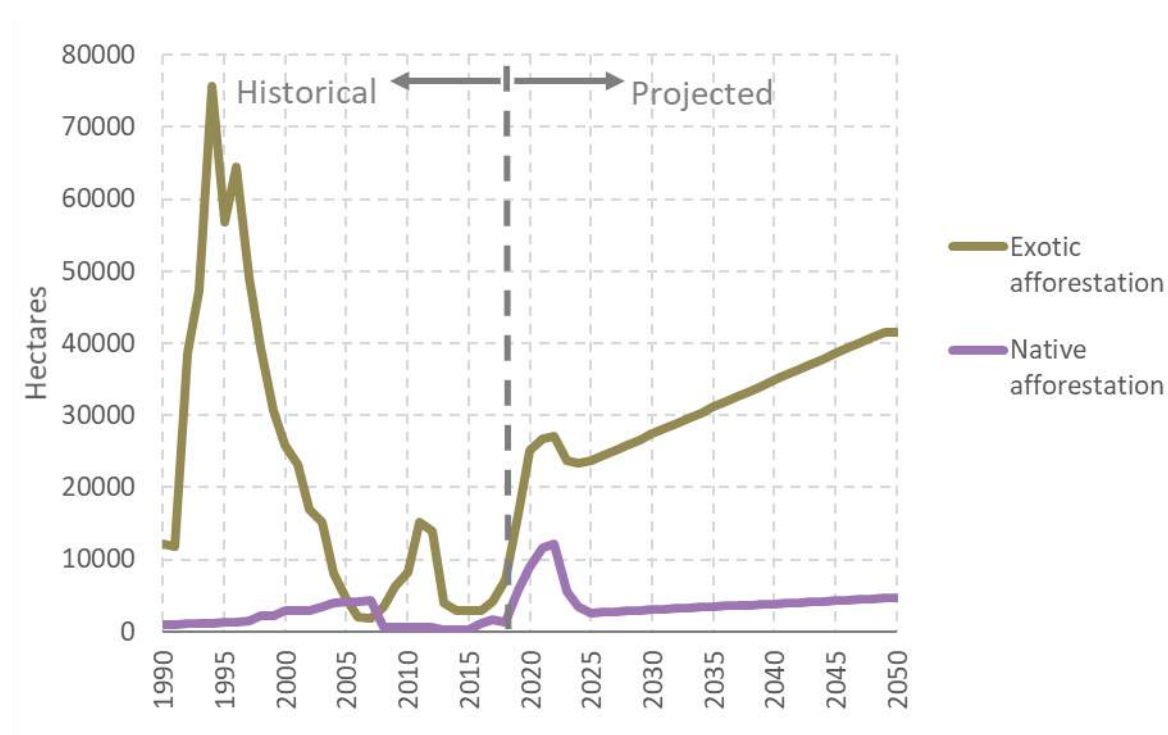


Figure 7.22: Current Policy Reference case gross afforestation

Source: Commission analysis.

Table 7.21: Current Policy Reference case gross afforestation (hectares/year)

	2018	2030	2040	2050
<b>Exotic forest</b>	7,174	27,381	34,862	41,595
<b>Native forest</b>	1,339	3,042	3,874	4,622
<b>Total</b>	8,512	30,424	38,736	46,216

Notes:

- Gross afforestation represents the increase in post-1989 exotic and native forest.
- During the 1990s, there was a large spike in afforestation, reaching over 70,000ha per year. This was followed by a period of net deforestation and low afforestation until 2018.
- In the Current Policy Reference case, most of afforestation is of exotic forests.<sup>17</sup> Exotic afforestation rates increase from 7,174ha in 2018 to 27,381ha in 2030 and 41,595ha in 2050. Native afforestation rates increase from 1,339ha in 2018 to 3,042ha in 2030 and 4,622ha in 2050. The additional spike in afforestation between 2018 and 2023 is due to the One Billion Trees afforestation grant scheme.
- The afforestation numbers are taken from MPI, who use an assumption that 90% of afforestation driven by the NZ ETS is exotic and 10% native. The data also includes an assumption that 6.1% of the exotic forests are permanent and not harvested.
- Total gross exotic afforestation in the reference case between 2018-2050 is 1.1Mha.

<sup>17</sup> Afforestation areas refer to “net-stocked” area, meaning the total area of actual forest, excluding roads and other non-forest parts of a forested area.

- Māori collectively-owned land use is likely to follow a slightly different trajectory than these national numbers. Cultural and spiritual ties with the whenua and indigenous biodiversity mean some Māori-collectives have stronger preferences for native forests over exotic forests. This means that the percentage of afforestation on Māori collectively-owned land driven by the NZ ETS that are native forests in the Current Policy Reference case is likely to be higher than the 10% nationwide number.

### 7.7.6 Deforestation

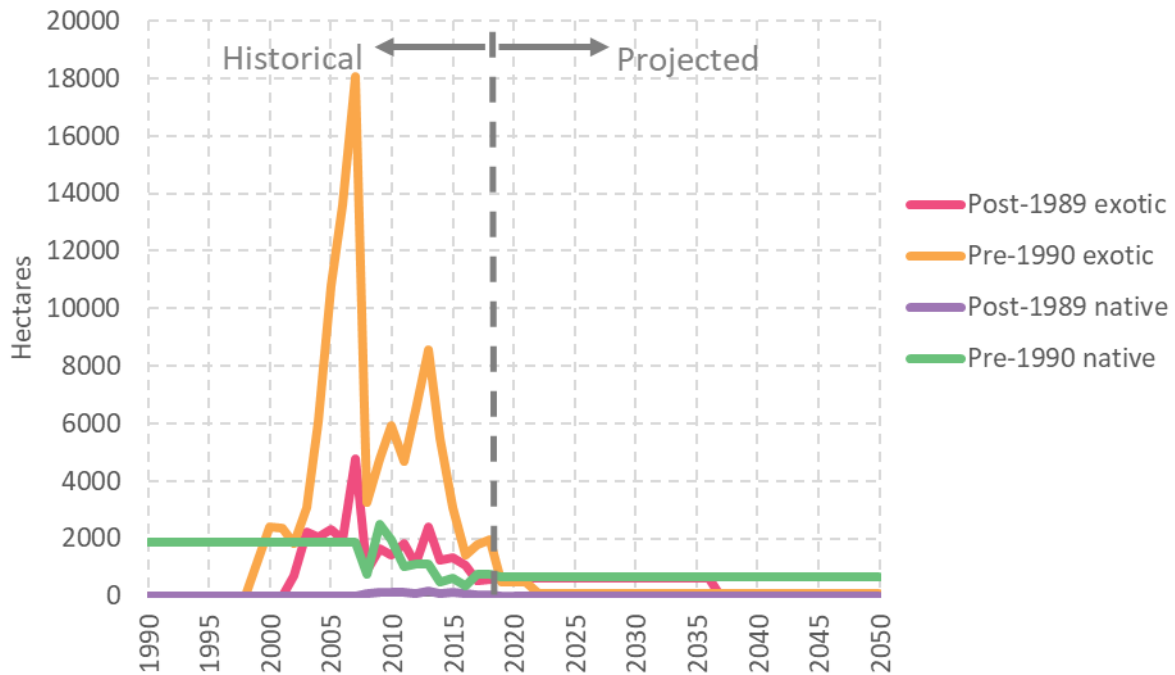


Figure 7.23: Current Policy Reference case deforestation (hectares)

Source: Commission analysis.

Table 7.22: Current Policy Reference case deforestation (hectares)

	2018	2030	2040	2050
<b>Post-1989 exotic</b>	562	620	0	0
<b>Pre-1990 exotic</b>	1941	73	73	73
<b>Post-1989 native</b>	46	0	0	0
<b>Pre-1990 native</b>	740	664	664	664
<b>Total exotic deforestation</b>	2503	693	73	73
<b>Total native deforestation</b>	786	664	664	664

Notes:

- Deforestation is when forests are removed and converted to another land use.
- In the 1990s there were spikes in deforestation in anticipation of the introduction and reforms to the NZ ETS. In 2018 there were 562ha and 1,941ha of post-1989 and pre-1990 exotic deforestation, respectively. There were 46ha and 740ha of post-1989 and pre-1990 native deforestation, respectively.

- In the Current Policy Reference case there are low levels of ongoing deforestation. Post-1989 exotic deforestation decreases to 620ha in 2030 and then 0ha from 2037 onwards. Pre-1990 exotic deforestation is stable at 73ha per year from 2023. From 2019 onwards there is no projected post-1989 native deforestation and pre-1990 native deforestation rates are constant at 664ha.

### 7.7.7 Net emissions removals by forests

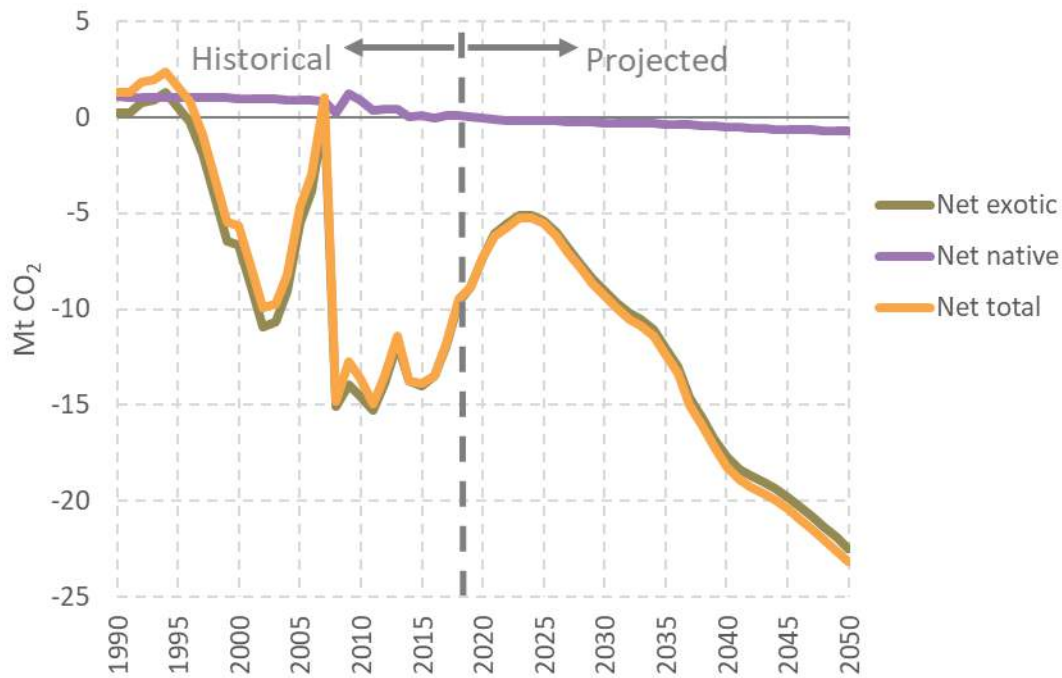


Figure 7.24: Current Policy Reference case net forest emissions

Source: Commission analysis.

Table 7.23: Current Policy Reference case net forest emissions (Mt CO<sub>2</sub>)

	2018	2030	2040	2050
<b>Exotic forest emissions removals</b>	-12	-10	-18	-23
<b>Native forest emissions removals</b>	-0.3	-0.7	-0.9	-1.1
<b>Exotic forest deforestation emissions</b>	2.20	0.67	0.07	0.07
<b>Deforestation forest deforestation emissions</b>	0.43	0.39	0.40	0.40
<b>Exotic forest net emissions</b>	-9.6	-9.1	-17.7	-22.5
<b>Native forest net emissions</b>	0.1	-0.3	-0.5	-0.7
<b>Total net forest emissions</b>	-9.5	-9.3	-18.2	-23.2

Notes:

- Net forest emissions represent the carbon sequestered by forests minus emissions associated with deforestation and land use change. Greater emissions removals result in negative net forest emissions when they exceed deforestation emissions. Net forest emissions therefore align closely with afforestation and deforestation rates.
- In the Current Policy Reference case, net forest emissions decline from -9.5Mt CO<sub>2</sub> in 2018 to -5.7Mt CO<sub>2</sub> in 2023, before steadily increasing to reach -9.3Mt CO<sub>2</sub> by 2030 and -23.2Mt CO<sub>2</sub> by 2050. Most of these net emissions removals are from exotic forests.
- Within net forest emissions, there are exotic deforestation emissions decline from 2.2Mt CO<sub>2</sub> in 2018 to 0.67Mt CO<sub>2</sub> in 2030 and to 0.07Mt CO<sub>2</sub> from 2040 onwards. Native deforestation emissions stay constant at about 0.4Mt CO<sub>2</sub> from 2018 onwards.

### 7.7.8 Forestry output

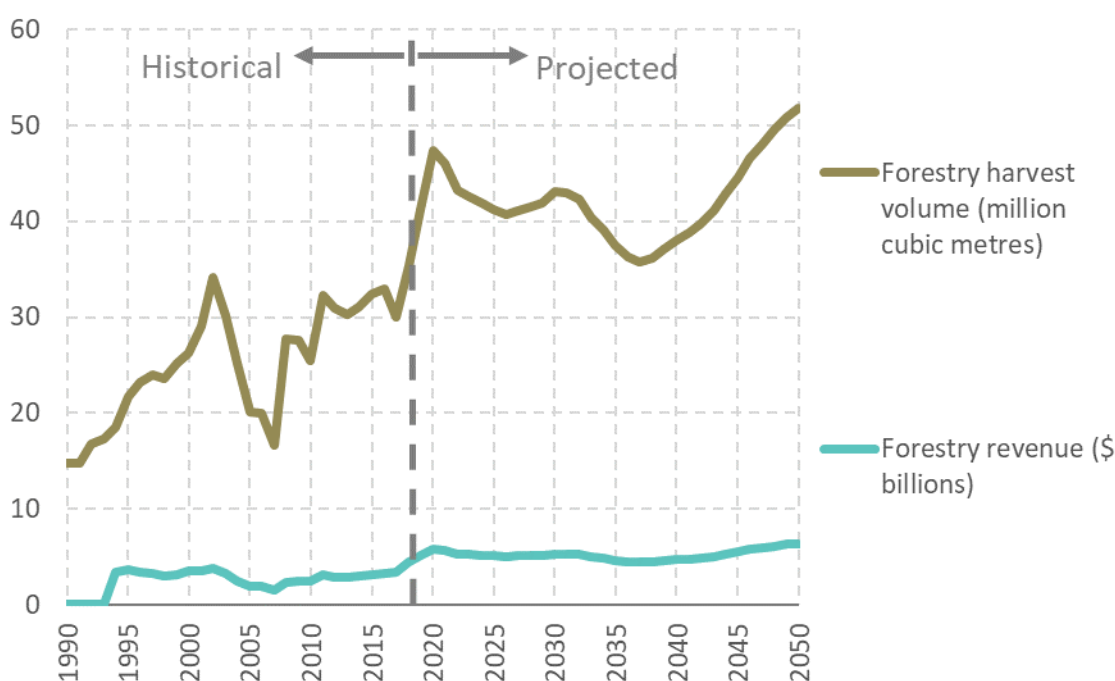


Figure 7.25: Current Policy Reference case forestry harvested volumes and revenue

Source: Commission analysis.

Table 7.24: Current Policy Reference case forestry harvested volumes and revenue

	2018	2030	2040	2050
<b>Forestry harvest volume (million cubic metres)</b>	35.3	43.0	38.0	51.8
<b>Forestry revenue (\$ billions)</b>	4.46	5.30	4.69	6.38

Notes:

- Our production forests are mostly radiata pine and produce significant volumes of harvested wood for both export and domestic use.
- Between 1990 and 2018, harvested volumes increased from 14.8 to 35.3 million cubic metres. The growth is staggered in large part because of the mixed age class of the

production forests. Forestry revenue increased from \$3.4 billion in 1994<sup>18</sup> to \$4.46 billion in 2018.

- In the Current Policy Reference case, harvested volumes increase to 43.0 million cubic metres in 2030 and 52.1 million cubic metres in 2050. Forestry revenue increases to \$5.31 billion in 2030 and \$6.42 billion in 2050. The growth in forestry output after 2030 is linked to the large projected increases exotic production forests shown above.

### 7.7.9 Sheep and beef production

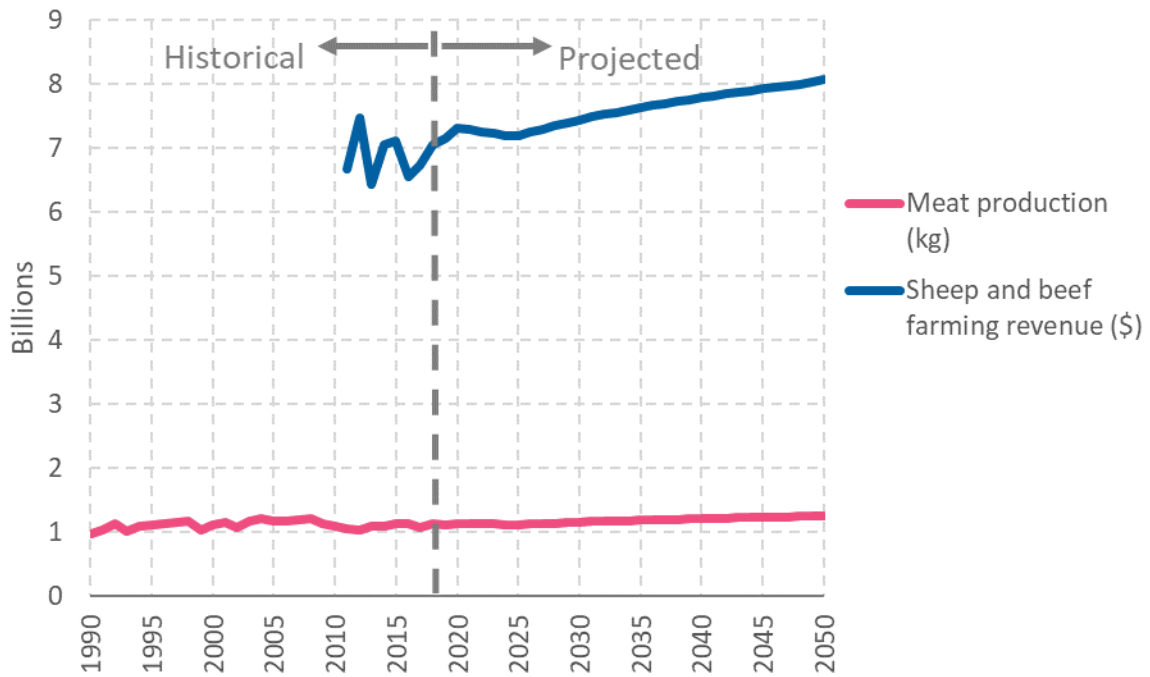


Figure 7.26: Current policy reference case sheep and beef production

Source: Commission analysis.

Table 7.25: Current policy reference case sheep and beef production

	2018	2030	2040	2050
<b>Meat production (billion kg)</b>	1.12	1.15	1.21	1.25
<b>Sheep and beef farming revenue (\$ billions)</b>	7.06	7.44	7.79	8.07

<sup>18</sup> Forestry revenue data was only available from 1994.

Notes:

- Our meat exports are primarily based on sheep and beef meat.
- Between 1990 and 2018 meat production fluctuated between 0.97 and 1.21 billion kg per year.
- In the Current Policy Reference case, meat production increases from 1.12 billion kg in 2018 to 1.25 billion kg by 2050.
- This is due to improving animal performance, with an annualised averaged productivity gains in meat production per stock unit between 2018-2050 of 1.0% in the reference case. The historical rate from 1990-2018 was 2.6%. However, these gains are partially offset by the decline in sheep and beef land area shown in the *Agriculture and forest land area* section above.
- In turn, sheep and beef revenue<sup>19</sup> is expected to increase, from \$7.06 billion in 2018 to \$7.44 billion in 2030, and \$8.07 billion in 2050.
- Revenue reflects production and the export price assumptions in Table 7.44.

### 7.7.10 Sheep and beef stock numbers

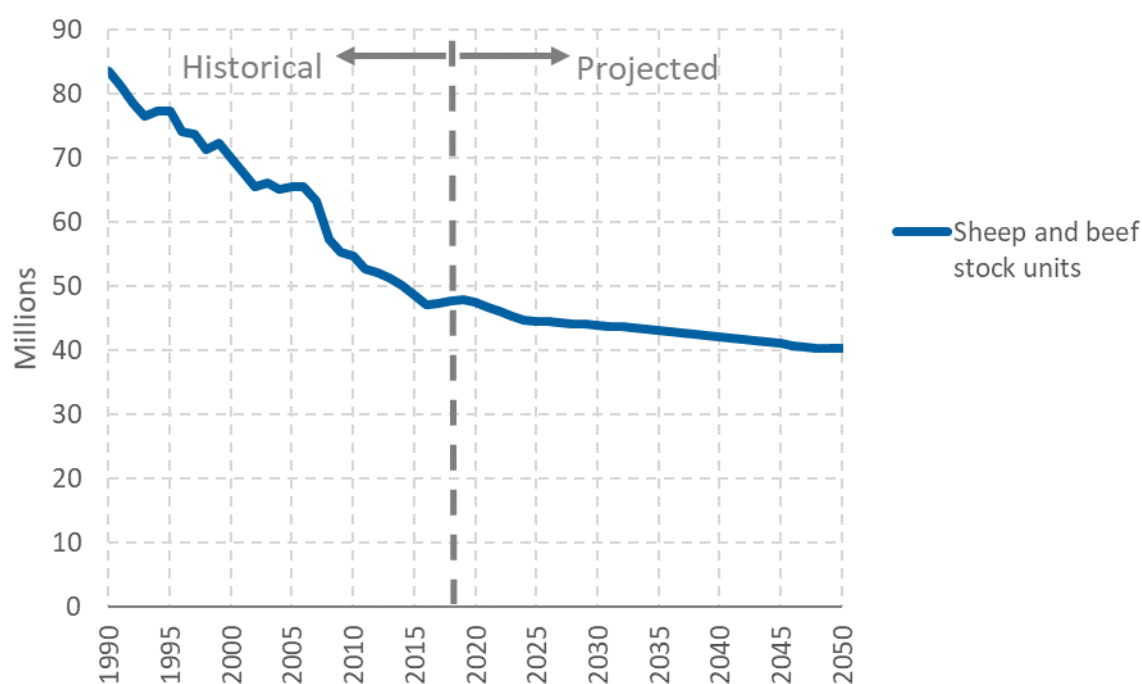


Figure 7.27: Current Policy Reference case sheep and beef stock units

Source: Commission analysis.

Table 7.26: Current Policy Reference case sheep and beef stock units (millions)

	2018	2030	2040	2050
<b>Sheep and beef stock units</b>	47.6	43.9	42.1	40.2

<sup>19</sup> Sheep and beef revenue data was only available from 2010.

Notes:

- Stock units is a measurement to standardise sheep and beef herds across animal type and size. Different types of sheep convert to between 0.7-1.0 stock units, while cattle convert to between 4.0 and 6.0.<sup>20</sup>
- Between 1990 and 2018 sheep and beef stock units decreased steadily from 83.5 million to 47.6 million. This was driven by the significant decrease in sheep and beef land area shown in Figure 7.20.
- In the Current Policy Reference case, sheep and beef stock units are expected to decline more slowly than the historical trend, in line with sheep and beef farm area. Stocking units reach 43.9 million in 2030 and 40.2 million in 2050.

### 7.7.11 Dairy production

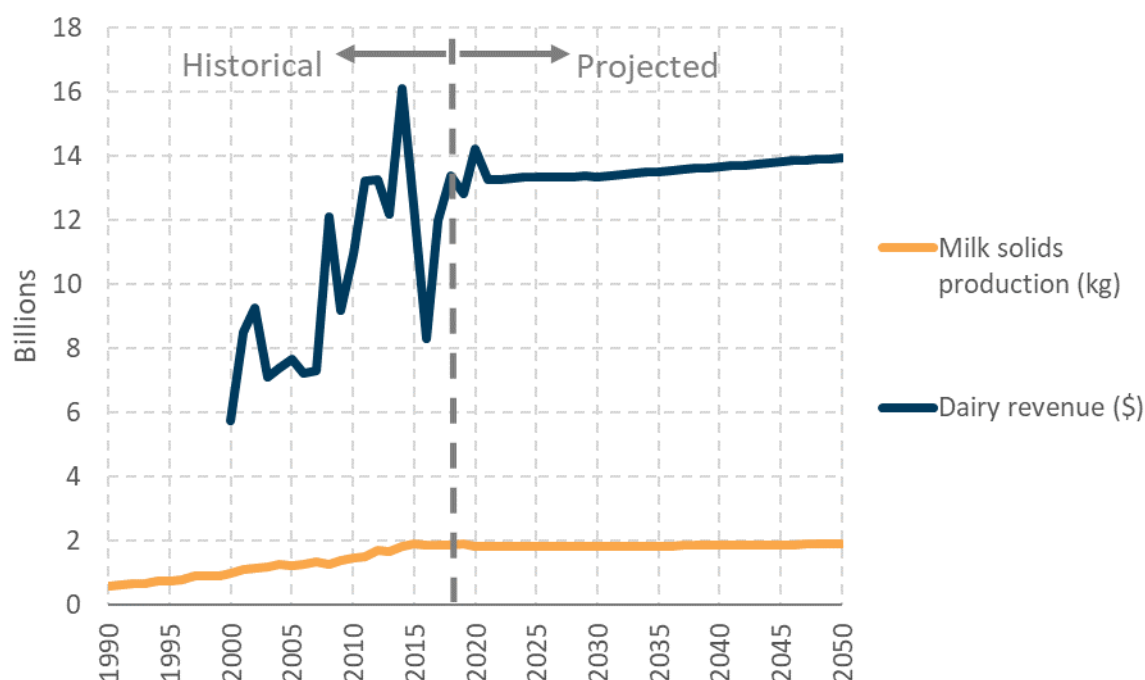


Figure 7.28: Current Policy Reference case dairy production

Source: Commission analysis.

Table 7.27: Current Policy Reference case dairy production

	2018	2030	2040	2050
<b>Milk solids (billion kg)</b>	1.84	1.81	1.85	1.89
<b>Dairy farming revenue (\$ billions)</b>	13.4	13.4	13.7	13.9

<sup>20</sup> Beef + Lamb NZ (2017, p. 21) and BakerAg (2018). Animal numbers were provided by MPI and converted into stock units by our team.

Notes:

- Dairy products are some of our leading exports and production typically measured in terms of kilograms of milk solids.
- Between 1990 and 2018, milk solids production increased steadily, from 600 million kg milk solids to 1.84 billion.
- This is driven by both productivity gains and a growing area of land dedicated to dairy farming. The average annualised growth of milk solids production per milking cow between 2018-2050 is 0.7% in the reference case. This compares to 1.6% for the period 1990-2018.
- Dairy revenue follows a similar trend to production.<sup>21</sup> It increases steadily from 1990 to 2018, varying due to changes in export prices and reaching \$13.39 billion in 2018.
- In the Current Policy Reference case, milk solids production decreases to 1.81 billion kg in 2030 but increases to 1.89 billion kg in 2050. Dairy revenue follows a similar trend, reaching \$13.9 billion in 2050.

7.7.12 Dairy milking cows

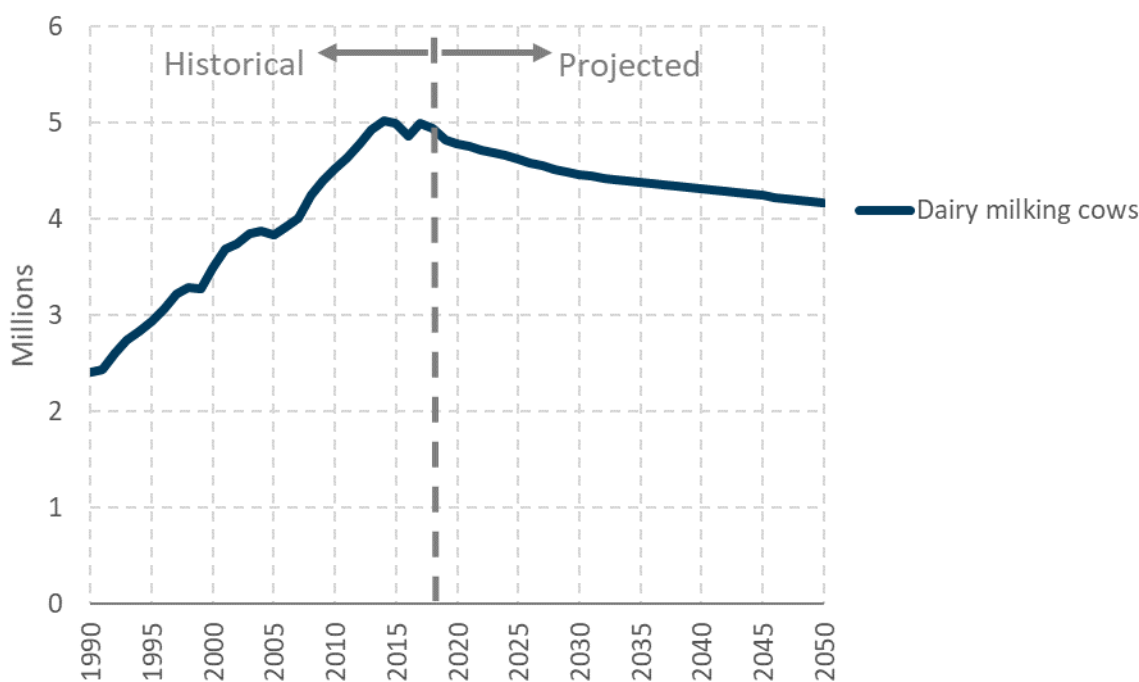


Figure 7.29: Current Policy Reference case dairy stock numbers

Source: Commission analysis.

Table 7.28: Current Policy Reference case dairy milking cows (millions)

	2018	2030	2040	2050
<b>Dairy milking cows</b>	4.95	4.45	4.31	4.16

<sup>21</sup> Dairy revenue data was only available from 2000.

Notes:

- Dairy stock numbers are measured in terms of milking cows.
- Between 1990 and 2018 the number of milking cows increased substantially in line with the increasing land area used for dairy farming. Milking cows increased from 2.65 million in 1990 to 4.95 million in 2018.
- In the Current Policy Reference case milking cow numbers are expected to decrease to 4.45 million in 2030 and 4.16 million in 2050.
- This decrease is due to a combination of declining in dairy farming land area shown in the 7.7.4 *Agricultural and forest land* area section and some decreases in animal stocking rates.

## 7.8 Waste

For the waste sector, ENZ draws on the Ministry for the Environment's (MfE) "with existing measures" scenario modelling and assumptions for both future volumes and destinations of waste, and the current use of different emissions reduction technologies. These Government projections estimate what might occur in the waste sector if existing policies and measures are maintained.

It models the main parameters which affect waste generation and waste emissions: how much waste ends up in landfill sites, how much waste can be recovered from landfill and how widespread and efficient gas capture systems are at disposal sites.

ENZ includes the broad categories of disposal sites: municipal with landfill gas (LFG) capture, municipal with no LFG capture, non-municipal landfills and farm fills. It also includes other waste disposal end points including biological treatment (composting), anaerobic digestion and open burning/incineration.

The Current Policy Reference case assumes that in the absence of further support and direction from Government, that waste reduction and waste recovery rates remain low and that there are no expansion of gas sites or increases in the average gas recovery rate.

Please note that all information in this section are provisional as the CCC has not been able to access the latest version of the updated calculations for the upcoming Greenhouse Gas Inventory due to Tier 1 statistics limitations. Our staff have done some analysis based on the 4<sup>th</sup> Biennial Report which gives a rough idea of overall biogenic methane emission trends in waste but may change for the final report depending on updated information from the 2021 update of the Greenhouse Gas Inventory.

## 7.8.1 Waste Emissions by Category

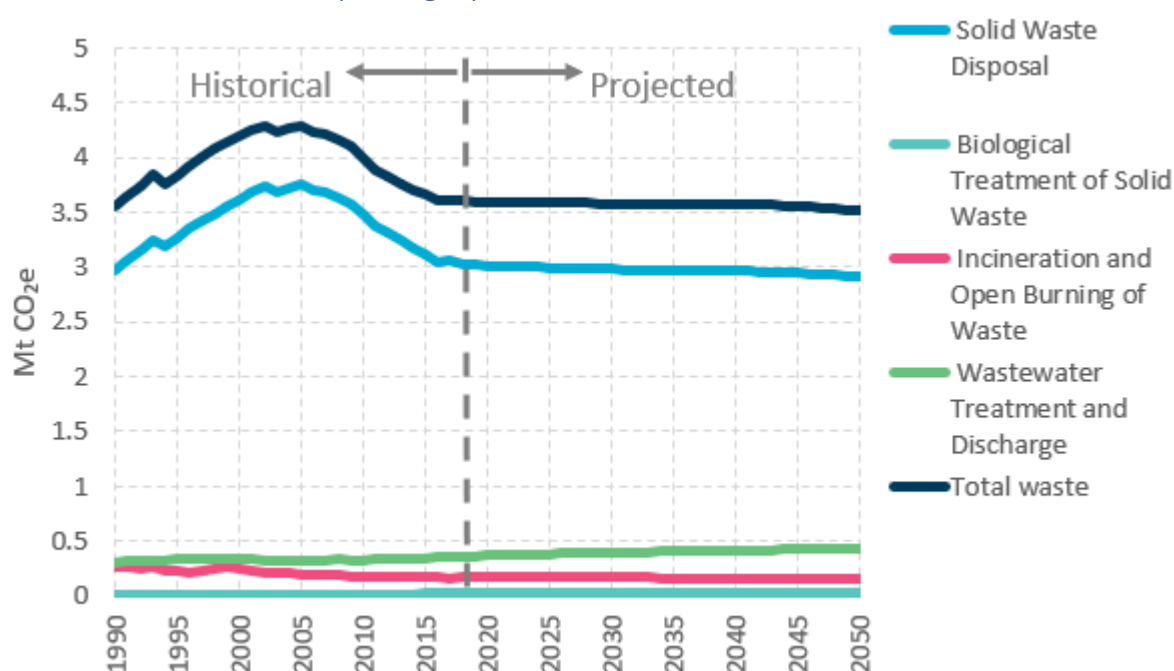


Figure 7.30: Current Policy Reference case waste emissions per category

Source: Commission analysis.

Table 7.29: Current Policy Reference case waste emissions per category (Mt CO<sub>2</sub>e)

	2018	2020	2030	2040	2050
<b>Solid Waste Disposal</b>	3.0317	3.0151	2.9805	2.9645	2.9069
<b>Biological Treatment of Solid Waste</b>	0.0349	0.0303	0.0324	0.0324	0.0284
<b>Incineration and Open Burning of Waste</b>	0.1832	0.1811	0.1706	0.1600	0.1494
<b>Wastewater Treatment and Discharge</b>	0.3621	0.3689	0.3962	0.4162	0.4325
<b>Total waste</b>	3.6120	3.5954	3.5796	3.5730	3.5173

### Notes:

- Waste emissions in Aotearoa are mostly from organic waste decomposing at landfill which produces biogenic methane emissions (81%), with the second largest source from wastewater treatment (10%), with the remainder coming from open burning/incineration (6%) and composting (3%). These emissions are mostly biogenic methane emissions (94%) with a smaller portion coming from nitrous oxide emissions (4%) and carbon dioxide (2%).
- Despite the large increase in waste volumes of nearly 50% from 1990 to 2018, this has been counteracted by the increased adaptation of landfill gas capture technology due to the requirements imposed by the National Environment Standards for Air Quality (Air Quality NES). The Air Quality NES require landfills that meet a particular threshold of organic content and waste volumes to have landfill gas capture systems, this has driven a consolidation of municipal landfills from 300 municipal landfills in 1990 to 19 landfills by 2017.
- In the Current Policy Reference case waste emissions are set to have a slight decrease due to decreasing volumes of organic waste going to landfill.

## 7.8.2 Waste Emissions by Gas

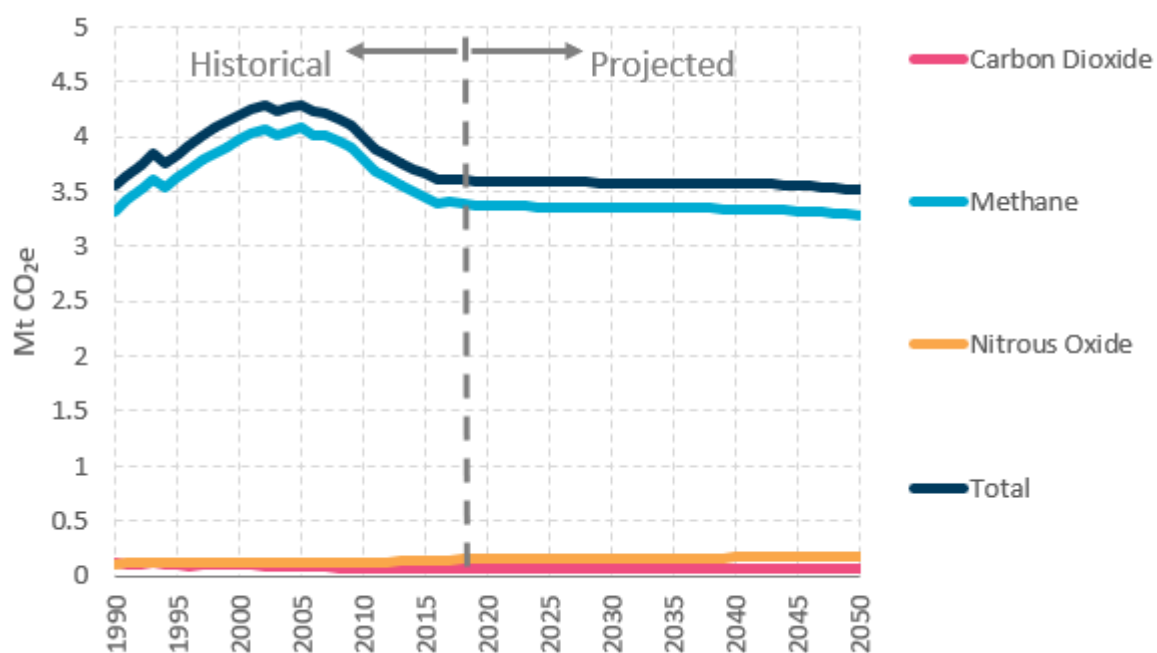


Figure 7.31: Waste emissions by gas Mt CO<sub>2</sub>e

Source: Commission analysis.

Table 7.30: Waste emissions by gas kt CO<sub>2</sub>e  
(actual methane in Mt and nitrous oxide amounts in kt within the bracket)

	2018	2030	2040	2050
<b>Carbon Dioxide</b>	0.0735	0.06841	0.0642	0.0600
<b>Methane</b>	3.3881 (0.135)	3.35062 (0.134)	3.3423 (0.133)	3.2882 (0.131)
<b>Nitrous Oxide</b>	0.1504 (15.04)	0.16061 (16.06)	0.1666 (16.66)	0.1691 (16.9)
<b>Total</b>	3.6120	3.57964	3.5730	3.5173

### Notes:

- These emissions are mostly biogenic methane emissions (94%) with a smaller portion coming from nitrous oxide emissions (4%) and carbon dioxide (2%).
- Biogenic methane emissions are mostly from waste decomposing from landfill, with some coming from wastewater treatment plants and another smaller portion from burning and composting. A slight decrease to 2050 is projected due to the decrease in municipal and farm fill waste volumes.
- Nitrous oxide emissions are mostly from wastewater treatment plants and are expected to increase through to 2050 driven largely by an increase in population.

- Carbon dioxide emissions are from the open burning of waste in rural areas and incineration of mostly medical waste. They are project to decline through to 2050 due to the decrease in farm activity.

### 7.8.3 Waste Biogenic Methane Emissions

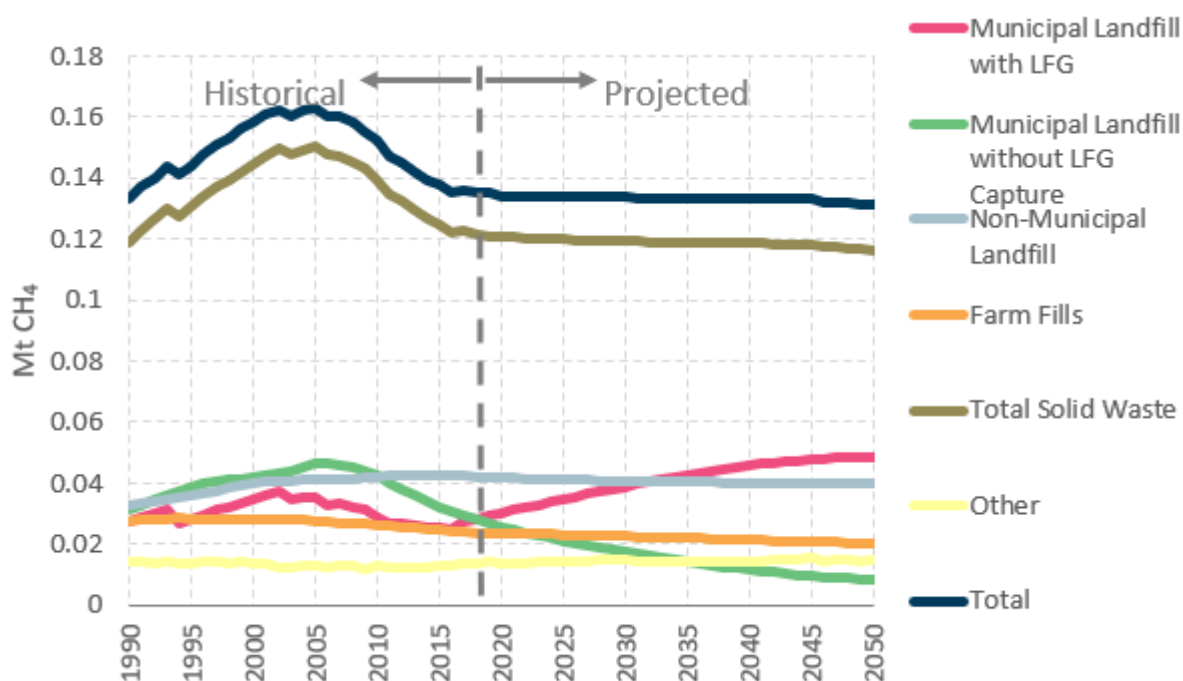


Figure 7.32: Current Policy Reference case biogenic waste emissions

Source: Commission analysis.

Table 7.31: Current Policy Reference case waste biogenic methane emissions (Mt CH<sub>4</sub>)

	2018	2030	2040	2050
<b>Municipal Landfill with LFG</b>	0.0279	0.0389	0.0457	0.0484
<b>Municipal Landfill without LFG Capture</b>	0.0278	0.0172	0.0115	0.0081
<b>Non-Municipal Landfill</b>	0.0420	0.0406	0.0401	0.0397
<b>Farm Fills</b>	0.0236	0.0225	0.0214	0.0201
<b>Total Solid Waste</b>	0.1213	0.1192	0.1186	0.1163
<b>Other</b>	0.00137	0.0148	0.0144	0.0147
<b>Total</b>	0.1350	0.1340	0.1330	0.1310

Notes:

- Solid waste is the largest source of biogenic methane in waste with wastewater treatment, composting and open burning/incineration making up the rest of the 'other' emissions.
- Between 1990 and 2018, emissions from municipal landfills without LFG capture and farm fill emissions fell, while emissions from municipal landfill with LFG capture and non-municipal landfills rose. The shift in municipal landfill emissions is due to closure of many municipal landfills without LFG capture due to the requirement to capture LFG emissions which led to the shift of waste volumes towards sites with LFG capture. The change in non-municipal and farm film emissions can be attributed to changing waste volumes from decreased farm activity and increased industrial, construction and commercial activity.

## 7.8.4 Waste Volumes at Disposal Sites

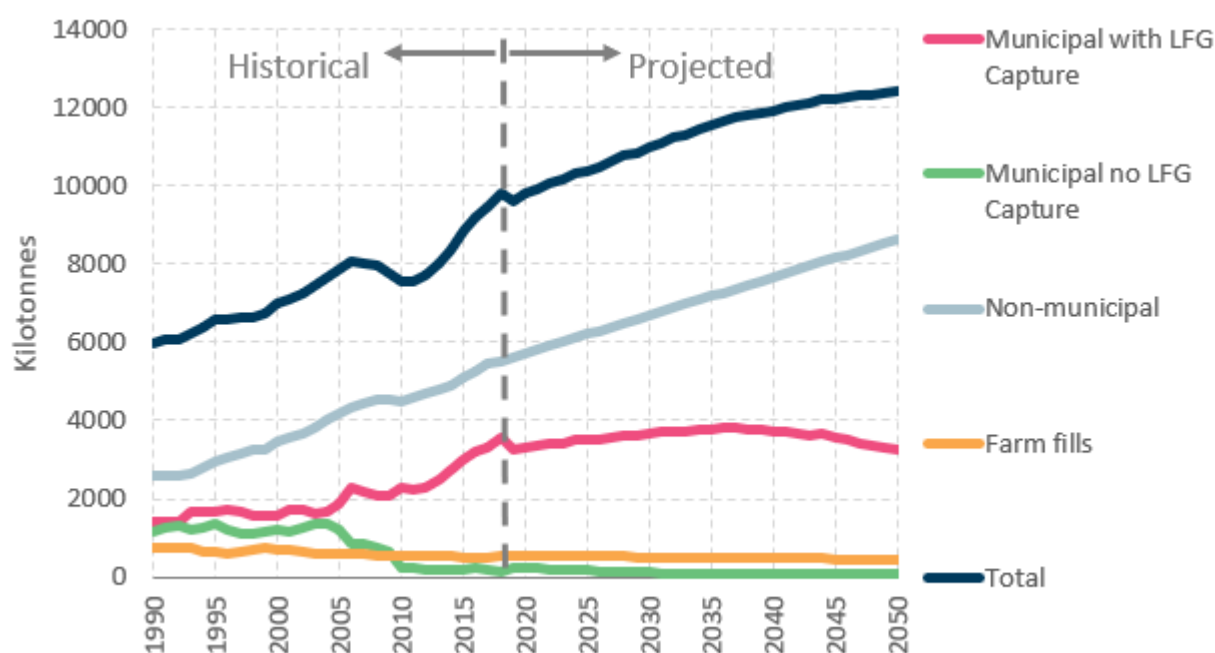


Figure 7.33: Current Policy Reference case waste emissions per category

Source: Commission analysis.

Table 7.32: Current Policy Reference case waste volumes at end disposal sites (kt)

	2018	2030	2040	2050
<b>Municipal with LFG capture</b>	3,557	3,674	3,717	3,256
<b>Municipal without LFG capture</b>	153	109	68	63
<b>Total municipal</b>	3,706	3,783	3,786	3,319
<b>Non-Municipal</b>	5,517	6,683	7,655	8,626
<b>Farm sites</b>	1,043	513	480	448

### Notes:

- Waste volumes are a key driver of waste emissions as organic waste decomposes at landfill and produces emissions.
- As previously mentioned, the shift in waste volumes between 1990 and 2018 from municipal landfills without LFG capture and municipal sites with LFG capture has been driven by the NESAQ.
- In the Current Policy Reference case, while non-municipal waste volumes are projected to increase, this is largely inert waste. Municipal waste peaks at 2040 before decreasing by 2050 and farm fill waste has a consistent decline from the decrease in the number of farms.

## 7.8.5 Hydrofluorocarbon gases (HFCs)

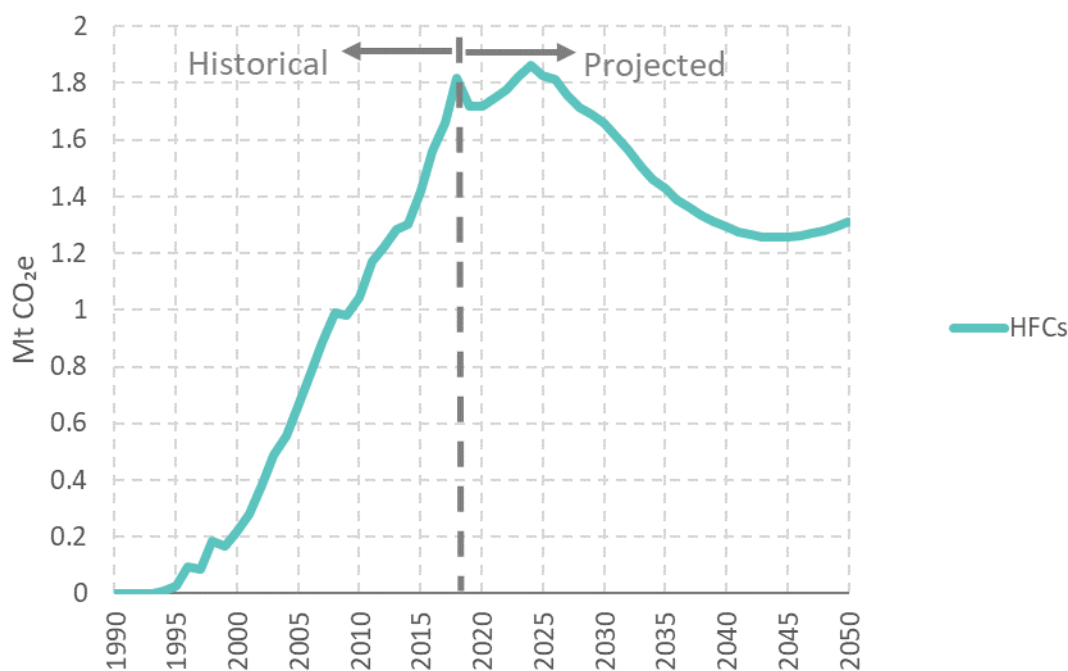


Figure 7.34: Current Policy Reference case HFC emissions

Source: Commission analysis.

Table 7.33: Current Policy Reference case F-gases emissions (Mt CO<sub>2</sub>e)

	2018	2030	2040	2050
<b>HFCs</b>	1.8	1.7	1.3	1.3

### Notes:

- These emissions are primarily from leakage and improper disposal of hydrofluorocarbons (HFCs) used in refrigeration and air conditioning equipment. Over the period from 1990 to 2018 these emissions increased significantly due to the growing use of HFCs as a replacement for chlorofluorocarbons (CFCs). CFCs were recognised as being destructive to the ozone layer and the Montreal Protocol, an international treaty, successfully phased out their use.
- Projected emissions from HFCs peak at around 1.9Mt CO<sub>2</sub>e in 2024 and reduce to 1.7Mt CO<sub>2</sub>e in 2030 and 1.3Mt CO<sub>2</sub>e by 2050.
- The reduction in emissions is a result of the Kigali Amendment to the Montreal Protocol which restricts the bulk imports of HFCs in new equipment from 2019 and the uptake of alternative low global warming potential refrigerants. Despite the regulation, emissions reductions are limited due to continued use of HFCs in existing equipment.
- This projection was produced by the Verum Group in a 2020 piece of work commissioned by MfE.<sup>22</sup>

<sup>22</sup> Verum Group (2020)

## 7.9 Comparisons with other projections

As part of our obligation to the United Nations Framework Convention on Climate Change, the Government publishes biennial reports which track historic emissions and project future trends. The most recent version of this is the 'Fourth Biennial Report' produced by MfE in December 2019 drawing on contributions by multiple Ministries<sup>23</sup>

These Government projections were updated in October 2020<sup>24</sup> in order to reflect new policy developments and the ongoing disruption the COVID-19 pandemic has had across the economy. Shown below are comparisons between our Current Policy Reference case, as presented throughout this chapter, and the updated Government projections. The Government projections explore multiple emissions scenarios, however the comparisons shown here are for the 'with existing measures' projection, which, in exploring a future without additional policy intervention to target emission reductions, is similar in logic to the Current Policy Reference case. The comparisons here are made at an aggregated level with emissions largely classified in terms of the Greenhouse Gas Inventory conventions. Emissions are split between transport, non-transport energy, IPPU, land use and waste.

As mentioned earlier in this chapter, a major strength of the ENZ modelling tool, which has been used to create our Current Policy Reference case, is that it can represent ways of reducing emissions for all sectors of the economy in detail. It also represents many of the key interactions that can happen between sectors; for example, changes to dairy production would impact the energy requirement in the food processing sector. Because of this additional detail, our Current Policy Reference case may present a more consistent vision of our future emissions than the Government projections.

In addition to the official Government projections, there have been other modelling efforts which consider future emissions in the energy sector. Most notably, the BusinessNZ Energy Council contributed their BEC 2060 Energy Modelling Scenarios, which explored two alternative futures for Aotearoa.<sup>25</sup> Neither of their scenarios is a strictly current policy scenario. Their 'Tūi' scenario, however, assumes a limited policy response. Although it does assume Aotearoa takes some action on climate change, it does so only as a 'follower'. We include this scenario in our comparison for transport, but not for the other sectors.

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<sup>23</sup> Ministry for the Environment (2019). The Ministry of Business, Innovation and Employment (MBIE) contributes energy use emissions, MfE contributes IPPU and waste emission projections and MPI contributes forestry and agriculture emissions projections

<sup>24</sup> The updated projections were unpublished at the time of this writing but were provided to us by government agencies.

<sup>25</sup> Business NZ Energy Council (2019)

### 7.9.1 Non-transport energy emissions



Figure 7.35: Comparison of Current Policy Reference case and Government projected non-transport energy emissions

Source: Commission analysis.

Table 7.34: Comparison of Current Policy Reference case non-transport energy emissions with other projections (Mt CO<sub>2</sub>e)

	2018	2030	2040	2050
<b>Current Policy Reference</b>	15.5	12.3	12.6	12.3
<b>Government projections</b>	15.3	13.8	12.2	12.6

#### Notes:

- Non-transport energy includes emissions from fossil fuel use in industry, buildings and in electricity generation as well as fugitive emissions.
- There is broad agreement between the official Government projections and this Current Policy Reference case for non-transport energy, as shown in Figure 7.35. Both projections show a general reduction in emissions with levels plateauing at around 12Mt CO<sub>2</sub>e per year by 2035.
- The discrepancies in non-transport energy emissions prior to 2030 are largely due to variances in the projected amount of fossil fuel electricity generation. The Current Policy Reference case projects a higher initial amount of this thermal generation but then a faster displacement of this generation with renewable generation plants. The Current Policy Reference case also projects a more abrupt completion of domestic methanol production.

## 7.9.2 Industrial process and product use emissions

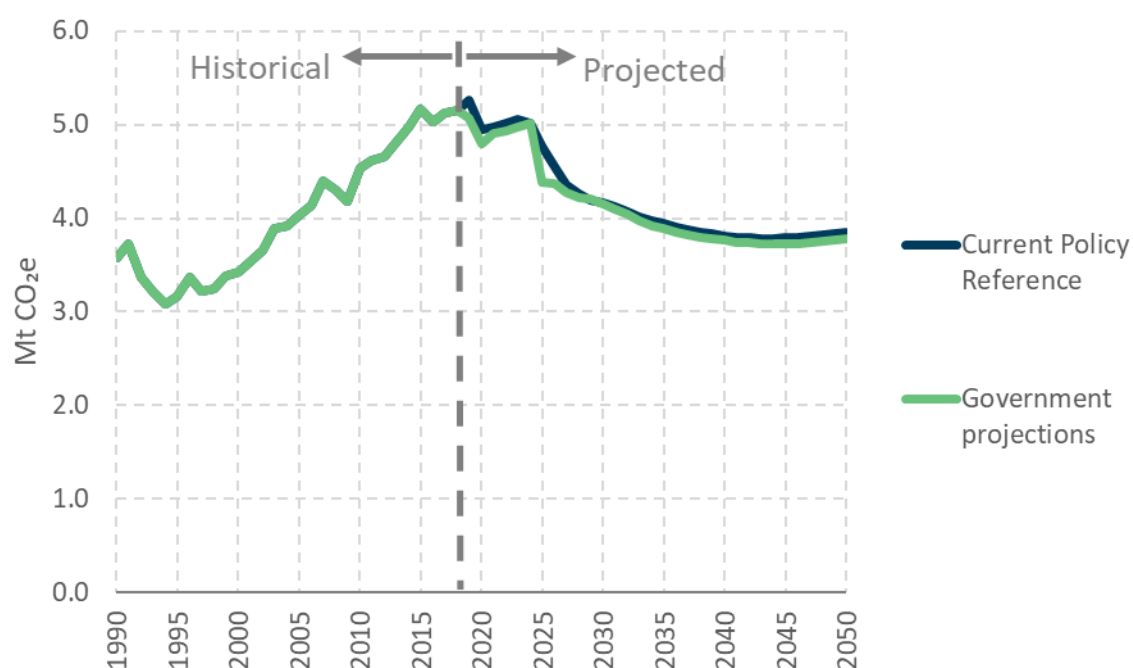


Figure 7.36: Comparison of Current Policy Reference case and Government projected IPPU emissions

Source: Commission analysis.

Table 7.35: Comparison of Current Policy Reference case IPPU emissions with other projections (Mt CO<sub>2</sub>e per year)

	2018	2030	2040	2050
<b>Current Policy Reference</b>	5.2	4.2	3.8	3.9
<b>Government projections</b>	5.2	4.2	3.8	3.8

### Notes:

- Industrial process and product use (IPPU) emissions includes non-energy emissions from steelmaking, cement production and other industrial activities. It also includes emissions from HFCs and other F-gases.
- There is good agreement between the official Government projections and this Current Policy Reference case for IPPU emissions, as shown in Figure 7.36.
- Both projections show stepped reductions in the level of emissions due to the closure of the aluminium smelter at Tiwai Point beginning in 2025 and steady emissions of around 4Mt CO<sub>2</sub>e per year beyond this.

### 7.9.3 Transport emissions

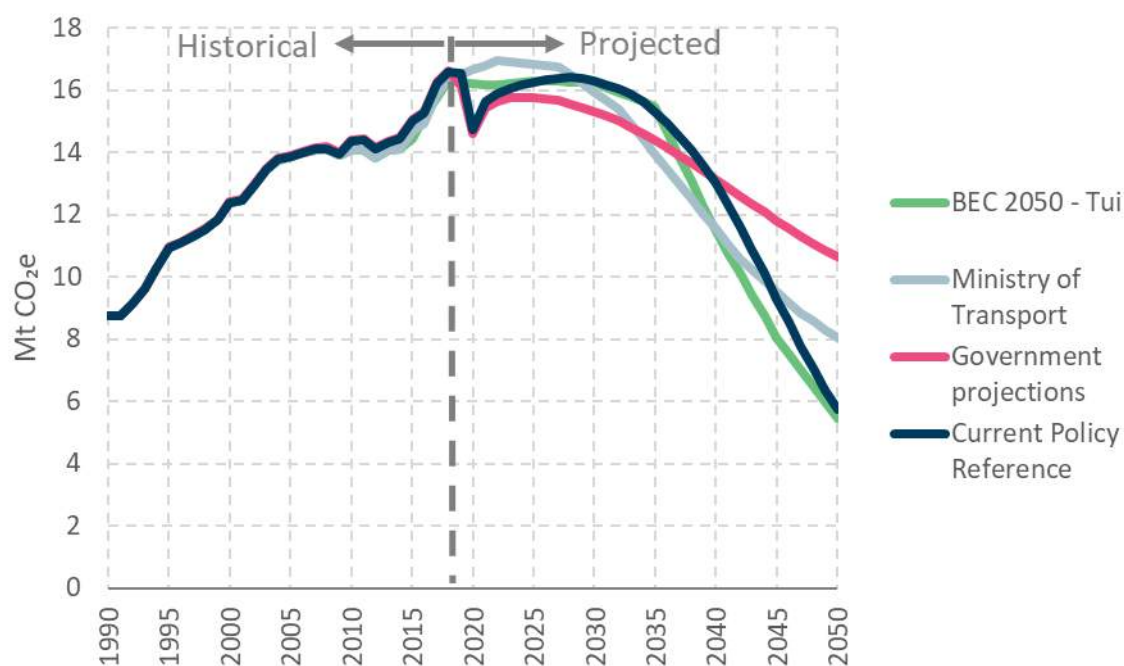


Figure 7.37: Comparison of Current Policy Reference case transport emissions with other projections

Source: Commission analysis.

Table 7.36: Comparison of Current Policy Reference case transport emissions with other projections (Mt CO<sub>2</sub>)

	2018	2030	2040	2050
<b>Current Policy Reference</b>	16.6	16.3	13.0	5.7
<b>BEC 2050 - Tūi</b>	16.3	16.3	11.5	5.5
<b>Ministry of Transport</b>	16.4	15.9	11.5	8.1
<b>Government Projections</b>	16.6	15.3	13.1	10.6

#### Notes:

- All of the projections considered show a long-term decline in transport emissions, driven by the uptake of electric vehicles. As the speed of this uptake is quite uncertain, it is not surprising that the shape of the curves differ.
- The Ministry of Transport Vehicle Fleet Emission Model<sup>26</sup> projections are very similar to our Current Policy Reference case, although they have a steeper decline in the earlier years and a slower decline in the later years.
- Government projections of transport emissions show a strong shock in 2020 due to the COVID-19 pandemic, followed by a partial recovery and the start of a long-term decline, which is not as rapid as our Current Policy Reference case.

<sup>26</sup> Ministry of Transport (2019b)

- The Business NZ Energy Council Tūi scenario projections<sup>27</sup> are similar to our current policy case but drop off somewhat more rapidly. This is probably because the Tūi scenario is not a strictly current policy scenario, in that it does assume Aotearoa takes some action on climate change.

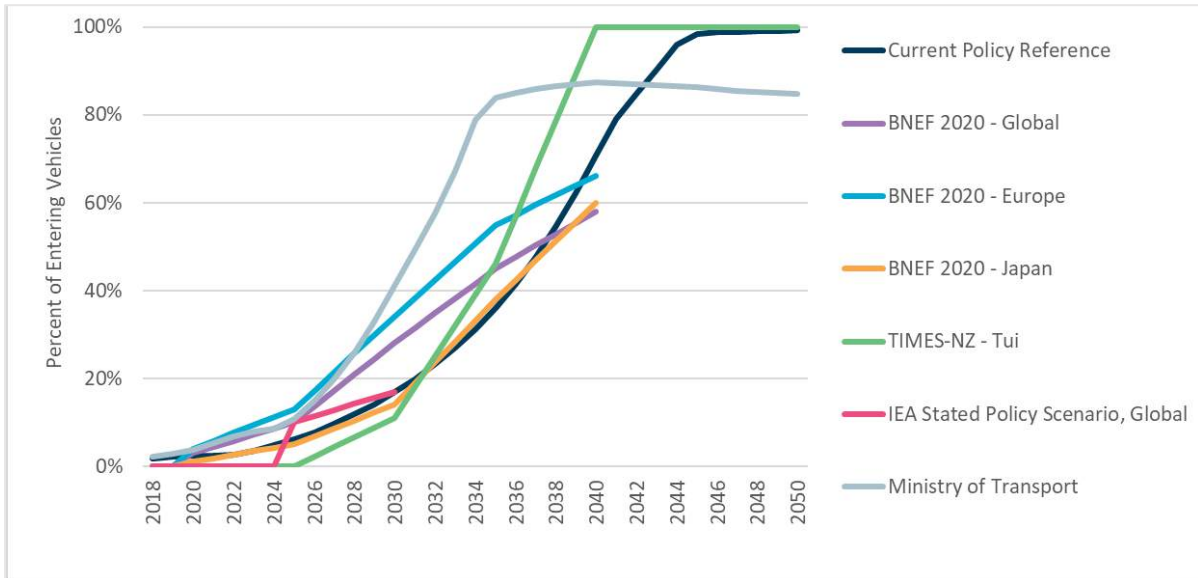


Figure 7.38: Comparison of Current Policy Reference case electric vehicle uptake for light passenger vehicles (cars/SUVs) with other projections

Source: Commission analysis.

Table 7.37: Comparison of Current Policy Reference electric vehicle uptake for light passenger vehicles (cars and SUVs) with other projections

	2018	2030	2040	2050
<b>Current Policy Reference</b>	2%	17%	71%	99%
<b>BNEF 2020 - Global</b>	0%	28%	58%	NA
<b>BNEF 2020 - Europe</b>	0%	34%	66%	NA
<b>BNEF 2020 - Japan</b>	0%	14%	60%	NA
<b>TIMES-NZ - Tui</b>	0%	11%	100%	100%
<b>TIMES-NZ - Kea</b>	0%	42%	100%	100%
<b>IEA Stated Policy Scenario, Global</b>	0%	17%	NA	NA
<b>Ministry of Transport</b>	2%	41%	87%	85%

Notes:

- Figure 7.38 compares the ENZ model projections of electric vehicle uptake rates for light passenger vehicles (cars and SUVs) to recent projections produced by other organisations in for Aotearoa, Europe, Japan and globally. The projections for Japan are especially relevant as Aotearoa imports the majority of its second-hand fleet from there.
- Figure 7.38 demonstrates that the projected uptake of electric vehicles in ENZ is reasonably aligned with the other projections.

<sup>27</sup> BusinessNZ Energy Council (2019)

- The Ministry of Transport projections of electric light passenger vehicle uptake plateau in the late 2030s as their model assumes internal combustion engine vehicles continue to improve in fuel efficiency and continue to decline in cost, thereby keeping them competitive with electric vehicles. The Ministry of Transport is currently re-examining their assumptions.
- The Bloomberg New Energy projections use the same battery cost assumptions as the Current Policy Reference case. We do not have a good understanding as to why their projections are lower than ours in the later years.

#### 7.9.4 Land

Other organisations have modelled the dynamics of future developments in the land sector using sector specific models. Motu’s Land Use in Rural New Zealand (LURNZ) model simulates land-use change in response to changes in economic returns for different land uses. Manaaki Whenua – Landcare Research’s New Zealand Forestry and Agricultural Regional Model (NZFARM) is another model which projects agricultural production and land use. It optimises these for maximum profits based on costs, prices and environmental constraints.

Motu used LURNZ and NZFARM to project a land sector base case for the Biological Emissions Reference Group in 2018<sup>28</sup> and reports by the Productivity Commission<sup>29</sup> and the Parliamentary Commissioner for the Environment<sup>30</sup> have used LURNZ to project avenues towards future emissions reductions targets. However, these projections are not directly comparable with the Current Policy Reference case. Significant policy developments since they were published mean that key assumptions used in those modelling efforts differ considerably from those in our reference case. The emissions reductions targets used in these reports are also different from the 2050 and 2030 targets now under legislation.

One important land sector comparison to make is between our Current Policy Reference case and government projections. As mentioned, we used Government “with existing measures” baseline projections activity data to inform our forestry projection. We aimed to make our ENZ-generated reference case projections identical to those from MPI. As shown in Figure 7.39 below, our projections are closely aligned but some minor difference remain that we have not yet been able to reconcile.

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<sup>28</sup> Dorner et al. (2018)

<sup>29</sup> New Zealand Productivity Commission (2018)

<sup>30</sup> Parliamentary Commissioner for the Environment (2019)

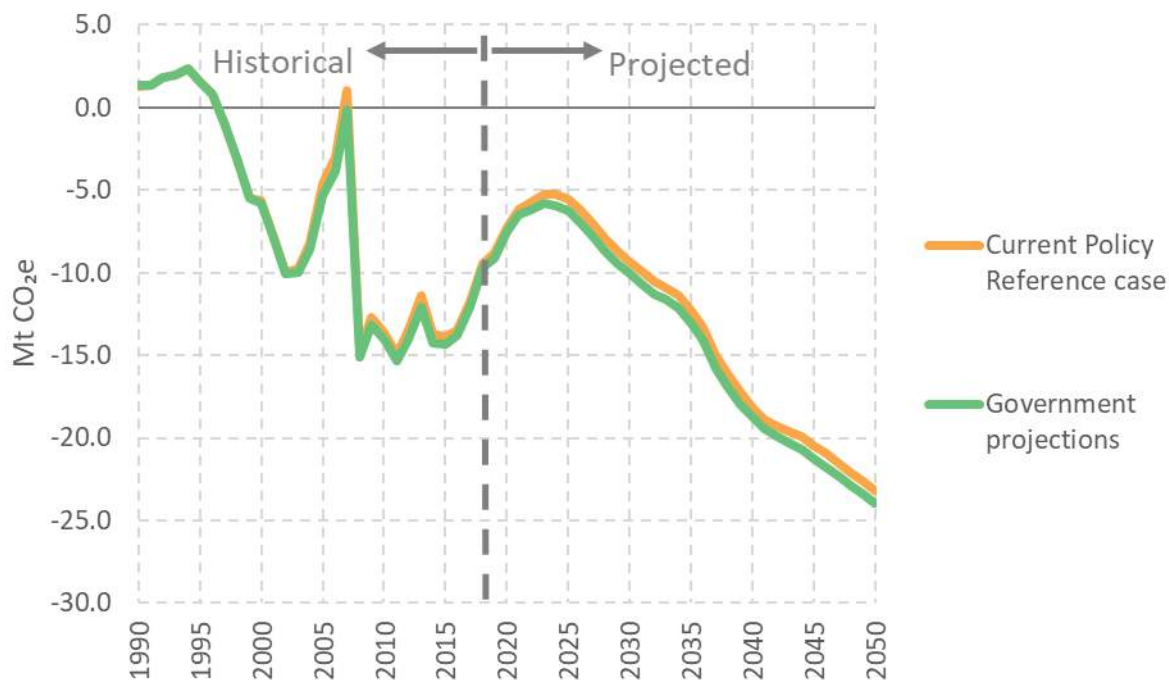


Figure 7.39: Current Policy Reference case net forest emissions compared to Government WEM baseline projections

Source: Commission analysis.

Table 7.38: Current Policy Reference case net forest emissions compared to Government WEM baseline projections (Mt CO<sub>2</sub>e)

	2018	2030	2040	2050
<b>Current Policy Reference case</b>	-9.5	-9.3	-18.2	-23.2
<b>Government WEM baseline projections</b>	-9.6	-10.1	-18.8	-24.0

### 7.9.5 Waste

We have drawn heavily on MfE's waste models with the result that our projections are near identical to their 4<sup>th</sup> Biennial Report. However, there are two key differences with the BR4 report:

- Our analysis of the source reports for farm fill emissions have informed us that almost all of the wood waste from farms are being burnt rather than buried. We can potentially infer that farmers are burning almost all of their waste rather than having separated systems of burial and burning. However, due to the paucity of the data and in the absence of further analysis, we have assumed that half of all farm waste is burnt with the other half being buried, rather than assuming that all of it is being burnt.
- MfE's linear projection of non-municipal waste emissions overestimates emissions. Commission staff explored several projection methods including a linear extrapolation of waste volume trends, however we ran into the problem of organic waste streams such as garden and wood waste eventually reaching zero within 10-20 years. In the end, we decided

to go with a conservative approach of flatlining all non-municipal waste types at their current volume except for inert waste which was a linear projection. Given the absence of good quality data for non-municipal waste, this cautious approach was appropriate.

It is likely that the waste Current Policy Reference case will change before the final report in May with updated data in the upcoming Greenhouse Gas Inventory. These will likely include changes to:

- Composting baseline and projection
- The fraction of decayable waste for different waste types
- Projected waste volumes

## 7.10 Dealing with uncertainty

As discussed at the beginning of this chapter, there is uncertainty surrounding the single Current Policy Reference case presented here. The broader issue of potentially significantly different futures is addressed largely through our consideration of multiple future scenarios in *Chapter 8: What our future could look like*. Smaller uncertainties, related to potential variation in key variables and assumptions, however, can also be very important. We have considered these through two primary routes.

1. Where possible, we have compared our results to a range of domestic and international projections for emissions and other indicators. These comparisons were discussed in the previous section.
2. We have tested the sensitivity of the projections, to see what would happen if specific things were different. For example, what if global oil prices were higher or lower, than our assumptions?

The key uncertainties for each sector are discussed below alongside the presentation of select key sensitivity analyses.

### 7.10.1 Transport

Probably the largest source of uncertainty in our Current Policy Reference scenario for transport is the cost and performance of batteries for electric vehicles. We believe our assumptions are in line with both the expectations of industry experts and ongoing trends. If battery costs decline as we have assumed, electric vehicles would become increasingly competitive with conventional fossil-fuelled vehicles. There are, however, no guarantees that this will happen, or about the speed at which it would happen.

Other key sources of uncertainty in our Current Policy Reference case for transport include

- Oil prices, which affect both the competitiveness of fossil-fuelled vehicles compared to electric vehicles, and the attractiveness of owning larger and less energy efficient conventional vehicles;
- Population and economic growth rates, which underlie the demand for transport;
- Changing work practices and advancing information technology, which could facilitate more remote working;
- Changing tastes and markets for housing, including potential shifts to more multi-family housing and more urban living;

- Changing tastes in transport choices, including potential shifts to more walking, cycling and public transport;
- Certain behavioural changes to car ownership could be highlighted through an initiative Ākina are piloting which is enabling fifty whānau in Manukau South access to low emissions cars via leasehold arrangements;
- Self-driving vehicle technologies, which could change the amount of travel and the way vehicles are used, in ways that are still unclear;
- For international aviation especially, the long-term impacts of COVID-19 are another huge source of uncertainty, which are discussed in a separate section below.

### 7.10.2 Heat, industry and power

As discussed throughout the sector discussion, much of the emissions across these sectors results from the production activity of individual industries. Changes in the level or production of these industries would have a significant impact on the emission totals over the budget periods. This makes industry activity a key uncertainty. Emission-intensive industrial activity in Aotearoa is concentrated at a small number of sites operated by a small number of companies.

The signalled closure of the aluminium smelter at Tiwai Point demonstrates the significant impact on the emissions trajectory, and expected totals for any given Budget period, that even a single major change can have. For this Current Policy Reference case, we assume that heavy industry largely continues to operate at close to current production levels. The exceptions to this are the aluminium smelter and the petrochemical industry.

### 7.10.3 Land

There are multiple sources of uncertainty for the land sector relevant to the Current Policy Reference case.

First, there are a number of external market factors which could affect the sector. For example, if the price of milk or logs changes significantly from what is in the Current Policy Reference case. Changes in export prices can strongly influence land use decisions with significant implications for emissions by the sector. There are multiple factors which could shape export prices, with global demand for meat and dairy products being of crucial relevance to producers in Aotearoa. Two important trends in this regard include a growing global middle class that may demand more of these products and the development of plant-based and synthetic protein products that may undercut demand for traditional meat and dairy.

Market factors are also a key source of uncertainty for forestry, with global log demand being the key driver of harvesting activity in Aotearoa. Changes in the average harvest age of planted forests due to processing constraints and market forces could cause fluctuations in estimates of emissions removals compared to our Current Policy Reference case. Log demand also combines with the NZ ETS carbon price to drive commercial afforestation in Aotearoa. Deviations in the carbon price from the constant \$35 in real terms used in the Current Policy Reference case would likely see variation in afforestation and thereby net forest emissions forests.

We consider sensitivity of case to alternative afforestation rates driven by different carbon prices through the effect of MPI's "high" and "low" "with existing measures" (WEM) afforestation scenarios that use a constant \$50 and \$25 real emissions price, respectively.

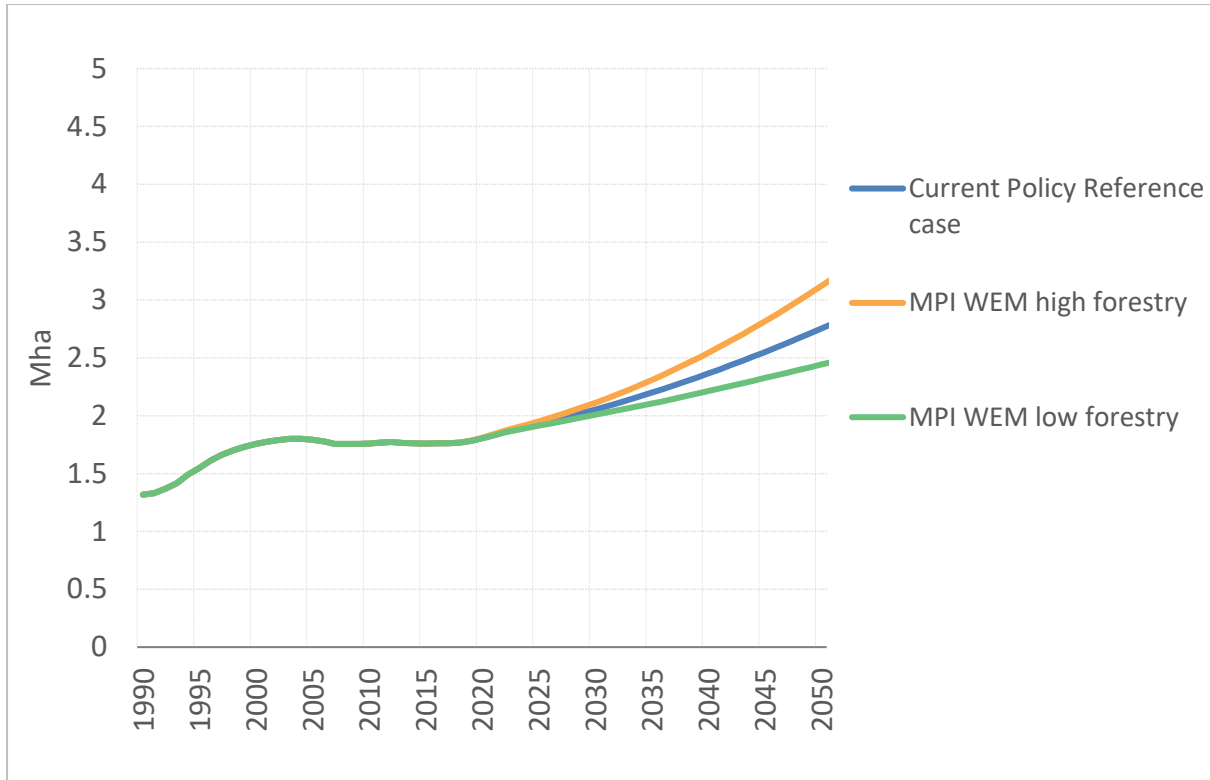


Figure 7.40: Current Policy Reference case exotic forest area compared to MPI high and low afforestation scenarios

Source: Commission analysis.

Table 7.39: Current Policy Reference case exotic forest area compared to MPI high and low afforestation scenarios (Mha)

	2018	2030	2040	2050
<b>Current Policy Reference case</b>	1.77	2.05	2.36	2.75
<b>High afforestation</b>	1.75	2.09	2.52	3.10
<b>Low afforestation</b>	1.75	1.99	2.19	2.42

Notes:

- Figure 7.40 shows exotic afforestation in the Current Policy Reference case, which uses a \$35 carbon price, compared to MPI’s “high” and “low” afforestation scenarios.
- As shown in Table 7.39, by 2030, the exotic forest area in the high afforestation scenario is 0.04Mha greater than the Current Policy Reference case and 0.35Mha greater in 2050.
- The low afforestation scenario sees 0.06Mha and 0.33Mha less exotic forest area in 2030 and 2050, respectively, compared to the Current Policy Reference case.



Figure 7.41: 2050 Sectoral and net long-lived gas emissions in the Current Policy Reference case compared to alternative forestry scenarios

Source: Commission analysis.

Table 7.40: 2050 Sectoral and net long-lived gas emissions in the Current Policy Reference case compared to alternative forestry scenarios (Mt CO<sub>2</sub>e)

	Current Policy Reference case	MPI WEM High forestry	MPI WEM low forestry
<b>Gross</b>	29.5	29.4	29.6
<b>Forestry</b>	-23.2	-31.7	-15.9
<b>Net</b>	6.3	-2.3	13.7

Notes:

- Figure 7.41 shows sectoral and net long-lived gas emissions in 2050 for the Current Policy Reference case compared to the high and low MPI forestry scenarios.
- Gross emissions are essentially the same across the scenarios. Notably, however, net-zero long-lived gas emissions is reached and surpassed in 2050 under the high forestry scenario. This represents a scenario of “planting our way out” to achieve the 2050 target as there are little to no gross emissions reductions beyond the Current Policy Reference case. Due to the risks associated with such a large reliance on forestry and the impacts that would be associated with this, it is not a route towards the targets we support.
- The high forestry scenario results in an additional 8.5Mt CO<sub>2</sub>e of emissions removals beyond the Current Policy Reference case. The low forestry scenario achieves 7.3Mt CO<sub>2</sub>e less emissions removals.

Market forces and export prices also likely intersect with the trend of declining sheep, beef and deer land area. Higher meat export prices may mean land that might have otherwise been unprofitable to

farm becomes productive again. Lower prices would have the opposite effect. This could alter the trend of sheep, beef and deer land retirement, which is strong historically, but which essentially stops in the Current Policy Reference case after 2025. As exotic afforestation is assumed to occur on sheep, beef and deer land, varied carbon and log prices may also lead to a change in sheep, beef and deer land area. We test this sensitivity with an alternate reference case where land retirement reduces gradually to zero by 2050 instead of suddenly in 2025.

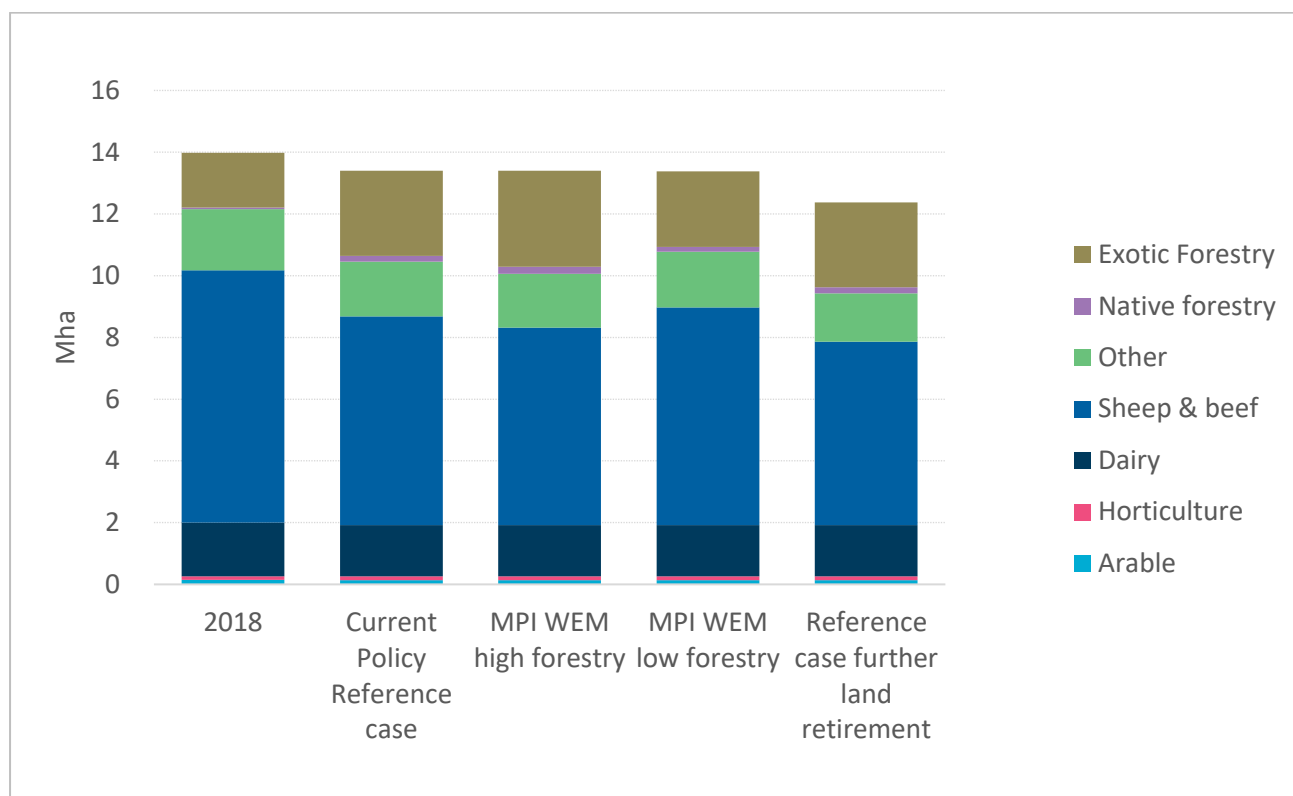


Figure 7.42: Current Policy Reference case sheep, beef and deer area compared to MPI high and low afforestation scenarios and further land retirement

Source: Commission analysis.

Table 7.41: Current Policy Reference case sheep, beef and deer area compared to MPI high and low afforestation scenarios and further land retirement (Mha)

	2018	2030	2040	2050
<b>Current Policy Reference case</b>	8.17	7.41	7.12	6.75
<b>High afforestation</b>	8.17	7.36	6.95	6.40
<b>Low afforestation</b>	8.17	7.45	7.25	7.05
<b>Reference case further land retirement</b>	8.17	7.13	6.45	5.94

Notes:

- Figure 7.42 shows sheep, beef and deer land in the Current Policy Reference case, the MPI high and low forestry scenarios and a modified reference case where land retirement reduces gradually to zero by 2050 instead of suddenly in 2025.
- The low forestry scenario results in 0.30Mha more sheep, beef and deer land in 2050 compared to the Current Policy Reference case. The high afforestation and further land retirement scenarios result in 0.35Mha and 0.81Mha less than the Current Policy Reference case.
- This highlights that perhaps the greatest trend affecting sheep, beef and deer land is that of retiring land.
- These differences in sheep, beef and deer land also have important flow-on effects for biogenic methane emissions.

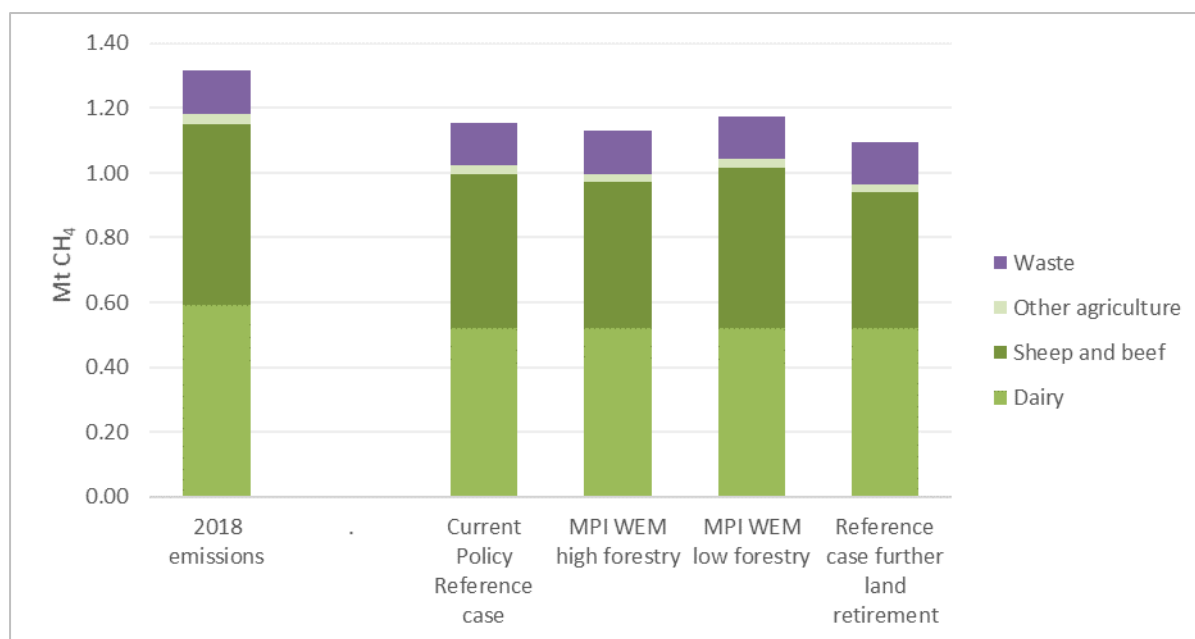


Figure 7.43: Current Policy Reference case biogenic methane emissions in 2050 compared to alternative scenarios and 2018 emissions

Source: Commission analysis.

Table 7.42: Current Policy Reference case biogenic methane emissions compared to alternative scenarios

	2018	2030	2040	2050
<b>Current Policy Reference case</b>	1.32	1.22	1.19	1.15
<b>High afforestation</b>	1.32	1.22	1.18	1.13
<b>Low afforestation</b>	1.32	1.22	1.20	1.17
<b>Reference case further land retirement</b>	1.32	1.20	1.15	1.10

Notes:

- Table 7.42 compares the Current Policy Reference case projected biogenic methane emissions to those in alternative reference case scenarios continues out to 2050.
- The high forestry scenario results in an additional 2.3% reduction in biogenic methane emissions by 2050 while the low forestry scenario results in 1.8% less. The further land retirement, however, results in an additional 4.1% reduction beyond the Current Policy Reference case.

### *Physical climate change effects*

The physical effects of climate change itself and responses to this could affect the land sector. These climate response dynamics are not included in the Current Policy Reference case. Yet, the risk of extreme weather events increases with continued global warming, and weather and temperature patterns are also likely to change. This may create fundamental challenges to agriculture and forestry by 2050. These could include large areas of land becoming unsuitable for their current land use or the rapid adoption of different technologies and practices, such as irrigation, in order to adapt. Research is underway to quantify these potential impacts, but data is not yet available to include in our modelling.

#### 7.10.4 Waste

The unreliability of activity data for waste in non-municipal sites and farm fills means that any projections must be considered with a high degree of caution. The efficiency of landfill gas capture efficiency, particularly for non-municipal and legacy fills also makes it difficult to estimate with a high degree of accuracy.

Another potential variable is the potential impact of the waste levy increases, which has not yet been incorporated into the Current Policy Reference case. However, depending on the level of actual sensitivity of waste volumes to the levy increases, this may result in higher or lower increases than forecast.

There is also large uncertainty around the refrigerants space, such as the impacts of the carbon price on the consumption of F-gases, potential for continued imports of recycled HFCs and the potential leakage rates. Because of these uncertainties, there is potential for the Current Policy Reference case to be under or overstating the emissions reductions from the Kigali Amendment.

#### 7.10.5 Impact of COVID-19

Of course, any discussion the uncertainties in future emissions must address the current COVID-19 public health crisis. At the time of this writing, international aviation to and from Aotearoa is operating at token levels, the tourism and tertiary education sectors in Aotearoa are taking a huge hit, export and import supply chains for many products have been disrupted, seasonal workers and many skilled workers are unable to enter the country and unemployment is well above levels of the past few years. Yet the Commission's planning horizon remains a long-term one, to 2050 and beyond. Our first budget period does not even begin until 2022. The key uncertainty around COVID-19 for the Commission is therefore the long-term impacts.

The ENZ model results presented in this section have been adjusted to reflect our best estimate of the short and long-run impacts of COVID-19. In the short-term, defined to be 2020 and 2021, our transport and industrial projections have been scaled down to match the demand impacts on each

type of transport and industry, as shown in the most recent update to the Government projections of emissions. These generally show a sharp drop in 2020 compared to 2019, with an assumed recovery in 2021. The recovery is, however, not a complete one, in that it will only bring demand back to roughly where it was in 2019, rather than showing growth relative to 2019, as would have been expected pre-COVID-19. After 2021, we assume growth continues at a rate similar to what would have been expected pre-COVID-19, but starting from this new, slightly lower level.

Complicating the situation is that there appears to have been a downgrading of economic growth expectations over the last few years even apart from COVID-19. Figure 7.44 shows a comparison of GDP projections underlying three of the emission projections discussed under ‘Comparisons with other projections’ above. The one from 2016 underlies the Ministry of Transport emission projections; the one from 2019 underlies the Fourth Biennial Report, while the one from 2020 underlies the latest Government projections. The Figure shows that the GDP projections have trended lower over time, even in the 2016 to 2019 period preceding COVID-19.

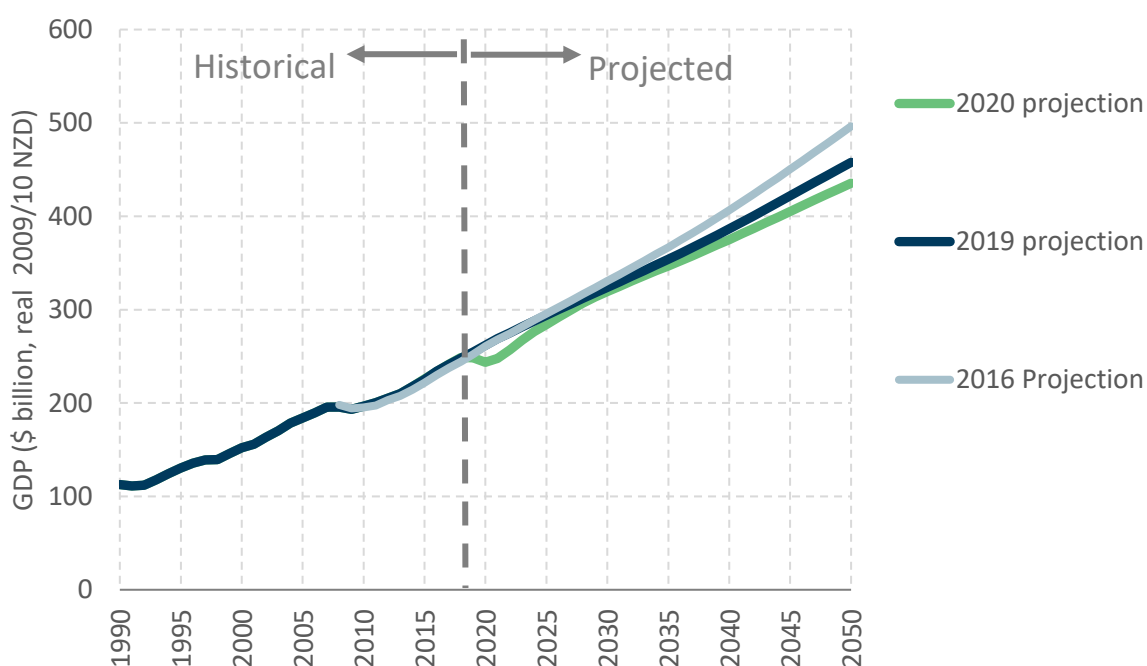


Figure 7.44: Comparison of GDP Projections Underlying Recent Emissions Projections

Source: Commission analysis.

Table 7.43: Comparison of GDP Projections Underlying Recent Emissions Projections (\$ billion, real 2009/10 NZD)

	2018	2020	2030	2040	2050
<b>2020 projection</b>	249	244	319	375	435
<b>2019 projection</b>	248	262	324	387	458
<b>2016 Projection</b>	244	261	331	407	496

Although we have adjusted our long-term projections to reflect the impacts of COVID-19, and implicitly other changes to the economic outlook since 2019, these impacts are relatively small. This

view is consistent with the fact that, at the time of this writing, COVID-19 vaccines appear to be imminent. If successful, they should bring the health crisis to a close within the next year or so.

We recognise that there is a wide divergence of opinion as to what the long-term impacts of COVID-19 will be on emissions and the economy. Our message here is not intended to be dismissive. COVID-19 poses very serious challenges to the future of the world economy and severe long-term outcomes are within the realm of possibility. The Commission will need to closely monitor the situation and adjust its projections to reflect any new developments. For the moment, however, we are taking the view that the crisis will resolve in a relatively short time and that economic growth will return to something like its previous path. This is also a conservative assumption. COVID-19 cannot, and should not, be counted upon to provide Aotearoa with much help in reaching net zero emissions by 2050.

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## Appendix 1: ENZ

### ENZ: our scenarios model

We produce our emissions scenarios, including the Current Policy Reference case, using a purpose-built computer model called ENZ that was originally developed by Concept Consulting. 'ENZ' was originally an acronym for 'Energy Emissions in New Zealand' but is now the complete name of the model. We purchased ENZ and have enhanced it to meet our needs.

ENZ allows us to investigate, from a whole-of-system point of view, which emission reductions might be technically and economically achievable in each sector of the economy. It also allows us to factor in anticipated technological developments. As well as the Current Policy Reference case, we use ENZ to generate other scenarios to investigate alternative possible futures in *Chapter 8: What our future could look like*.

ENZ models all the main emissions sectors of the Aotearoa economy – energy, industry, transport, agriculture, forestry, product use and waste. It gives a detailed sense of feasible emissions reductions in each of these sectors by factoring in specific technologies and emissions reductions opportunities.

The model accounts for key supply chain links between sectors and factors in resource constraints. For example, if ENZ projects the number of electric vehicles to rise, it also calculates the increase in electricity demand and increases electricity generation accordingly. If ENZ projects a conversion of coal boilers to using biomass, it also calculates the forestry residues required to supply this.

The main sectors are included in ENZ as follows:

#### Transport

ENZ includes road, rail, shipping and aviation, with the latter two split into domestic and international. It also includes different fuel types: fossil and alternatives. It models the main levers which influence emissions, including the makeup of the vehicle fleet, transport demand and the factors driving them, such as the size of the population. The model also takes account of behavioural change, including shifts between travel types, such as more walking or cycling, or reduced demand for travel because of a move to working from home. In both cases, ENZ responds by reducing the distance travelled by road.

#### *Electric vehicles*

One of the most significant aspects of the transport modelling in ENZ is the uptake of electric vehicles. In the light vehicle market, electric vehicles may be either pure battery electric vehicles or plug-in hybrids. The split between these two vehicle types for vehicles imported new starts with the actual split in 2019 and moves gradually to 100% battery electric by 2035. ENZ assumes that consumers choose between conventional vehicles and electric vehicles based on the total cost of ownership of each type of vehicle over an assumed five-year ownership period.

The major driver of electric vehicle uptake is the assumed decline in battery costs. These are based on projections by Bloomberg New Energy Finance's *Electric Vehicle Outlook 2020*.<sup>1</sup> These figures suggest, for example, that the cost of batteries for a typical light passenger vehicle will decline from about NZD13,500 in 2018 to NZD6,100 in 2030 even while the battery size increases from 53kWh to 66kWh (with a corresponding increase in vehicle range). It also implies that, based on cost alone (excluding penalties), the purchase price of a light electric vehicle will drop below the purchase price of a conventional vehicle sometime between now and 2030.

There are also non-price barriers to electric vehicle uptake, such as consumer range anxiety and lack of vehicle charging infrastructure. These barriers are discussed in more detail in *Chapter 4b: Reducing emissions – opportunities and challenges across sectors, Transport, Buildings and Urban Form*. To represent these, ENZ includes three classes of penalties to slow the uptake of electric vehicles in Aotearoa compared to what costs alone would indicate:

- global early tech capital cost penalties, reflecting the global barriers to electric vehicle production;
- Aotearoa-specific capital cost penalties, reflecting barriers to electric vehicle uptake specific to this country;
- productivity penalties, which apply mainly to trucks, reflecting how batteries could reduce vehicle payload or range, thereby increasing operating costs per unit of payload.

In addition, there is a bias against electric vehicles built into the consumer choice function. This causes conventional vehicles to take a larger share of the market than electric vehicles even when the total operating costs of electric vehicles (including penalties) and conventional vehicles are the same. This bias reduces as electric vehicles gain in market share. There are also limits in the model on the speed at which the electric vehicle shares of newly registered vehicles can increase.

Assumptions are also made for the number of vehicle kilometres travelled by each class of vehicle in the reference case to reflect assumed travel type shifts for both travellers and freight.

## **Buildings**

Buildings in ENZ are represented in terms of the energy utilised in their operation. Energy used for space and water heating as well as cooking, lighting and electrical equipment are modelled explicitly within ENZ at an aggregated level for residential, commercial and public buildings. As population and GDP increase within the model, the number of buildings and requirement for energy increase.

Greenhouse gas emissions from these uses of energy and are accounted for in ENZ. Whether it from gas combusted onsite in a gas boiler or from the plants which generate the electricity used in a hot water cylinder. This means that we can see from a whole energy system point of view the emissions footprint of operating our homes and workplaces.

Within the model, buildings are split into existing and future builds with varying energy efficiency opportunities, construction rates and retrofit cycles. Energy uses are disaggregated into space heating, water heating, cooking, lighting and other for each fuel type (electricity, gas, LPG, coal, biomass). In the model, consumer choice of heating technology (fossil fuel or electric) at the time of a new build or retrofit is based on relative costs of equipment and fuel.

A fossil fuel phaseout profile overrides this economic based selection – this phaseout either reflect societal behavioural changes or a mandated approach. Improvements in energy efficiency improvements of appliances and in buildings are also represented within ENZ.

## **Heat, industry and power**

There are a diverse range of energy use types and industrial processes represented within ENZ. Generally, the activities which produce the largest share of emissions are represented in the most detail. A number of high emitting, single site industries are also modelled explicitly. For example, the refinery, steel mill, aluminium smelter and cement plant.

How industries operate and function within the model is based on detailed in-house analysis as well as analysis of published literature. It is also informed by engagement with technical experts, industry specialists and takes into account industry forecasts. This means where there are physical constraints on how a plant operates, for example, this is reflected.

ENZ models future activity for heat, industry and power based on historic trends, assumed growth and known dependencies such as fuel costs, competition for resource and other input drivers. ENZ deploys new emissions reduction technologies when they become technologically ready and economically viable.

### *Electricity generation*

ENZ includes a basic representation of the electricity sector and runs and builds generation to meet the demand set by industries, households and other user groups. Demand is coarsely classified in terms of baseload demand and flexible demand – flexible demand sets the requirement for flexible generation which fossil fuelled ‘thermal’ power plants help to meet in the system.

Most thermal generation plants are represented explicitly in the model, whereas renewable resources are aggregated by primary energy resource. There is a short ‘generation stack’ of committed projects which add to this renewable resource and beyond this a representative cost and supply curve of new geothermal, wind and solar projects.

Thermal generation runs in the model up to the threshold where it would be equivalent cost to build a renewable resource which is only generating some of the time and spilling energy for the rest. As the cost of thermal generation increases with fuel and carbon price, and the cost of renewable generation is projected to fall, thermal generation plays a decreasing share in each of these scenarios.

Other points to note:

- As wind and solar generation penetrate further into the system they became less valuable in the electricity market as they can be always generating, or not generating at the same time – this effect is represented by cost penalties in the model which dynamically increase the cost of these resources.
- The operation of gas and coal generation is one cause of electricity generation emissions that the model reports. The model also reports aggregate emissions from geothermal generation.
- The model does not represent varying hydro flows and manage hydro reservoir resource. Hydro generation is for an average year, but the dry year risk sets the capacity of thermal generation still in the system.
- This is not a market model with offers and bidders. The wholesale electricity price for the year is set by the long run marginal cost of the next renewable project to be built.
- This price becomes the input for other users in the model and is a factor on their decision to fuel switch to electricity.

### *Process heat*

ENZ includes a regional representation of process heat users in Aotearoa which links in with the forestry and agricultural modules. The food processing sector is represented in the most detail with dairy, meat and other food processing activity broken down to the regions of Northland, Central North Island, East Coast, Hawke’s Bay, Southern North Island, Nelson and Marlborough, West Coast, Canterbury, Otago and Southland.

Within the model the regional agricultural activity sets the demand for energy for the meat and dairy processing sectors. Along with deploying efficiency measures, these industries undertake fuel switching to biomass or electricity as fossil fuel costs increase. The local forestry harvest sets the availability of biomass as forestry residue or pulp logs which users generally take up to the extent they are available. The model ensures that the biomass resource is not utilised multiple times.

The cost of fuel switching from coal, gas and diesel to biomass or electricity is based on new boiler cost estimates, connection costs and fuel prices. These factors are encapsulated within a 'marginal abatement cost' calculation and industries begin to convert their boilers as the carbon price approaches this.

## Land

ENZ contains the land uses which are the main sources of emissions and removals from the land sector. It includes the area and emissions associated with each land use.

The land uses included in ENZ are:

- Sheep, beef and deer farming<sup>31</sup>
- Dairy farming
- Horticulture
- Arable farming
- Exotic forest (pre-1990 and post-1989)
- New native forest (Post-1989)
- Other

While these are not the only land uses that contribute to emissions or emissions removals, they make the biggest contribution towards emissions budgets and targets. For example, pre-1990 native forests are not included in the model as legal protections mean their area is restricted from changing significantly.

ENZ models land in Aotearoa at a national level. However, also understanding the trends in Māori collectively-owned land is a critical layer in the analysis. Data limitations mean it is not possible to consider specific projections for Māori collectively-owned land out to 2050 but relevant information about Māori collectively-owned land is considered alongside the reference case projections.

Of note, a crude attempt at estimating a Māori emissions profile by iwi takiwā could be achieved through Crown agencies including Te Puni Kōkiri, Ministry for the Environment, Ministry for Primary Industries, Manaaki Whenua, Te Tumu Paeroa and other Crown Research Institutes, giving effect to kotahitanga and working collaboratively to build on existing data. Addressing this gap, and the associated information and capability enablement required, is consistent with giving effect to rangatiratanga and supporting more equitable outcomes for iwi/Māori. However, it is imperative that the enabling platform/mechanism ensures iwi/Māori-collectives maintain mana motuhake (control and autonomy) over their data and information.

For the land sector, ENZ draws on land areas and livestock numbers from the Ministry for Primary Industries (MPI) October 2020 data update and uses these to model emissions and output. ENZ is calibrated to historic data and produces similar but not identical outcomes to Government models.

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<sup>31</sup> Area used for production, not whole owned area.

The key model underlying the activity data is MPI's Pastoral Supply Response Model, which projects trends in animal populations, primarily in response to export prices, productivity trends and the returns on agricultural land relative to forestry.

Greenhouse gas emissions are calculated as a function of land area, stocking rates, animal productivity and the application of emissions reduction technologies:

- Land areas for the different farm types are input assumptions
- Average stocking rates are specified for dairy and sheep and beef. In the Current Policy Reference case these are based on projected livestock populations from MPI.
- Production per animal is projected based on two factors: (1) a baseline rate of improvement based on MPI's projections, (2) an equation relating changes in stocking rate to changes in production. The latter assumes production per animal can increase up a curve towards a maximum value as stocking rate is reduced. The curve parameters are varied by scenario.
- Baseline emissions per animal are projected based on the observed relationship to production per animal, with parameters fitted to historic data.
- The impact of emissions reduction technologies, such as low-methane breeding, is superimposed on this baseline trend. These technologies are assumed to have no impact on production.

Forestry carbon dioxide emissions and removals are calculated in the ENZ model using methodology and assumptions consistent with MPI's forestry emissions model. We apply the accounting approach described in *Chapter 3: How we measure progress*, with post-1989 exotic production forests credited up to an 'averaging age' of 22 years.

Forestry yields and economics are modelled based on assumptions provided by Scion. Harvest yields are assumed to increase over successive forestry vintages due to genetic improvements. However, carbon sequestration lookup tables are assumed to remain constant over time, in line with current accounting conventions. Volumes of forest harvest residues, pulp logs and saw logs are calculated to provide estimates of available biomass supply for bioenergy and forestry sector revenue.

The small proportion of emissions from other livestock is taken as a fixed projection from MPI. Emissions from horticulture and cropping, which arise from fertiliser and lime application, are assumed to scale with land area.

## **Waste**

For the waste sector, ENZ draws on the Ministry for the Environment's (MfE) "with existing measures" scenario modelling and assumptions for both future volumes and destinations of waste and the current use of different emissions reduction technologies. These Government projections estimate what might occur in the waste sector if existing policies and measures are maintained.

It models the main parameters which affect landfill and waste emissions: how much waste ends up in landfill sites, how much waste can be recovered from landfill and how widespread and efficient gas capture systems are at disposal sites.

The recovery measures modelled in the waste module are: recycling, composting, anaerobic digestion and boiler fuel. The baseline for all the recovery measures has been set at zero, as any changes to waste volumes will reduce the waste to landfill baseline.

ENZ includes the broad categories of disposal sites: municipal with landfill gas (LFG) capture, municipal with no LFG capture, non-municipal landfills and farm fills. It also includes other waste disposal end points including biological treatment (composting), anaerobic digestion and open burning/incineration.

## Appendix 2: Detailed Current Policy Reference case assumptions

In addition to what has been outlined in this chapter, the Current Policy Reference case uses several other assumptions for the overall economy and each sector. These are presented here. The assumptions represent some of the vectors of uncertainty discussed in the chapter and as such should not be taken as expectations of what “will” happen in the future. Real values will likely vary from the reference case assumptions. We aim to capture the potential variation this may cause for the level of additional effort required to meet emissions budgets through the multiple scenarios developed in *Chapter 8: What our future could look like*.

Table 7.44: Key assumptions in the Current Policy Reference case

Assumption	2018	2030	2050	Source/evidence
<b>General</b>				
Population (million)	4.841	5.524	6.160	Stats NZ (50th percentile population)
GDP (billion NZD)	248	324	458	Stats NZ (1.2% labour productivity growth)
NZ ETS carbon price (real NZD)	\$35	\$35	\$35	Government October 2020 data update
Oil Price (real 2020 USD/barrel)	\$70	\$60	\$60	Broadly consistent with International Energy Agency, Sustainable Development Scenario <sup>32</sup>
Exchange rate (NZD/USD)	1.5	1.5	1.5	
Notes and explanations				
<b>Transport</b>				
Assumption	2018	2030	2050	Source/evidence
Total household passenger-kilometres (billions)	56.0	62.2	68.7	Ministry of Transport (2019A) <sup>*33</sup>
Total freight tonne-kilometres (billions)	30.6	36.3	41.1	Ministry of Transport (2019A)*

<sup>32</sup> IEA (2020)

<sup>33</sup> Items with a “\*” also incorporate Commission updates to reflect revised assumptions about population, GDP, and COVID-19.

<b>Domestic air passenger-kilometres (billions)</b>	7.3	8.0	11.0	Ministry of Transport (2019A)*
<b>International air passenger departures (millions)</b>	6.0	7.0	12.0	Ministry of Transport (2019A)*
<b>International shipping tonnes imports + exports (millions)</b>	51	56	48	Ministry of Transport (2019A)*
<b>Public transport type share by distance</b>	3.4%	5.0%	6.3%	Ministry of Transport (2019A)*
<b>Walking and cycling share by distance</b>	2.2%	2.1%	2.1%	Ministry of Transport (2019A)
<b>Rail and coastal shipping freight share by tonne-kilometres</b>	26.3%	24.5%	24.6%	Ministry of Transport (2019A)
<b>Cost of batteries (USD/kWh)</b>	\$176	\$60	\$37	BloombergNEF New Energy Finance (2020)
<b>Capital cost penalties on light passenger electric vehicles</b>	26%	15%	0%	Commission Staff Assumption
<b>Productivity penalty for electric heavy trucks</b>	20%	16%	9%	Commission Staff Assumption
<b>RUC Exemption for electric vehicles</b>	Light electric vehicles are assumed to be exempt from road user charges (RUC) until 2022, and heavy electric vehicles are assumed to be exempt from RUC until 2028, consistent with existing policy. After these dates, electric vehicles are assumed to pay applicable RUC for their vehicle class.			
<b>Notes and explanations</b>	<p>Household travel is defined as per the New Zealand Household Travel Survey.<sup>34</sup> It includes travel for personal reasons and commuting to work, but does not include other business travel.</p> <p>International shipping declines between 2030 and 2050 due to the expected peaking in log shipments in the 2030s, the so-called 'wall of wood'.</p> <p>Rail and coastal shipping freight share declines slightly due to expected declines in two major rail commodities: logs and coal. Both types of transport are assumed to maintain their current market share for each major commodity group.</p>			
<b>Buildings</b>				

<sup>34</sup> Ministry of Transport (2020)

Assumption	2018	2030	2050	Source/evidence
Number of residential buildings	1.77 million	2.00 million	2.23 million	2018 value is number of registered electricity meters. Projection is based on historic relationship with population
Number of commercial and public buildings	0.18 million	0.21 million	0.23 million	2018 value is number of registered electricity meters. Projection is based on historic relationship with GDP
Energy intensity of retrofitted building relative to 2018 building stock average	95% (residential buildings) 90% (commercial and public buildings)			Modest energy reduction is consistent with findings from Warmer Kiwi Homes program that energy efficiency improvements in existing homes do not reduce metered energy use but do lead to warmer and healthier homes. <sup>35</sup>  More substantial opportunities in other buildings which are not underheated to the same extent.
Energy intensity of new buildings relative to 2018 building stock average	100%	77% (space heating) 89% (water heating)	70% (space heating) 85% (water heating)	More significant opportunity for reducing energy use in new buildings compared with existing.
Retrofit cycle	1.3% of total residential buildings per year 2.5% of total commercial and public buildings per year			
Notes and explanations	<p>The modelling approach is a basic building stock model of residential and commercial and public buildings. Old and new buildings have different assumptions around existing and future energy intensity.</p> <p>Assumptions around use of gas are the most critical in terms of operational emissions. There is a consumer choice function in the model which selects gas or electric heating at the time of a new build or during a retrofit. The selection depends on the relative costs of technologies and operation. In this Current Policy Reference case, energy costs do not change significantly and so the balance of gas heating to electric systems is similar to today.</p>			
<b>Heat, industry and power</b>				

<sup>35</sup> Grimes et al (2011)

Assumption	2018	2030	2050	Source/evidence
Food processing efficiency improvements per year	0.7%	0.7%	0.7%	Based on industry engagement and industry targets
Aluminium smelter closure	Staged closure between 2024 and 2026			Assuming a further 3-5 years operation beyond signalled closure date. The Government has signalled that this is the extension they are trying to negotiate. <sup>36</sup>
Methanol production completion	Staged closure between 2026 and 2029			Based on Methanex's current gas contracts <sup>37</sup>
Iron and steel production	10% reduction in production in 2020 relative to 2016-2019 average. Constant production beyond this.			Bluescope Steel are undertaking operation restructuring which is likely to reduce production
Oil refining production	18% reduction in production in 2020 relative to 2016-2019 average. Constant production beyond this.			Based on Refining New Zealand's announcement that production is being cut to 1995 levels <sup>38</sup>
Notes and explanations	<p>The assumptions of food processing energy efficiency improvements represent business as usual improvements which are largely met by industry under annual energy performance targets. These energy intensity reductions are not price driven in the model to acknowledge the barriers to energy efficiency which exist, even when many technologies are identified as low cost.<sup>39</sup></p> <p>There are not enough gas reserves for methanol production to continue out to 2050, based on current production levels.<sup>40</sup> As such, the closure of methanol production is assumed. The assumption that production will end in 2029 is based on the end date of Methanex's existing gas contracts. When a closure occurs is subject to a high level of uncertainty.</p> <p>There is a high degree of uncertainty in the assumption that steel, cement, oil refining and lime and glass production remain constant out to 2050. In 2020, strategic reviews of both the oil refinery and the steel mill were undertaken. The outcome of both reviews resulted in a cut back on jobs and production, and the ongoing operation of these sites remains uncertain.</p>			
<b>Land</b>				
Assumption	2018	2030	2050	Source/evidence

<sup>36</sup> New Zealand Labour Party (2020)

<sup>37</sup> Methanex (2018)

<sup>38</sup> Refinery New Zealand (2020)

<sup>39</sup> Atkins (2019)

<sup>40</sup> Ministry of Business, Innovation & Employment (2020)

<b>Average log price (\$/t harvest volume)</b>	148.54	145.00	145.00	MPI October 2020 update
<b>Milk price (\$/kg milk solids)</b>	6.73	6.83	6.83	MPI October 2020 update
<b>Meat prices (indexed to 2019 actual price)</b>	0.98	1	1	MPI October 2020 update
<b>Methane inhibitor or vaccine</b>	None			
<b>Freshwater policy</b>	National Environmental Standards for Freshwater and National Policy Statement for Freshwater Management (3 September 2020)			Incorporated in MPI October 2020 updated activity data
<b>NZ ETS policy Settings</b>	<ul style="list-style-type: none"> <li>- Agriculture included at the processor level with 95% free allocation from 2025</li> <li>- June 2020 amendments to forestry in the NZ ETS, including averaging for post-1989 forests and a permanent forest activity phasing in by 2023.<sup>41</sup></li> </ul>			Reflected in Government October 2020 projections update
<b>Notes and explanations</b>	Key land sector assumptions include commodity prices for meat, milk and logs, which are taken from MPI projections. As future export prices are notoriously difficult to predict, these projections hold constant from five years onwards.			
<b>Waste</b>				
<b>Assumption</b>	<b>2018</b>	<b>2030</b>	<b>2050</b>	<b>Source/evidence</b>
<b>Waste to landfill</b>	9,779 kt	10,978 kt	12,394 kt	Modified BR4/MfE waste models
<b>Waste recovery (increase from 2018 levels)</b>	-	-	-	Commission Staff Assumption
<b>Sites with LFG capture</b>	Existing municipal sites	Existing municipal sites	Existing municipal sites	MfE waste models
<b>LFG recovery rate</b>	68%	68%	68%	MfE staff
<b>Notes and explanations</b>	<p>The assumptions of total waste volumes have been taken from MfE projections, as have the number of sites with landfill gas capture and the average landfill gas recovery rate.</p> <p>There has been no increase of waste recovery in alignment with MfE's "With Existing Measures" scenario. Any potential changes to future waste volumes in the upcoming Greenhouse Gas Inventory will be reflected as a new baseline for total waste volumes</p>			

<sup>41</sup> For further details see Ministry for Primary Industries (2020).

