Chapter 6

Te pae tawhiti ki 2050
Long-term scenarios to 2050

Summary

There are a number of actions that are critical over the next 15 years to put Aotearoa on track to meeting its 2050 targets. How quickly these actions can be taken up is uncertain and will depend on a number of factors, for example availability of technology.

The Commission has developed multiple scenarios to understand how Aotearoa could meet the 2050 targets under a range of possibilities. This shows what actions are key to meeting the 2050 targets.

We have also looked at what would happen to emissions if Aotearoa continued as it is now and made no changes to policy, and what would happen if Aotearoa followed an approach that focused on reducing net rather than gross emissions. The 2050 targets would not be achieved or sustained under either scenario.

Our scenarios allow us to gain a number of insights on critical actions:

For long-lived gases

- Replacing fossil fuels with low-emissions electricity is an essential part of the transition and will require major expansion in the electricity system that needs to start now.
- Road transport can be almost completely decarbonised by 2050 by increasing walking, cycling and public transport use, reducing travel by working from home, and by switching to low emissions vehicles.
- Reducing emissions from transport will require a rapid increase in electric vehicle sales so that nearly all light vehicles entering the country are electric by 2035.
- Low- and medium-temperature heat in industry and buildings could be decarbonised by 2050 through a switch away from coal, diesel and fossil gas to electricity and biomass.
- New native forests can be established on steeper, less productive land to provide a long-term carbon sink.
- Exotic production forestry has a role to play until other more enduring sources of carbon removals, such as native forestry, can scale up.

For biogenic methane

- Meeting the 2050 biogenic methane target is possible through widespread adoption of improved farm management practices, and a combination of waste reduction and diversion from landfills.
- Developing and widely adopting new technologies to reduce livestock methane emissions could enable Aotearoa to exceed the more ambitious end of the 2050 methane target range. Increasing landfill gas capture would also contribute.
- Without new technologies, meeting the more ambitious end of the target range would likely require significantly lower agricultural production from livestock and more land-use change.

Changes in our final advice

We have provided more details of would happen without changing policy, and what would happen if Aotearoa focused on net emissions and not gross.

Figures for greenhouse gas emissions have been updated to reflect the latest national Greenhouse Gas Inventory published in April 2021. This update provided estimates of emissions in 2019, as well as improving estimates of past emissions.

Introduction

1 Under the Climate Change Response Act (the Act), emissions budgets must put Aotearoa on track to meet its 2050 emissions reduction targets (2050 targets).

2 To understand the pace and types of change that might be needed over the next 15 years to put Aotearoa on track to meet these targets, we modelled a series of long-term scenarios. Each of these long-term scenarios differed in the assumed amount of technology and behaviour change.

3 Assessing the potential for future emissions reductions always has some uncertainty. Technologies could end up reducing in cost faster than we expect, while other technologies could be slower. To provide us with confidence that Aotearoa can meet the 2050 targets, Aotearoa needs to make decisions now that open up options in the future. This will provide some contingency in the case that particular technologies or behaviour changes do not play out as expected.

4 In this chapter, we look at the emissions reductions that could be achieved if Aotearoa was to continue under its current policy settings. We then look at several long-term scenarios to understand the actions that would be critical to deliver the 2050 targets. We also looked at what would happen if Aotearoa was to take an approach that focused on reducing net rather than gross emissions.

6.1 Emissions in Aotearoa now

5 In 2019, gross greenhouse gas emissions in Aotearoa were about 48.6 $MtCO_2e$ of long-lived greenhouse gases and 1.35 $MtCH_4$ of biogenic methane. These are the most recent numbers available.

6 Agriculture is currently the largest source of biogenic methane, with the remainder from waste.

7 Long-lived greenhouse gas emissions are mainly from carbon dioxide, but also include nitrous oxide. We have also included non-biogenic methane and F-gases in this category to align with the split-gas target in the Act, although non-biogenic methane and some F-gases are short-lived. Transport, buildings, heat, industry and electricity, agriculture and waste all emit long-lived greenhouse gases (Figure 6.1).

8 The level of gross emissions has been relatively stable in recent years. However, emissions from domestic transport have continued to rise even as emissions from other sectors stabilised or decreased. The next section considers how emissions could change in the coming years under current policy settings.

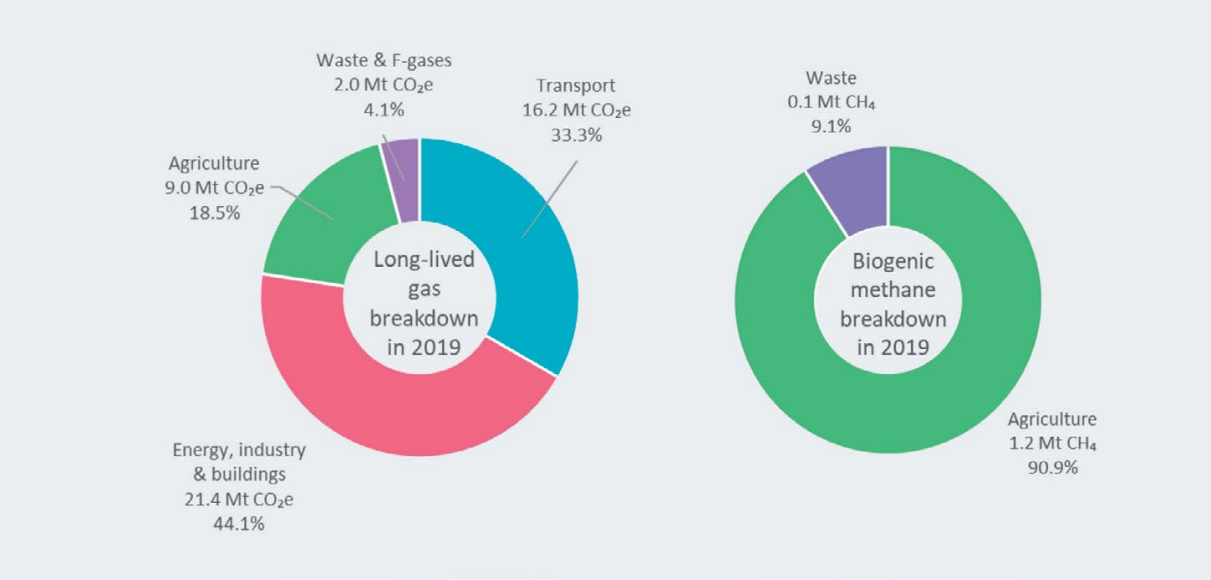

Figure 6.1: The sources of gross long-lived greenhouse gases and biogenic methane in 2019 broken down by sector. Agricultural biogenic methane emissions are 50% dairy, 48% sheep and beef and 2% other. Note: Building emissions relates to their energy use, but not construction.

Source: *New Zealand's Greenhouse Gas Inventory.*

Box 6.1: Revisions to New Zealand's Greenhouse Gas Inventory

Figures for greenhouse gas emissions presented in this report have been updated to reflect the latest version of *New Zealand's Greenhouse Gas Inventory* (the GHG Inventory) which was published by the Government in April 2021. This update provided estimates of emissions in 2019, as well as improving estimates of past emissions.

The new estimates are higher than the estimates that were available when the Commission provided its *2021 Draft Advice for Consultation* in February 2021. Improvements to the GHG Inventory can increase or decrease the estimated level of emissions and are important for keeping the GHG Inventory in line with the latest understanding of the science. The Government will need to take into account the impact of changes in the GHG Inventory in how it plans to meet the emissions budgets. This is discussed further in *Chapter 10: Rules for measuring progress towards emissions budgets and 2050 targets.*

6.2 Current policies do not enable Aotearoa to achieve targets

9 As a starting point for our analysis, we looked at how emissions and activities could evolve assuming no changes to current government policy between now and 2050.

10 We assess this through our Current Policy Reference case, which is a scenario that aligns with government agencies' latest emissions projections as far as possible. Under current policies, long-lived greenhouse gas emissions (Figure 6.2) and biogenic methane emissions (Figure 6.3) are both projected to fall. However, the level of emissions reductions would not be sufficient to meet the 2030 and 2050 targets.

11 Net long-lived greenhouse gas emissions are projected to fall from 41.3 $MtCO_2e$ in 2019 to 9.8 $MtCO_2e$ by 2050 under current policy settings. These net emissions reductions come mostly from increased carbon removals, with 1.1 million hectares of new forest, mostly exotic, planted by 2050. This level of forest planting is projected to occur in response to emissions prices, and in particular the price of units in the New Zealand Emissions Trading Scheme (NZ ETS), staying constant in real terms at $35.

12 Gross long-lived greenhouse gas emissions would also fall. This is primarily due to widespread use of electric vehicles expected after 2035, the announcement by Rio Tinto that the Tiwai Point aluminium smelter would close at the end of 2024, and the assumption that declining fossil gas supply results in methanol production declining in Aotearoa in the next few decades. Other sources of long-lived greenhouse gas emissions are largely unchanged.

13 Biogenic methane emissions are projected to fall 7% below 2017 levels by 2030 compared with the target of 10%. By 2050, they are projected to fall 11% below 2017 levels compared with the target range of 24–47%. Emissions reductions occur through a combination of land-use change from agriculture to forestry and other uses, reductions in dairy cow numbers partly due to freshwater policy, and ongoing improvements in the emissions efficiency of agricultural production.

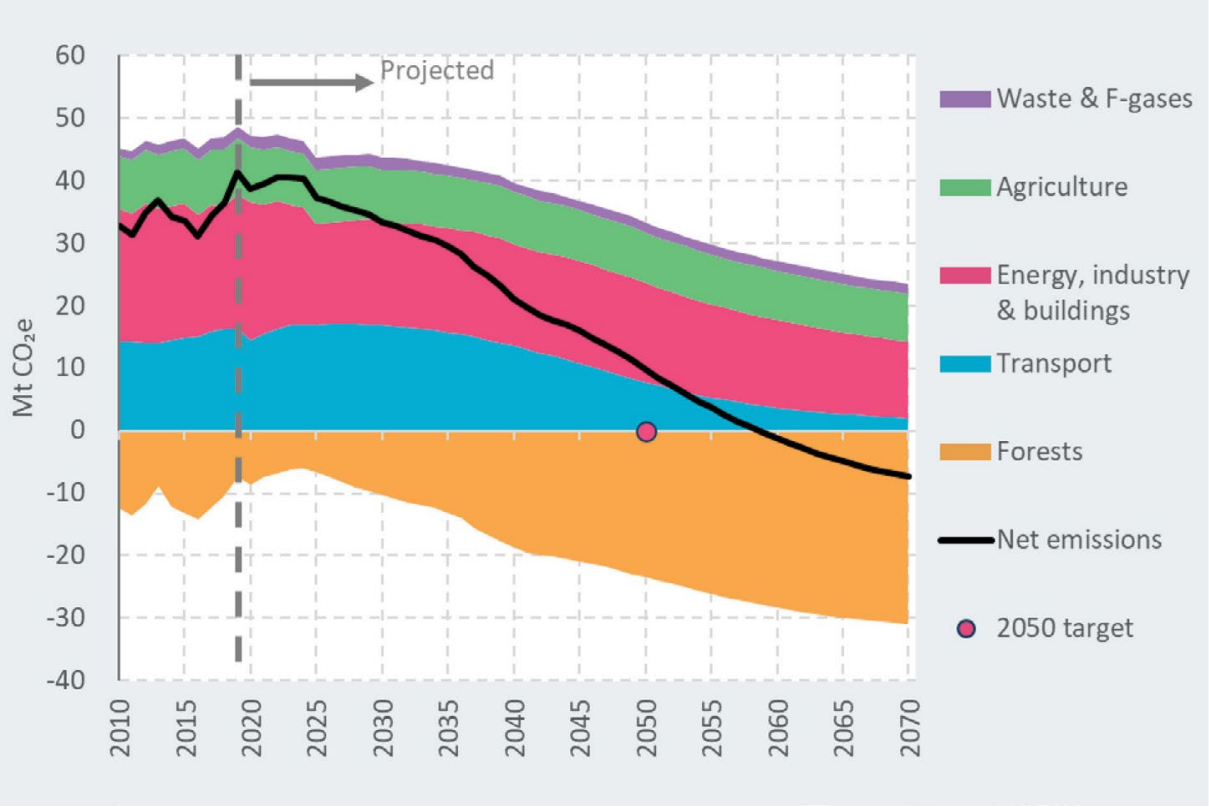

Figure 6.2: Long-lived greenhouse gas emissions to 2070 projected under current policies.

Source: Commission analysis.

Figure 6.3: Biogenic methane emissions to 2070 projected under current policies.

Source: Commission analysis.

6.3 Relying too much on forests will not lock in net zero

14 Previous analysis of how to reach a low-emissions Aotearoa by the Productivity Commission and Ministry for the Environment have focused on reducing net emissions without constraining the contribution of carbon removals by forests. This is different to the approach we have taken in our analysis, which is focused on delivering the requirements in the Act.

15 We ran a scenario where we did not constrain carbon removals by forests to get a sense of what the future could look like under that approach. We found that increasing the emissions price from $35 a tonne of CO_2e under the Current Policy Reference case to $50 a tonne of CO_2e would come close to meeting the 2050 net zero target for long-lived greenhouse gases (Figure 6.4).

16 However, the slightly higher emissions price under this 'unconstrained removals' scenario would encourage only a very small reduction in gross long-lived greenhouse gas emissions, of around 0.5 $MtCO_2e$.

17 Instead, it would encourage much more exotic forestry to be planted. Exotic forestry would sequester a further 8.7 $MtCO_2$ in 2050 compared to the Current Policy Reference case. This would come from planting a further 400,000 hectares of new forest by 2050, in addition to the 1.1 million hectares expected under the Current Policy Reference case.

18 Significant further forest planting would be required after 2050 to maintain net zero long-lived greenhouse gas emissions. Figure 6.4 shows that if there were no further forestry planting or policy changes, net emissions would bounce back above zero before 2065 as the temporary exotic forest carbon sink declines.

19 This would be despite gross emissions reducing significantly after 2050 due to continued turnover of vehicles from internal combustion engine models to electric, and reductions in fossil gas use as supply declines.

20 An approach that does not constrain carbon removals by forests would not drive meaningful decarbonisation before 2050 and would instead use up land resources for the purpose of offsetting emissions in areas where there are proven options to reduce gross emissions.

21 This approach is not sustainable, would leave Aotearoa out of step with the rest of the world, and would leave the next generation with the task of reducing gross emissions at the same time as they will need to be adapting to escalating climate change impacts.

22 As described in the next section, our scenarios for meeting the 2050 targets represent a shift away from this approach.

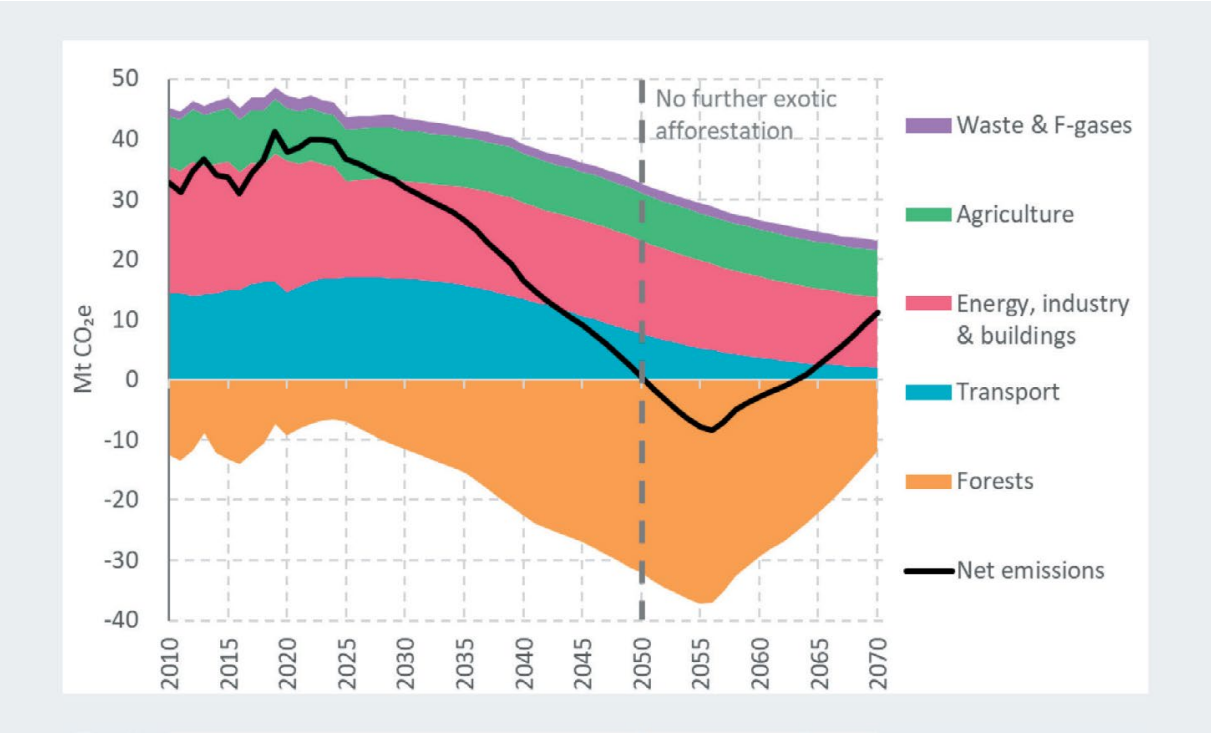

Figure 6.4: Long-lived greenhouse gas emissions in the 'unconstrained removals' scenario, with a $50/tonne emissions value applied to forestry, energy and transport.

Source: Commission analysis.

6.4 Understanding the changes required to reach 2050 targets

23 We have developed a set of scenarios (depicted in Figure 6.5) designed to deliver the 2050 targets, with an emphasis on gross emissions reductions, under a range of future conditions.

24 This set of scenarios helps us to understand the changes that are possible over time. Our scenarios have been designed to look at how Aotearoa could meet the 2050 targets if future conditions were more, or less, favourable. The main scenarios are:

- **Headwinds** – our least optimistic scenario. It examines a future where there are more barriers to adopting both technology and behaviour changes in the future.
- **Further Technology Change** – examines a future where there are fewer barriers to technology changes. Relative to the Headwinds scenario, technologies could be available sooner, perform better or have lower costs which help drive greater adoption.
- **Further Behaviour Change** – examines a future where there are fewer barriers to people and businesses changing behaviour and choosing low emissions options. There are conservative improvements in technology as per the Headwinds scenario, but barriers to adopting existing technologies are lower.
- **Tailwinds** – our most optimistic scenario. It examines a future where there are fewer barriers to technology and behaviour changes.

25 More information on these scenarios can be found in *Chapter 12: Long-term scenarios to meet the 2050 target* of the *2021 Supporting Evidence.*

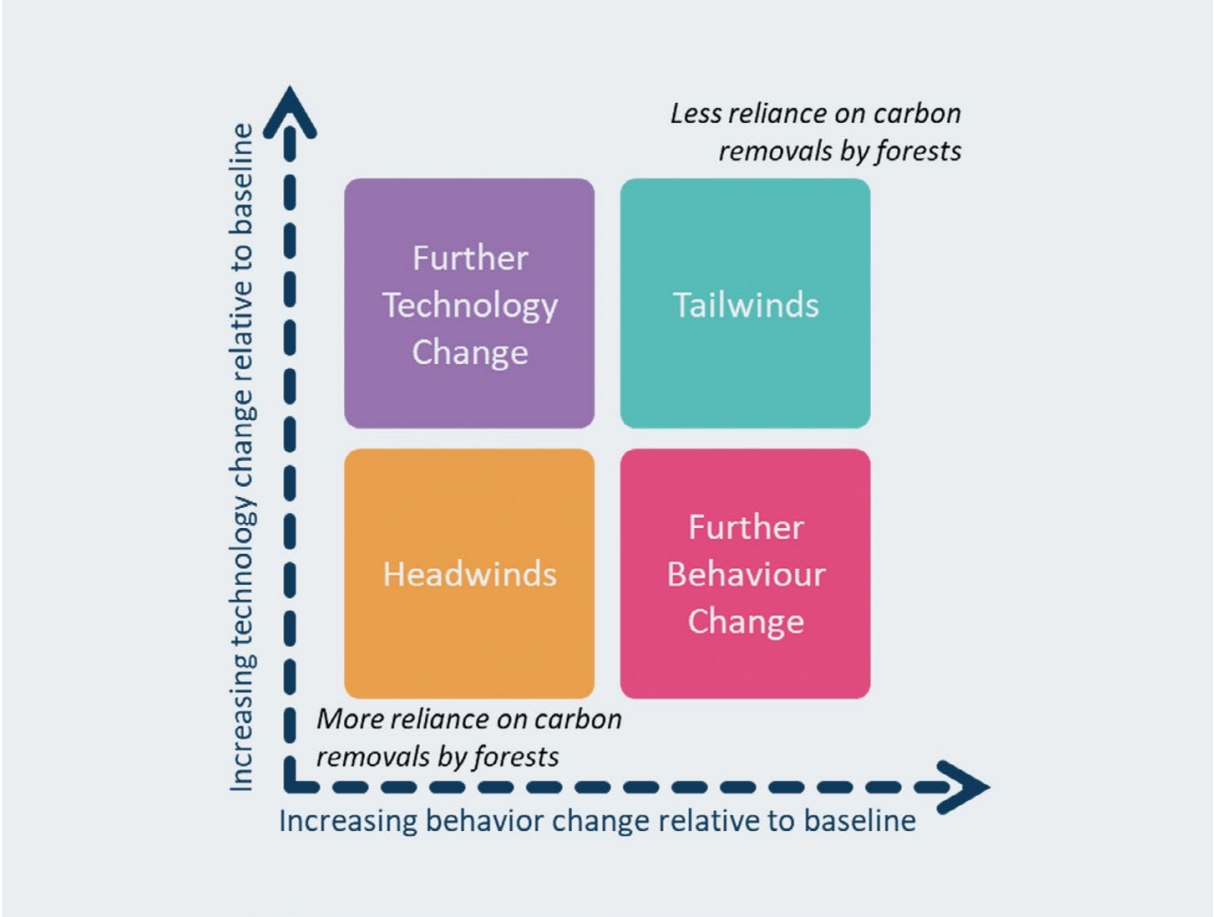

Figure 6.5: Scenario structure for the long-term scenarios to 2050.

6.4.1 Key insights from our scenarios for long-lived greenhouse gases

26 Aotearoa could achieve net zero long-lived greenhouse gases sometime in the 2040s through changes in technology and behaviour (Figure 6.6). Our Tailwinds scenario achieves this by 2040. In our Headwinds scenario net zero long-lived greenhouse gases would still be achieved by 2048, with a greater reliance on carbon removals by forests (Figure 6.7).

27 Many actions to reduce emissions are common to both the Headwinds and Tailwinds scenarios, but differ in terms of the timing or level of uptake. This is because most of the solutions for reducing long-lived greenhouse gases already exist and are commercially available. This means it is not a question of 'if', rather it is a question of 'how fast' and 'how much'. Tailwinds also includes some actions to reduce emissions which are dependent on further innovation or behaviour change, and which are not included in Headwinds.

28 Key insights into emissions reductions from our scenario analysis include:

- Displacing fossil fuels with electricity is an essential part of the transition and will require major expansion of the electricity system. Wind, geothermal and solar power can meet the expected growth in demand from electrifying transport and heat to 2050 while keeping electricity affordable. Despite this growth, the emissions from generating electricity can reduce considerably relative to today.

- Road transport can be almost completely decarbonised by 2050 by increasing walking, cycling and public transport use, reducing vehicle travel, and by switching to low emissions vehicles. Decarbonising transport will require a rapid increase in electric vehicle sales so that nearly all vehicles entering the country are electric by 2035.
- Low- and medium-temperature heat in industry and buildings could be decarbonised by 2050 through a switch away from coal, diesel and fossil gas to electricity and biomass. The scale of switching required would require a steady and sustained effort over the 2020s, 2030s, and 2040s.
- Energy efficiency and behaviour changes that reduce energy demand will play an important role in many areas. These can help to cut emissions sooner and in hard-to-abate sectors. They can also contribute cost reductions and co-benefits.
- Nitrous oxide emissions from agriculture are relatively difficult to reduce, but reductions are possible through changes to farm practices, including reducing use of nitrogen fertiliser and by developing technology such as nitrification inhibitors.
- New native forests can be established on steeper, less productive land to provide a long-term carbon sink. With a sustained high rate of planting through to 2050, new native forests could provide a long-term carbon sink of more than 4 $MtCO_2$ per year, helping to offset residual long-lived greenhouse gas emissions from hard-to-abate sources.
- Exotic production forestry continues to have a role to play in removing carbon dioxide, particularly until other more enduring sources of carbon removals, such as native forestry, can scale up. The deep reductions in gross emissions in our scenarios mean the 2050 targets could be met with a significantly smaller area of new exotic forestry than would occur under current policy settings: a total of 570,000–760,000 hectares to 2050.

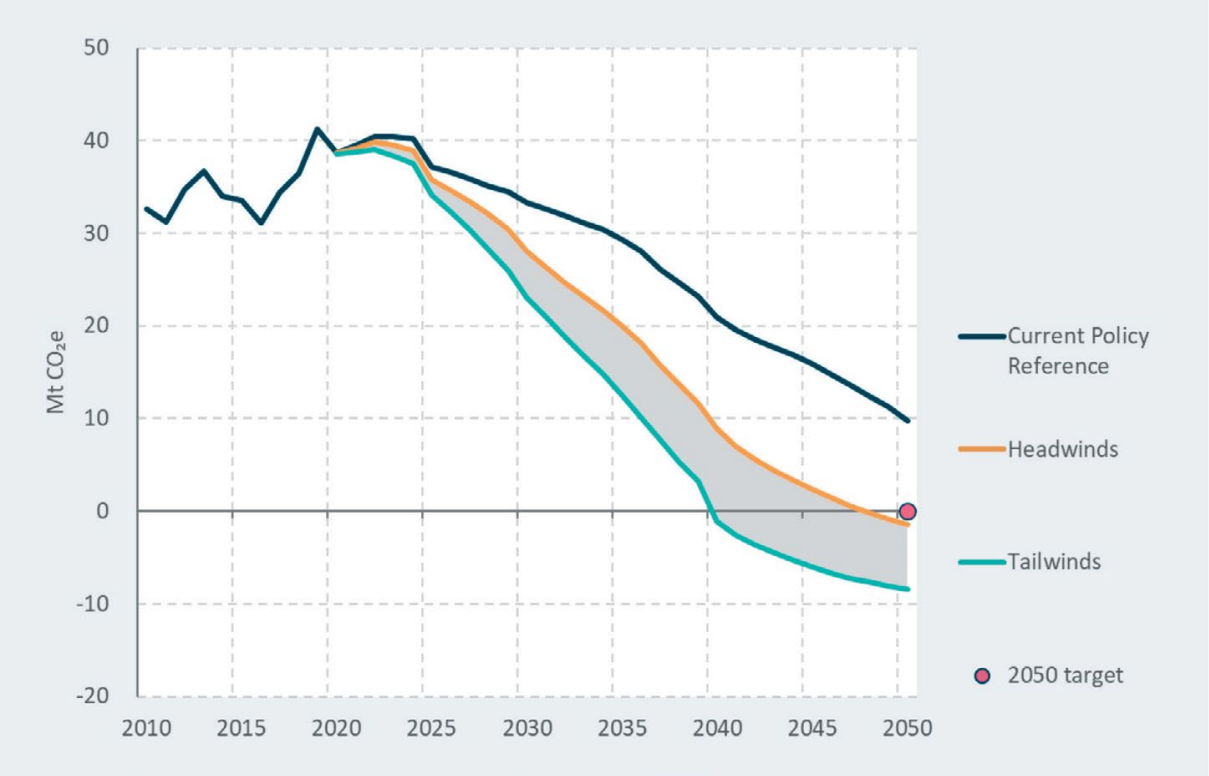

Figure 6.6: The path for net long-lived greenhouse gas emissions in the Headwinds and Tailwinds scenarios, compared with under current policies.
Source: Commission analysis.

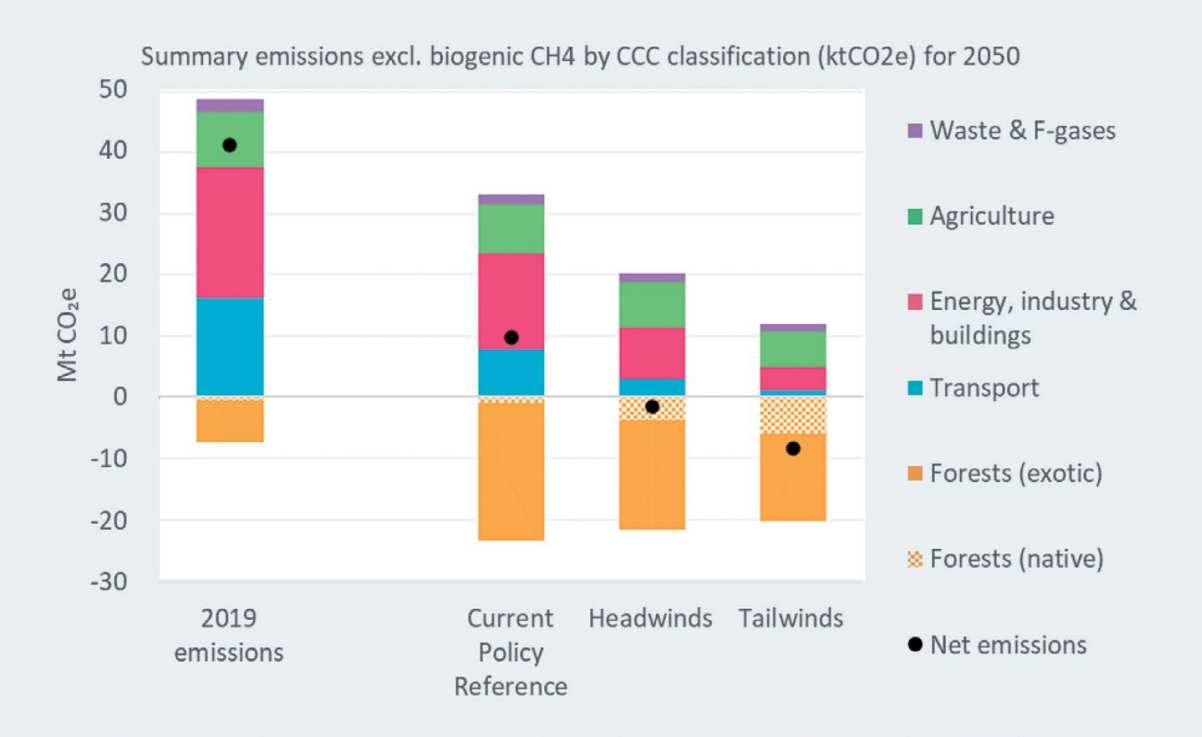

Figure 6.7: Long-lived greenhouse gas emissions by sector in 2050 in the Headwinds and Tailwinds scenarios, compared with under current policies and with 2019 emissions.

Source: Commission analysis.

6.4.2 Key insights from our scenarios for biogenic methane

29 Our scenarios show that, depending on technology and behaviour change in the next 30 years, it is possible to meet both the less ambitious (24% reduction) and more ambitious (47% reduction) ends of the 2050 target range for biogenic methane.

30 As our Headwinds and Tailwinds scenarios look out to 2050, we have anticipated that some new technologies are commercialised. However, for emissions budgets out to 2035 we have tested to ensure they could be met without any new technologies.

31 Under the Tailwinds scenario, major technology and behaviour changes combine to reduce biogenic methane to 57% below 2017 levels by 2050. This scenario assumes that:

- Biogenic methane inhibitors, biogenic methane vaccines and low emissions breeding are developed and widely adopted
- Farmers successfully implement ambitious practice changes to become more emissions efficient
- More than 100,000 hectares is converted from livestock agriculture to horticulture by 2050, nearly doubling the current area of horticulture
- Total organic waste to landfills is almost halved by 2035 alongside major expansion of landfill gas capture

32 Under the Headwinds scenario, slower changes in technology and behaviour make it challenging to meet the biogenic methane targets of 10% below 2017 levels by 2030 and 24% below 2017 levels by 2050 (Figure 6.8). Compared with our other scenarios, meeting these 2050 targets requires more land use change from livestock farming to exotic forestry, which is also needed to provide sufficient carbon removals to meet the net zero long-lived greenhouse gas target.

33 The difference between the Tailwinds and Headwinds scenarios for biogenic methane is larger than for long-lived greenhouse gases (Figure 6.9). This is because there is more uncertainty in what is achievable – meeting the more ambitious end of the 2050 target range for biogenic methane depends on whether new technology is developed and commercialised.

34 Insights from our scenario analysis for biogenic methane include:

- It is possible to meet the 2030 target and the less ambitious end of the 2050 target range through widespread adoption of low emissions farm management practices and a combination of waste reduction and diversion from landfills. This is with less land-use change to forestry than expected under current policies.
- Developing and widely adopting new technologies to reduce livestock methane emissions could enable Aotearoa to exceed the more ambitious end of the 2050 biogenic methane target range. Increasing landfill gas capture would also contribute.
- Without new technologies, meeting the more ambitious end of the 2050 target range would likely require significantly lower agricultural production from livestock and more land-use change.

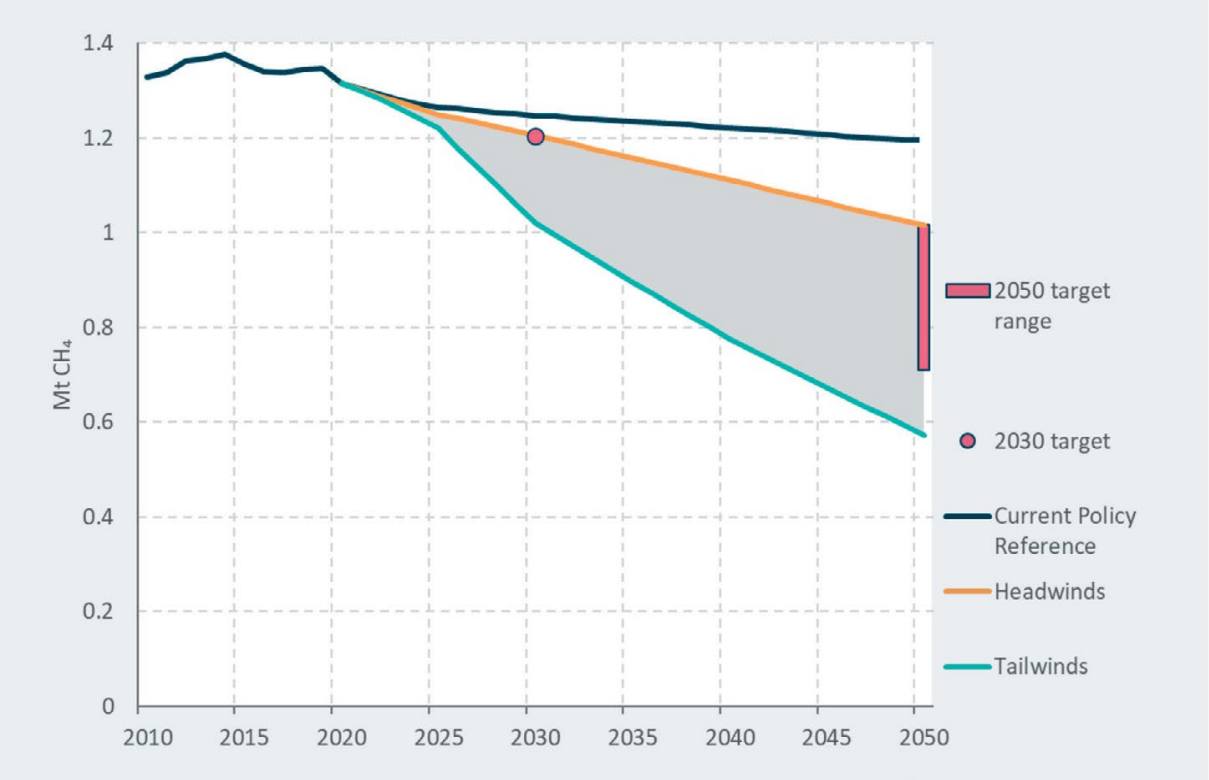

Figure 6.8: The path for biogenic methane emissions in the Headwinds and Tailwinds scenarios.
Source: Commission analysis.

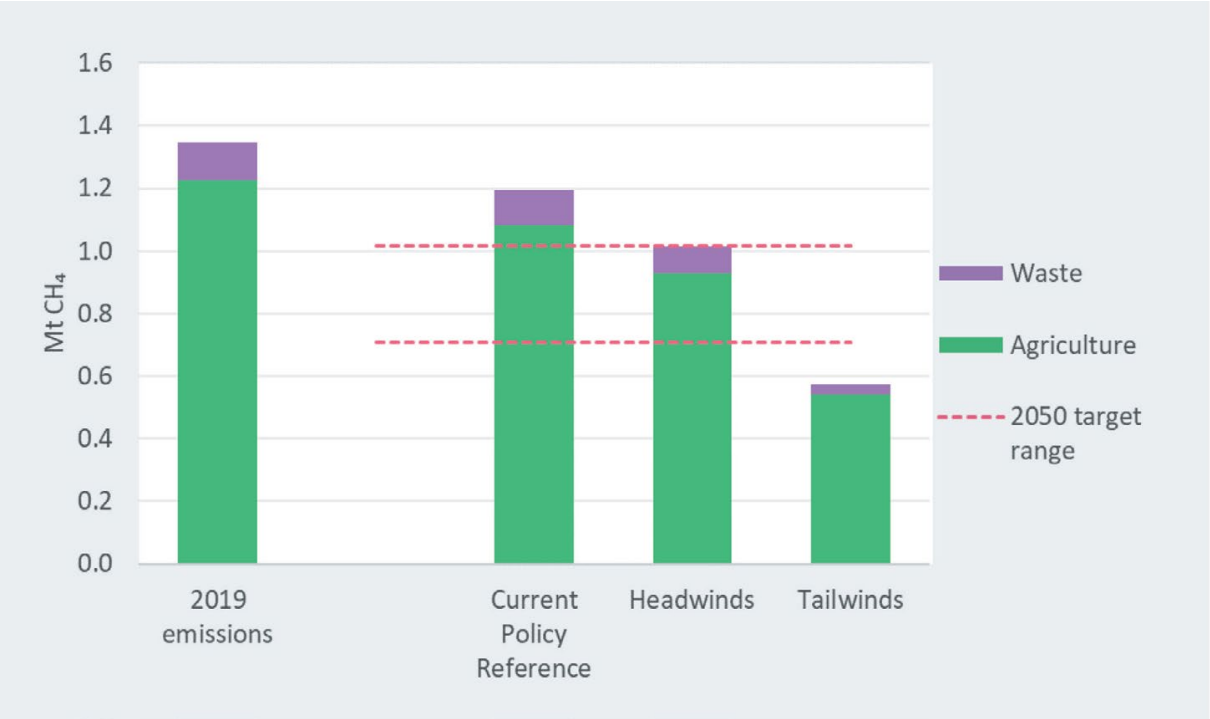

Figure 6.9: Biogenic methane emissions by sector in 2050 in the Headwinds and Tailwinds scenarios, compared with under current policies and with 2019 emissions.

Source: Commission analysis.

6.5 International aviation and shipping

35 Emissions from international aviation and shipping are not currently part of the 2050 targets in Aotearoa. We have heard from stakeholders that this is an important issue. We agree that these emissions are significant and part of the overall emissions footprint of Aotearoa that should not be ignored. As required by the Act, we will review whether these should be included in the 2050 targets in 2024.

36 We have designed the paths presented in the next chapter to make sure that our emissions budgets could allow Aotearoa to meet the net zero long-lived greenhouse gas 2050 targets including international aviation and shipping emissions in case a decision is made in future to include these.