He Pou a Rangi
Climate Change Commission

2021 Draft Advice for Consultation

Disclosure statement

As anticipated by the appointment criteria, the Climate Change Commissioners come from varying fields such as adaptation, agriculture, economics, mātauranga and the Māori-Crown relationship.

While a number of board members continue to hold roles within these fields, our advice is independent and evidence-based.

You can read more about our board members on the Climate Change Commission website. The Commission regularly updates and publishes on its website a register of relevant board and staff member interests.

Letter from the Chair

This report stands on the shoulders of many before us who have provided evidence and warnings about the impact of human created greenhouse gas emissions on our climate. It also recognises the people who have developed the tools we need to change our path. I want to acknowledge their work and express appreciation.

Now is the time for Aotearoa to take further steps to align its actions with its targets to reduce emissions. As a country we should use only our fair share of the remaining global carbon budget – the greenhouse gases we can emit and still limit warming. If we act now, we can create a thriving, climate-resilient and low emissions Aotearoa.

After 12 months of considered analysis, the Climate Change Commission's conclusion is that there are achievable, affordable and socially acceptable pathways for Aotearoa to take.

Now we must decide where our ambition lies. For my part, I want to be able to say I did as much as I could as soon as I knew about the impact I am having on this world. Increasingly I am sharing this sentiment with my fellow New Zealanders.

To achieve a cleaner, greener, healthier and more sustainable future, no emission reduction is too small – or too soon. All of us have a part to play and a contribution to make.

This means we need to change how we get around, and rethink what we produce and how we produce it. We need to reconsider what we buy, what we do with what we have used, and how we can reuse more of what we have left over.

The Commission recognises that what each of us can do depends on our circumstances. We will need to offer support to those most adversely impacted and who are also least able to absorb the impact of change.

Our draft advice is about the direction of policy necessary to put Aotearoa on a pathway to quickly, significantly and permanently reduce greenhouse gas emissions. Our advice sets out how to achieve the targets we have already agreed to.

We have drawn on the He Ara Waiora framework to help us understand wellbeing from a mātauranga Māori perspective. This has formed an anchor for our analysis.

We are seeking feedback on our draft advice before it is finalised. There are matters of fact, assumptions and value judgments we invite you to review. We are committed to true consultation. We will consider all evidence we receive through consultation and are prepared to change any part of our work in light of this.

It is reassuring to see central and local government, iwi/Māori, businesses, farmers and families taking action to understand and reduce emissions now. Every action makes a difference.

The climate science is clear, the direction of climate policy is laid out and the time for accelerated climate action is now.

Introducing the Climate Change Commission

Climate Change Commissioners

From left to right: Dr Judy Lawrence, Professor Nicola Shadbolt, Professor James Renwick, Ms Lisa Tumahai (Deputy Chairperson), Dr Rod Carr (Chairperson), Ms Catherine Leining, Dr Harry Clark.

Additional biographical information can be found on the Climate Change Commission website.

Contents

Vision

The Climate Change Commission's vision is of a thriving, climate-resilient and low emissions Aotearoa where our children thrive.

This future for Aotearoa is equitable and inclusive, protects livelihoods and makes economic sense. It is also a future that is possible if we take opportunities to evolve and change.

It is a country where people are respected stewards of the land. Where an innovative and resilient food and fibre sector succeeds in a low emissions world. Where abundant native bush stores carbon and is home to native birds and plants. Where our plantation forests support a flourishing bio economy, enabling low emissions construction, materials and energy.

It is an Aotearoa where cities and towns are created around people and supported by low emissions transport that is accessible to everyone equally. Where strong local businesses produce low emissions, high-value products that are in demand locally and globally. Where employers are successful and can support themselves and their employees in the transition to climate-resilience. Where everyone lives in warm, healthy, low emitting homes. Where urban form encourages cycling and walking, alongside efficient, affordable and interconnected public transport networks.

Hydro, wind, solar and geothermal energy power our country, and we are highly efficient and productive in resource use. Transport and industry are powered by electricity and other low emissions fuels. Energy is affordable and accessible. Communities can generate their own electricity using low emissions generation.

In our vision of the future, Aotearoa has a circular economy and generates very little waste. The waste that we do generate is recovered, reused where possible, and otherwise used to generate energy.

It is this vision of Aotearoa that is driving our work. To see it come to life we need strong and decisive action to address climate change. This advice presents the steps we need to take now to get there.

Executive Summary: work must start now

In Aotearoa, the Government has committed to reaching net zero emissions of long-lived gases by 2050, and to reducing biogenic methane emissions by between 24-47% by 2050.

The work that He Pou a Rangi, the Climate Change Commission, has carried out over the last year shows that meeting these targets is possible – and can lead to a thriving, climate-resilient and low emissions Aotearoa.

Transformational and lasting change across society and the economy will be needed, but the Commission's analysis shows the tools to start the work to reach our targets and address climate change in Aotearoa already exist.

To meet the Commission's proposed emissions budgets, Aotearoa does not need to rely on future technologies. As new technologies develop, this will allow the country to reduce emissions even faster.

However, the Government must pick up the pace. Aotearoa will not meet its targets without strong and decisive action now to drive low emissions technologies and behaviour change across all sectors. 2050 is not far away – particularly if you consider the life span of infrastructure, vehicles, buildings – and people.

Aotearoa must focus on decarbonising and reducing emissions at the source. As a country we can no longer rely on forests to meet our climate change targets.

Current government policies do not put Aotearoa on track to meet our recommended emissions budgets and the 2050 targets.

In 2018, gross greenhouse gas emissions in Aotearoa were about 45.5 Mt CO_2e of long-lived gases, and 1.34 Mt CH_4 (biogenic methane). Our analysis shows if policy stayed as it is now, Aotearoa would fall short of achieving the 2050 net zero long-lived gas target by 6.3 Mt CO_2e. Biogenic methane would reduce 12% below 2017 levels and fall short of the current target of 24-47%.

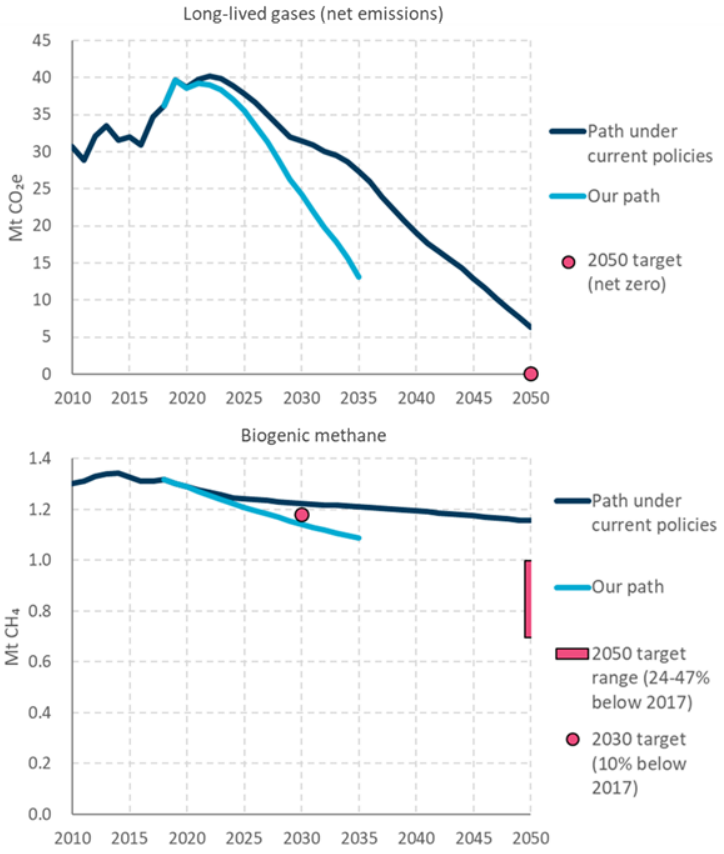


Figure ES1: Current government policies do not put Aotearoa on track to meet the Commission's emissions budgets and the 2050 targets. This figure shows how our path to 2035 would reduce emissions of long-lived gases (top figure) and biogenic methane (bottom figure)

The Emissions Trading Scheme (NZ ETS) alone won't get us to where we need to be. Action is needed across all sectors of the economy.

Priority areas for action include increasing the number of electric vehicles on our roads, increasing our total renewable energy, improving farm practices and planting more native trees to provide a long-term carbon sink.

Care should be taken to make sure climate related policies do not further compound historic grievances for Māori. To give effect to the Treaty Partnership, central and local government need to acknowledge iwi/Māori rights to exercise rangatiratanga and kaitiakitanga in a joint plan to reduce emissions.

The speed of this transition needs to be steady – fast enough to make a difference and build momentum but considered, with room to support people through the change. An equitable transition means making sure the benefits of climate action are shared across society, and that the costs of the climate transition do not fall unfairly on certain groups or people.

To achieve this, we need to understand that all things are connected: the people, the land, the atmosphere, the oceans. This connectivity – material and non-material – is central to Te Ao Māori. It is also essential to understanding how to guide a transition that is fair and equitable for people and the environment.

The transition must reduce emissions at pace while allowing the country to continue to grow, so that future generations inherit a thriving, climate-resilient and low emissions Aotearoa.

Our first package of advice

This advice provides Aotearoa with a comprehensive strategy for tackling climate change. It is also the starting point. It outlines the first in a series of steps that chart the course for reducing emissions.

We asked ourselves a series of questions when developing this advice. They are: Is this ambitious enough? Is it fair and equitable? Is it technically and economically feasible? And, can it be achieved through policy?

We have used a range of quantitative and qualitative tools, including economic models and analytical frameworks. Our analytical approach used the He Ara Waiora framework to understanding wellbeing from a mātauranga Māori perspective and form an anchor for our analysis.

Our advice includes recommendations on the level of the first three emissions budgets. It also provides advice on strategic policy direction for meeting the emissions budgets, looking at what's needed across different sectors. We recommend 17 critical actions the Government must take to reach its climate goals.

Many recommendations include indicators the Commission will use to monitor the Government's progress.

In developing our advice, we focused on key sectors across the economy, identifying where the greatest opportunities to reduce emissions are, and working with experts and stakeholders to understand the barriers for change. Some key findings from these sectors include:

Land

- Agriculture has a large role to play in reducing emissions, and farming needs to become even more efficient. There have been improvements in the last few decades, but more can happen.
- Aotearoa has been an agricultural world leader over recent decades. We must adapt and improve our use of our land to keep this status. This means developing, adopting and using practices and technologies that lower emissions and address climate change.
- Forests have a role to play, but we can't plant our way out of climate change.

What are we recommending?

- The Government needs a cohesive strategy that includes water, biodiversity and climate. There are multiple benefits to taking a holistic view of how we use and protect our land.
- There are changes farmers can make now to reduce emissions on their farms while maintaining, or even improving, productivity. This includes reducing animal numbers and better animal, pasture and feed management. Policy support is needed to make this happen.
- Our advice advocates for a long-term plan for targeted research and development of new technologies to reduce emissions from agriculture.
- Pine trees will still play an important role in getting to 2050 and could support a future bioeconomy, as bioenergy to replace fossil fuels and as timber for building.
- Existing forests, small blocks of trees, soils and wetlands can all store more carbon. Work is needed to better understand this potential and how to include this in accounting systems.
- Native forests can create a long-term carbon sink while providing a range of other benefits, like improving biodiversity and erosion control. Incentives are needed to get more native trees planted.

Agriculture

What is the sector's current emissions profile?

In 2018, agriculture emissions made up about 90% of biogenic methane and 18% of long-lived gas emissions. This is 1.2 Mt CH_4 and 8.3 Mt CO_2-e, respectively.

Where does this come from?

Long-lived gases from agriculture are largely nitrous oxide, coming from animal urine and synthetic fertiliser use. Smaller amounts of carbon dioxide are emitted through other types of fertiliser.

Biogenic methane emissions from agriculture are primarily from deer, sheep, beef and dairy cow burps.

What does our path show for this sector?

By 2035, our path shows that biogenic methane emissions from agriculture reduce to 0.97 Mt CH_4, and long-lived gases reach 6.9 Mt CO_2-e. This puts us on track to meeting our 2050 target.

Forestry

What is the sector's current emissions profile?

In 2018, forests removed 9.5 Mt CO_2 from the atmosphere. Our emissions would be 14% higher without this.

Where does this come from?

Forests remove carbon dioxide from the atmosphere as they grow and emit it when they burn or decompose after harvest or clearance.

What does our path show for this sector?

By 2035, our path shows that net forestry removals reach 14.5 Mt CO_2. This puts us on track to meeting our 2050 target.

Waste

- Aotearoa needs to fundamentally change the way it deals with and thinks about waste. A transformation to this sector will not only reduce emissions but move us from a throw away culture to one that values our resources.

What are we recommending?

- Creating a circular, self-sustaining economy will reduce Aotearoa's waste emissions and cut biogenic methane emissions. Strengthened product stewardship and a commitment to resource recovery and reuse must be part of this approach.
- Capturing methane from any remaining waste that makes it to landfill will further emissions reduction.

Waste and F-Gases

What is the sector's current emissions profile?

In 2018, waste emissions made up 10% of total biogenic methane. This is 0.14 Mt CH_4. The sector also emitted 0.22 Mt CO_2-e of long-lived gases. Emissions of hydrofluorocarbons (HFCs) were 1.8 Mt CO_2-e.

Where does this come from?

Most waste emissions are from solid waste decomposing at landfill (90%), with smaller portions from wastewater treatment (9%) and burning and composting emissions (1%). F-gas emissions are largely from the leakage of HFCs used in refrigeration and air conditioning systems.

What does our path show for this sector?

By 2035, our path shows waste emissions reduce to 0.12 Mt of biogenic methane. HFC emissions reduce to 1.2 Mt CO_2-e.

Transport

- Reducing transport emissions is crucial to meeting our climate targets. Action here will have an immediate and lasting impact. Aotearoa can cut almost all transport emissions by 2050. The technology already exists and is improving fast.
- In Aotearoa we need to change the way we build and plan our towns and cities and the way people and products move around. This includes making walking and cycling easier with good cycleways and footpaths. It means moving freight off the road and onto rail and shipping. It means reliable and affordable public and shared transport systems. And it means an electric or low emissions transport fleet.

What are we recommending?

- An integrated national transport network should be developed to reduce travel by private car. There needs to be much more walking, cycling and use of public and shared transport.

Transport

What is the sector's current emissions profile?

In 2018, transport emissions made up 36.3% of total long-lived gases. This is 16.6 Mt CO_2-e.

Where does this come from?

Most transport emissions are from fossil fuels used to power vehicles. For example, petrol and diesel used by cars, SUVs and trucks (91%), domestic flights (7%) and rail and coastal shipping (2%).

What does our path show for this sector?

By 2035, our path shows transport emissions reduce to 8.8 Mt CO_2-e. This puts us on track to meet our 2050 target.

- Electric vehicles are key and need to be widely adopted. We want to see the majority of the vehicles coming into New Zealand for everyday use electric by 2035. The government will need to provide support and incentives to make this happen.
- Use of low carbon fuels, such as biofuels and hydrogen, needs to increase, particularly in heavy trucks, trains, planes, and ships.

Heat, industry and power

- Aotearoa needs to decarbonise how we produce and use energy. We need to move towards a set of diverse and low emission energy sources by 2050.
- Aotearoa will need to maximise the use of electricity. This means generating and using more low emissions electricity for vehicles and for process heat. Building more renewable generation such as wind, solar and geothermal will be required.
- Reducing emissions from process heat is key. Other low emission energy sources, such as bioenergy, will be needed.
- Emissions must be reduced at pace while allowing the country to continue to grow. Planning ahead so that technologies, assets and infrastructure can be replaced with low emissions choices on as natural a cycle as possible will help business and industry keep pace with the transition.

What are we recommending?

- We need to almost eliminate fossil fuels. This means ending the use of coal.
- The homes, buildings and infrastructure we build now will still be here in 2050. We need to think about our choices with climate change in mind. That means using low emissions technologies and prioritising energy efficiency.
- In the long-term, we will need to reduce how much natural gas we use in homes and businesses.

Heat, Industry and Power

What is the sector's current emissions profile?

In 2018, heat, industry and power emissions made up 41% of total long-lived gases. This is 18.8 Mt CO_2-e.

Where does this come from?

Heat, industry and power emissions come from using fossil fuels, such as coal and gas, to generate electricity (22%); producing heat and chemical reactions to manufacture products (47%); fossil fuels used in our buildings and homes (7%); oil refining, oil and natural gas production and the operation of coal mines (12%); and the use of off-road vehicles and machinery (11%).

What does our path show for this sector?

By 2035, our path shows emissions from heat, industry and power reduce to 10.4 Mt CO_2-e. This puts us on track to meet our 2050 target.

Emissions budgets

We have proposed the first three emissions budgets for Aotearoa. These budgets set the maximum amount of greenhouse gases Aotearoa can emit over a five-year period and chart the course for stepping down emissions.

We have looked at opportunities and barriers for reducing emissions across the whole economy. The budgets are based on how far and how fast our analysis tells us Aotearoa can go towards the 2050 targets.

Our recommended budgets are consistent with putting Aotearoa on track to meeting the 2050 target under a wide range of future circumstances.

The budgets are ambitious, but achievable. They represent a significant reduction on current levels of emissions, and step down considerably over time.

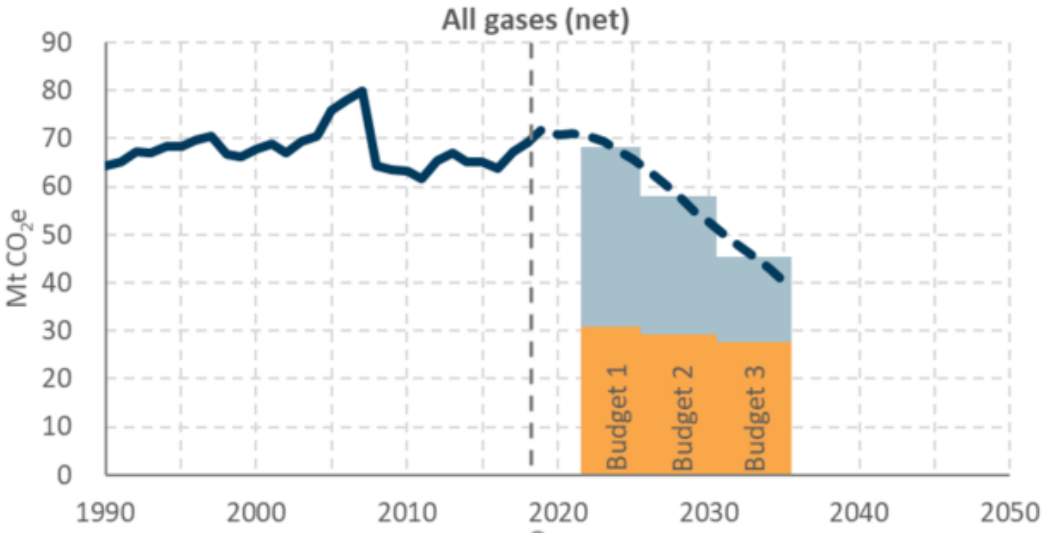


Figure ES1: Our proposed emissions budgets. The figure shows all gases combined as CO_2 equivalent – grey is emissions of long-lived gases, orange is biogenic methane emissions.

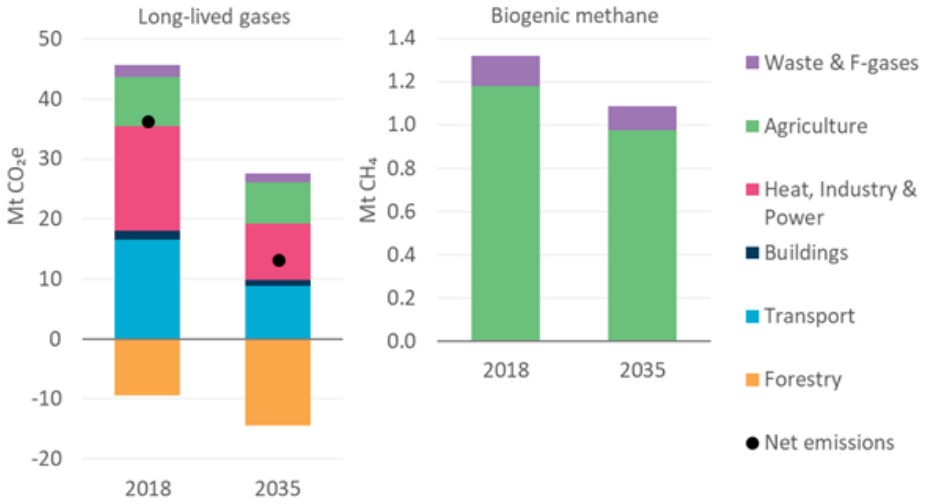


Figure ES2: How our path would reduce emissions across all sectors by 2035. Note that long-lived gases from agriculture are mainly nitrous oxide and some carbon dioxide.

Table ES1: Our proposed emissions budgets. All gases are combined as CO_2 equivalent

	2018	Emissions budget 1 (2022 – 2025)	Emissions budget 2 (2026 – 2030)	Emissions budget 3 (2031 – 2035)
All gases, net (AR4) (Mt CO_2e)		271	286	223
Annual average (Mt CO_2e/year)	69.2	67.7	57.3	44.6
Average reductions on 2018 levels		2%	17%	36%

Each budget must be met, as far as possible, through reducing and removing emissions here in Aotearoa. Gross emissions must be reduced to meet and sustain the country's emissions targets, and to avoid pushing the burden to future generations.

Relying heavily on forestry before 2050 is likely to make maintaining net zero long-lived greenhouse gas emissions after 2050 difficult. It would delay action, lead to higher cumulative emissions and make the job ahead of us more difficult.

How to meet the emissions budgets – direction of the emissions reduction plan

Meeting our proposed emissions budgets and 2050 targets requires transformational change across all sectors of the economy.

Our analysis shows that reducing transport emissions is crucial to meeting our emissions budgets and reaching net zero by 2050 – this will have an immediate and lasting impact.

This means changing the way we travel and move goods. New Zealanders should be able to walk and cycle more. Freight will need to come off the road and onto rail and shipping.

To lower emissions we will need to change the way we plan and build our cities to make it faster and easier to get around. Having an integrated public and shared transport system both locally and across Aotearoa will encourage a shift in the way we live and travel.

Our draft advice recommends action to drive change in all sectors, as described above. It also recommends changes that cut across sectors, to support behaviour change and make sure that climate change is factored into government decisions. Changes to the ETS are needed to make sure it drives low emissions choices. We also recommend measures to ensure policy decisions and investments made now do not lock Aotearoa into a high emissions path.

What will this mean for New Zealanders?

Aotearoa must have an equitable and fair transition to a low emissions economy and society with benefits widely shared.

We have looked at the impacts which our budgets could have on the economy and society over the next 15 years. The overall costs of meeting the country's targets and our proposed emissions budgets are likely to be less than 1% of projected GDP. This is significantly lower than what was estimated when the 2050 targets were set. While the overall costs are small relative to the size of the whole economy, they will not be evenly felt.

The transition to a low emissions society will bring opportunities, benefits, challenges and costs. Any change needs to be well-signalled, equitable and inclusive to make sure that it maximises opportunities while minimising disruption and inequities.

Different groups of society, regions and sectors will be affected in different ways, and impacts won't always be evenly distributed. The Government will need to address this through careful policy design and targeted support. At the same time, government will need to recognise and encourage the co-benefits that come from climate action. This includes health improvements, quieter streets, cleaner water and increased biodiversity through more native forests.

There will inevitably be changes to employment as Aotearoa moves to low emissions. The coal mining and oil and gas sectors, and the services that support them, will be impacted by the transition away from fossil fuels. This will particularly affect regions with lots of workers in these industries. While these industries are already declining, our proposed emissions budgets could speed this up and possibly result in 600-1,100 fewer jobs across both sectors by 2035.

It is worth noting that many of these workers have important skills that will be valuable in other sectors and new industries. We expect employment will rise in in the circular economy, development of biofuels and hydrogen, and in deploying and supporting new technologies. A well-signalled transition will allow time to plan and support workers to retrain and redeploy into new areas of work.

We recommend that the Government develop an Equitable Transitions Strategy to support an equitable, inclusive and well-planned climate transition.

Government will need to work alongside people, and ensure they are including young people, regional Aotearoa, low-income communities, some Māori and Pasifika and people with disabilities to make sure they benefit from the opportunities and are not disproportionately impacted.

Central and local government should support Māori communities to ensure they are appropriately resourced for the transition to a low emissions Aotearoa.

Government will need to co-develop plans to make this happen and recognise people are the experts – our communities know what actions need to be taken to benefit or empower them.

While some businesses will need to close there will be many opportunities for new industries, businesses and jobs. Our analysis suggests that our emissions budgets could result in job losses in the coal mining and oil and gas sectors. At the same time, taking action to meet the budgets is also likely to result in new jobs in other sectors and new industries, such as supporting and deploying new technologies.

The make-up of the economy will change, and some workers will need to be supported to retrain or move to similar jobs in new industries.

Reductions in biogenic methane

Current Aotearoa targets require biogenic methane emissions to reduce by 10% below 2017 levels by 2030 and between 24-47% by 2050.

The Commission has been asked to provide advice on how much biogenic methane emissions may need to be reduced by in the future for Aotearoa to meet its international obligations.

Our analysis shows that by 2100, Aotearoa could need to reduce methane emissions by 49-60% below 2017 levels.

Our country's world-leading agricultural sector has made big advances over the last 60 years, and improvements can and should continue.

Our analysis for our emissions budgets shows Aotearoa can achieve methane reductions of 24% by 2050 without any technology developments, such as vaccines or inhibitors. It is likely these technologies will become available, and this would increase the speed and efficiency of reducing methane emissions.

Our Nationally Determined Contribution (NDC)

The Commission was asked to determine if the first NDC for Aotearoa is compatible with contributing to global efforts to limit global warming to 1.5°C above pre-industrial levels.

Our analysis has found that the Government's commitment to reduce net emissions by an average of 30% from 2005 emissions levels over the 2021-2030 period is not compatible with global efforts.

If Aotearoa is to play its part as a developed nation, the NDC would need to be strengthened to reflect emission reductions of much more than 35% below 2005 levels by 2030.

The Commission's proposed emissions budgets are already ambitious – but the NDC goes further.

To achieve our NDC, Aotearoa will need some offshore mitigation. We are not using this to do less domestically – but to increase our contribution beyond what is possible at home.

Conclusion

This document contains the Commission's first draft advice to government, for input and consideration by the people of Aotearoa.

The advice and recommendations contained in this report draw on robust evidence and expert analysis. It incorporates knowledge and wisdom from a wide range of people and organisations to ensure it is sound and reflects our diverse experiences.

But this is draft advice. We are committed to true consultation and want to hear your feedback. We will consider all evidence we receive during consultation and are prepared to review and change any part of our work in light of this. We need to achieve a plan to address climate change that is effective, considered and ambitious – and Aotearoa won't get there unless we work together.

Part A: Emissions budgets and emissions reduction plan advice

Chapter 1: We are seeking your feedback

This report contains the draft advice of He Pou a Rangi – the Climate Change Commission. It includes advice on the first three emissions budgets and the Government's first emissions reduction plan. Together, these lay out the course for reducing emissions in Aotearoa and set the direction of policy that Aotearoa takes to get there.

We are seeking your feedback on this draft advice before providing our final advice to the Government and public by 31 May 2021. By seeking your input, we are recognising that this advice will affect everyone that lives in Aotearoa.

What we hear through consultation will shape the final advice that we provide to the Government. We will also share what we learn through consultation and provide our final advice publicly. This process will provide the foundation for the work needed across Aotearoa to achieve our climate goals.

We consider that our draft advice makes a clear case for swift and decisive action on climate change.

1.1 Our task

The Climate Change Commission is an independent Crown entity that was established in December 2019. We are tasked with providing independent, expert advice to the Government on reducing emissions, adapting to the impacts of climate change, and monitoring and reviewing the Government's progress towards its emissions reductions and adaptation goals. All of our advice to government must be made publicly available.

Our first task is to provide the Government with advice on:

- the level of the first three five-yearly emissions budgets that will put Aotearoa on track to meeting its domestic 2030 and 2050 emissions targets
- the direction of policy that should be included in the Government's first emissions reduction plan.

The Climate Change Response Act (2002) outlines six specific pieces of advice that we must provide to the Government. Table 1.1 outlines these six pieces and where they can be found in this draft report. This report is supported by a substantial body of evidence. More detail on the evidence, including references, is provided in the accompanying Evidence Report. This evidence includes results from modelling using data from Stats NZ Integrated Data Infrastructure. The full disclaimer for results based on data from Stats NZ is included in Chapter 12 of the Evidence Report.

Table 1.1: The six pieces of advice we must provide and where they can be found in this report.

Advice	**Where you can find the draft advice in this report**
The recommended quantity of emissions that will be permitted in each emissions budget period	Chapter 2: Our proposed emissions budgets advice
The proportions of an emissions budget that will be met by domestic emissions reductions and domestic removals, and the amount by which emissions of each greenhouse gas should be reduced to meet emissions budgets and targets	Chapter 2: Our proposed emissions budgets advice
The appropriate limit on offshore mitigation that may be used to meet an emissions budget, and an explanation of the circumstances that justify the use of offshore mitigation	Chapter 2: Our proposed emissions budgets advice
How the emissions budgets, and ultimately the 2050 target, may realistically be met, including by pricing and policy methods	Chapter 6: Direction of policy in the Government's emissions reduction plan
The direction of the policy required in the emissions reduction plan for that emissions budget period	Chapter 6: Direction of policy in the Government's emissions reduction plan
The rules that will apply for measuring progress towards meeting emissions budgets and the 2050 target	Chapter 7: Rules for measuring progress

We have also been asked by the Minister for Climate Change to provide advice on the eventual reductions needed in biogenic methane emissions, and on the country's Nationally Determined Contribution. This advice has been provided in Part B of this report.

1.2 Taking an inclusive approach

Addressing climate change requires transformational and fundamental change to the country's economy and society. The actions Aotearoa takes to address climate change will touch on the lives of everyone that lives in Aotearoa. This means we must take an inclusive approach.

Tikanga values can guide Aotearoa through a climate transition that is inclusive. The concept of tiakitanga – being a good guardian or steward – considers the wellbeing of both current and future generations of New Zealanders. The He Ara Waiora tikanga values are:

- **manaakitanga** – having a deep ethic of care towards people and the whenua (land), acknowledging their role in the ecosystem, and how they could be affected
- **tikanga** – ensuring the right decision makers are involved in the right decision-making process
- **whanaungatanga** – being mindful of the relationship between all things, our connections to each other and how we connect to our whenua
- **kotahitanga** – working collaboratively and inclusively to access the best ideas and information while uplifting collective efforts.

The He Ara Waiora framework is described in more detail in Chapter 6 of the accompanying Evidence Report.

Providing analysis and advice on the first three emissions budgets and the direction of the first emissions reduction plan represents a significant amount of work. However, it is in many ways just the beginning. We have an ongoing role to monitor the Government's progress towards emissions budgets and targets. As part of this, we will closely monitor how all of government addresses our final recommendations and share our conclusions publicly.

1.3 Our draft advice and recommendations

We have provided draft recommendations to government throughout this report. For many of these draft recommendations, we have also provided progress indicators that we would use to monitor the Government's progress.

The draft recommendations fall into four categories:

1. **budget recommendations** – these contain our draft recommendations on the levels at which to set the first three emissions budgets, the breakdown by gas, the proportion of domestic emissions reductions and removals and the limit on offshore mitigation for meeting emissions budgets

2. **enabling recommendations** – these recommendations are crucial for ensuring that processes are in place so that the actions to address climate change are enduring

3. **policy recommendations** – these recommendations inform the direction of policy needed in the Government's emissions reduction plan. There are two sub-categories:

    a. **time-critical necessary actions** – these are the policy recommendations that we consider critical for being able to deliver on our proposed emissions budgets

    b. **necessary actions** – these are further policy actions that support the time-critical recommendations and will be important for meeting emissions budgets.

1.4 Our analytical approach

In providing our draft advice, we have carried out analysis in the four major areas described below. These four areas cover the matters required to be considered in the Climate Change Response Act.

In this analysis, we break down emissions into biogenic methane and all other greenhouse gases. This is to acknowledge the short-lived nature of biogenic methane compared to other greenhouse gases, as well as the split-gas targets contained in the Climate Change Response Act. For ease of presentation, we refer to all other greenhouse gases as long-lived gases, though note that this does include a small amount of non-biogenic methane and some short-lived fluorinated gases (F-gases).

These four areas of analysis ensure that:

1. **Our proposed emissions budgets are technically and economically achievable.**

    For the first step of our analysis, we carried out a detailed assessment of the opportunities to reduce and remove emissions in each sector. These opportunities include both technological

change and behaviour change. For each opportunity, we have assessed the potential emissions reductions, cost, timeframes, constraints, risks, uncertainties, barriers and co-benefits. Further, we have looked at the interactions across the economy, and considered economy-wide labour and capital constraints.

We have modelled a range of scenarios looking at possible futures to 2050 and beyond. These helped us to understand the range of ways that Aotearoa could meet the 2050 targets and the critical actions that are necessary to achieve this. This factored in the changes we have seen from COVID-19, and interactions within sectors and across the economy – for example, increasing electricity demand from charging electric vehicles.

Drawing on our scenarios, we focused on the path to 2035. We looked in more detail at the available options that could be deployed in the next 15 years and used this to test different levels of emissions budgets that could set Aotearoa up to meet the 2050 targets. We also tested our proposed emissions budgets to ensure that they could be achieved. For example, if a particular technology does not play out as we might expect, is it still possible to meet the emissions budgets?

This analysis is outlined in chapter 3.

2. Our proposed emissions budgets are ambitious, put Aotearoa on track to meeting targets and contribute to the global goal to limit warming to within 1.5 °C of pre-industrial levels.

We have considered the global pathways that are consistent with limiting warming to within 1.5 °C, the contribution of the different greenhouse gases to those pathways, and the specific circumstances for Aotearoa.

This analysis is outlined in chapter 4.

3. Any potential negative impacts of our proposed emissions budgets can be sufficiently mitigated, and any co-benefits can be maximised.

We have carried out analysis looking at the potential impacts of the path to 2050 and of our proposed emissions budget levels on the economy, different sectors, regions, communities, households, different socioeconomic groups, iwi/Māori and different generations. This analysis considers economic, social, cultural, environmental and ecological impacts. We have sought to take a broad system view so we understand what our advice means for people, environment, land and economy, now and into the future.

This analysis is outlined in chapter 5.

4. Our proposed emissions budgets and targets can be delivered through policy

We have looked across all sectors and across the economy at the direction of policies needed to deliver our proposed emissions budgets. We have focused our advice on identifying the goals and key interventions that government climate change mitigation policies need to deliver, as well as mitigating impacts where necessary.

This analysis is outlined in chapter 6.

Further details on the analytical approach are set out in the Introduction to the Evidence Report.

1.5 What is different about our analytical approach?

We commissioned two economy-wide models that were designed specifically for informing us on the transition to a thriving, low emissions Aotearoa. These models allowed us to understand the scale of the transformation that could happen in Aotearoa.

For the first time in Aotearoa, we have taken a comprehensive look at at the balance of emissions reductions from long-lived gases and biogenic methane, and the balance between gross emissions reductions and removals of carbon from the atmosphere. This approach has guided our conclusions around the relative importance of reducing gross emissions compared to offsetting them through carbon removals from forestry. Previous exercises carried out by others pre-dated the Climate Change Response (Zero Carbon) Amendment Act 2019, and so focused on reducing overall net emissions.

Core to our approach is the need to make actual emissions reductions – that is gross emissions reductions – to prevent further warming of the atmosphere and meet the 2050 targets. There are risks associated with the permanence of forestry removals, especially as climate change makes forest fires, heavy winds, storms, droughts, pests and pathogens more likely. Gross emissions reductions must be achieved to meet and sustain the country's emissions targets, and to avoid pushing the burden to future generations. Therefore, we take the approach of reducing gross emissions where it is feasible and leave carbon removals to offset the hard-to-abate sectors.

1.6 Our engagement so far

We thank the people who have met with us for their time and expertise. The conversations we have had and the evidence that has been shared with us have been invaluable. Our discussions with interest groups and subject matter experts have helped to build our evidence base and shape how we have approached our analysis. They have also helped us understand the breadth of the task ahead of us and the ambition that exists within Aotearoa.

Since the Commission was established, Commissioners and staff have held over 700 meetings, workshops and hui. We have met with different sectors, people, partners and organisations to introduce ourselves and our work, and to hear varied views on what needs to be considered in Aotearoa in responding to climate change. More information about the organisations we have met with is available on our website.

We established four technical reference groups covering land, waste, transport, as well as heat, industry and power. These groups met on a regular basis, helping to build the evidence base and test our analysis. We also established an expert modelling group to test and advise us on our modelling approach.

The Interim Climate Change Committee carried out a Call for Evidence in late 2019 and received input from 77 individuals and organisations. Submissions covered topics including land use, transport, buildings and urban design, waste, and heat, industry and power, and included information on opportunities to reduce emissions, the linkages and interactions between different sectors and the potential benefits or impacts of different actions that could be taken. Several submitters indicated that they had data and analyses that they were willing to share with the Interim Climate Change Committee and Commission.

We held seven workshops covering equitable transitions, behaviour change, equity in access to transport, rural impacts, urban form, bioeconomy and the circular economy. The insights from these workshops have grounded our analysis, particularly in helping us to understand how changes would impact different groups of society.

To give effect to the Treaty principles of partnership, participation and protection, we took a multi-faceted approach to engaging with iwi/Māori. This included carrying over the insights gathered by the Interim Climate Change Committee (to reduce engagement fatigue). In addition to the hui and technical reference groups, we also initiated interviews and high-level case studies with Māori thought leaders and technical experts as well as Māori-collectives (including representatives of marae, iwi, and Ahu Whenua Trusts). In developing our work we applied the He Ara Waiora framework (version 2.0) to ensure the insights we gathered from iwi/Māori were understood from a Te Ao Māori and mātauranga Māori perspective. We also undertook research to ensure insights were understood in their historic and contemporary context.

Work done by the private sector and business community, including by the Aotearoa Circle, Business NZ Energy Council, Climate Leaders Coalition, Primary Sector Council and Sustainable Business Council, has been helpful in strengthening the evidence base and business case for transitioning to a thriving, climate-resilient and low emissions Aotearoa. A message that has clearly come through our engagement is that businesses require a stable, predictable policy environment in order to allow them to invest in ways that help deliver on the country's 2050 climate targets.

1.7 Our consultation questions

As a Commission we need to consider the perspectives of all New Zealanders. We know our work will mean changes for all of us.

We are releasing our draft advice and recommendations to give people outside the Commission the opportunity to share their knowledge and tell us whether we are steering Aotearoa in the right direction. The Commission is required to consult publicly on our advice, recognising the importance of public input.

There are some key components about which we are particularly interested to hear from you. These consultation questions are contained throughout this report.

We are seeking your responses to these questions via our website.

1.8 Biogenic methane and NDC advice

Beyond our emissions budgets and emissions reduction plan advice, we are also consulting on two additional pieces of draft advice. One looks at the eventual reductions Aotearoa might need to make to biogenic methane emissions. The second considers the compatibility of the country's Nationally Determined Contribution (NDC) with contributing to the 1.5°C global goal under the Paris Agreement.

These two additional pieces of draft advice are outlined in part B of this report.

Chapter 2: Our proposed emissions budgets advice

In passing the Climate Change Response (Zero Carbon) Amendment Act in 2019 – better known as the Zero Carbon Act – Parliament committed to long-term and enduring action on climate change and set emissions reductions targets for Aotearoa. These targets were developed with the goal of halting the contribution Aotearoa makes to climate change.

The targets require Aotearoa to:

- reduce emissions of greenhouse gases, other than biogenic methane, to net zero by 2050 and beyond. This refers to emissions of carbon dioxide, nitrous oxide, F-gases and non-biogenic methane.
- reduce biogenic methane emissions by at least 10% by 2030 and 24-47% by 2050 and beyond, compared to 2017 levels.

It is our assessment that current policy settings do not put Aotearoa on track to meet these targets. To do so, Aotearoa must accelerate action on climate change.

This chapter sets out our draft advice on the first three emissions budgets, to set Aotearoa up to achieve these targets and fulfil other requirements of the Climate Change Response Act. It outlines a set of principles that we have used to guide our draft advice. Finally, it outlines our draft recommendations for ensuring that Aotearoa enables change that is enduring.

Our policy recommendations can be found in chapter 6.

2.1 Emissions in Aotearoa

In 2018, gross greenhouse gas emissions in Aotearoa were about 45.5 Mt CO_2e of long-lived gases and 1.34 Mt CH_4 of biogenic methane. These are the most recent numbers available.

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

Long-lived gas emissions are mainly from carbon dioxide, but also include nitrous oxide. We have also included F-gases in this category to align with the split-gas target in the Act, although some F-gases are short-lived. Transport, buildings, heat, industry and power, agriculture and waste all emit long-lived gases (Figure 2.1).

Gross emissions have been relatively stable in recent years. However, emissions from domestic transport have continued to rise even as emissions from other sectors stabilised or decreased.

Gross emissions are projected to decrease as a result of current government policy. However, this decrease would not be enough to meet the country's 2030 and 2050 emissions reduction targets for biogenic methane and long-lived gases.

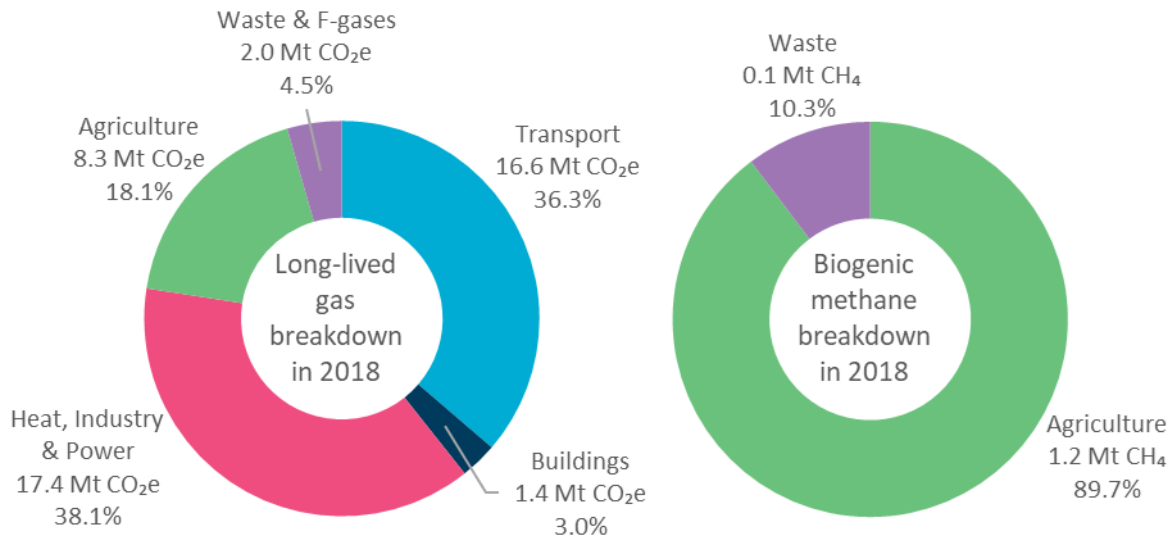


Figure 2.1: The sources of gross long-lived greenhouse gases and biogenic methane in 2018 broken down by sectors. Note: building emissions relates to their energy use, but not construction. Emissions are presented differently to the New Zealand Greenhouse Gas Inventory, see Evidence Report for info.

Source: New Zealand's Greenhouse Gas Inventory.

Box 2.1: How we present emissions in this report

Gross and net emissions

We present both gross and net emissions in this report. Gross emissions includes emissions from all sectors, including from:

- transport
- buildings
- heat, industry and power
- agriculture
- waste and F-gases.

Net emissions refers to gross emissions combined with emissions and removals through land-use, land-use change and forestry. In Aotearoa, emissions are mainly removed by forests, which sequester carbon dioxide from the atmosphere as they grow.

Split-gas approach

Throughout this report we present biogenic methane emissions in units of megatonnes of methane (Mt CH_4) to take account of the short-lived nature of the gas and for consistency with the split-gas target.

Long-lived greenhouse gases, and our proposed all gases emissions budgets, are expressed in units of megatonnes of carbon dioxide equivalent (Mt CO_2e).

Comparing gases using Global Warming Potential over 100 years (GWP_{100})

When presenting numbers in Mt CO_2e, these numbers are based on the GWP_{100} metric values from the Intergovernmental Panel on Climate Change's (IPCC) 4th Assessment Report of the IPCC (AR4). This aligns with the country's most recent Greenhouse Gas Inventory.

Emissions generated from 2021 onwards will be reported in the Inventory using more up-to-date GWP_{100} values from the IPCC's 5th Assessment Report (AR5). When we provide our final advice, we will convert the proposed emissions budgets using the AR5 GWP_{100} values. We expect that the Government will set emissions budgets using the GWP_{100} metric from AR5 for consistency with the Inventory.

2.2 Accelerating action to reduce emissions

We have developed a set of key principles to help guide our advice and the transition to a thriving, climate-resilient and low emissions Aotearoa. Our key principles are:

- **Principle 1: Align with the 2050 targets.** Aotearoa must adopt actions that set it on a path to meet the 2030 and 2050 emissions reduction targets, sustain those targets and set Aotearoa up for net negative emissions later, and contribute to the global effort to limit warming to 1.5°C. Meeting these targets requires a long-term view of investments and infrastructure developments. Assets and investments with long lifetimes will need to be transformed, and planning for and developing new low emissions infrastructure will take time. For these reasons, actions taken in the next five years will need to set Aotearoa up to deliver the deeper reductions required in subsequent emissions budgets and to meet and sustain the 2050 targets.
- **Principle 2: Focus on decarbonising the economy.** Aotearoa should prioritise actions that reduce gross emissions within our borders, as well as removing emissions by sequestering carbon dioxide in forests. Aotearoa should focus on decarbonising its industries rather than reducing production in a way that could increase emissions offshore. Forest sequestration should not displace making gross emissions reductions. Relying heavily on forestry before 2050 is likely to make maintaining net zero long-lived greenhouse gas emissions after 2050 challenging. It would delay action, lead to higher cumulative emissions and put the burden of addressing gross emissions on to future generations. This would require significantly more land to be converted to forestry in the future.
- **Principle 3: Create options.** There is much uncertainty in embarking on this decades-long transition. Uncertainty is not a reason for delay. There is value in creating options for meeting the targets and having the ability to adjust course as the transition proceeds. The decisions taken now should open up a wide range of future options and keep options open for as long as possible. This needs to be balanced with the need to take advantage of key windows of opportunity, where making significant investments in key technologies could ultimately make the transition to low emissions cheaper and faster.
- **Principle 4: Avoid unnecessary cost.** The actions Aotearoa takes to meet emissions budgets and targets should avoid unnecessary costs. This means using measures with lower costs and planning ahead so that technologies, assets and infrastructure can be replaced with low emissions choices on as natural a cycle as possible. This will help to avoid scrapping assets before the end of their useful lives or being left with stranded assets.

- **Principle 5: Transition in an equitable and inclusive way.** How Aotearoa responds to climate change should consider who will be most impacted, how those impacts can be mitigated and how existing inequities can be reduced. It should consider equity across different groups of society, regions and communities and generations. The climate transition should be well planned and signalled in advance to give communities, businesses and individuals time to innovate and adapt, build new markets and retrain. Aotearoa will need to build new markets, invest in peoples' skills, and provide opportunities for environmentally and socially sustainable work. It should not penalise early movers.
- **Principle 6: Increase resilience to climate impacts.** The actions Aotearoa takes to reduce emissions should avoid increasing the country's overall exposure to climate risks such as drought, flooding, forest fires and storms. Where possible, actions should increase the country's resilience to the impacts of climate change that are already being experienced and that will increase in the future.
- **Principle 7: Leverage co-benefits.** The actions Aotearoa takes to meet emissions budgets and targets should consider the wider benefits, including benefits to health, broader wellbeing and the environment. Co-benefits can provide further reason to take particular actions where the initial emissions reductions may be modest or appear relatively costly.

Consultation question 1
Principles to guide our advice

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

2.3 Emissions budgets – stepping down emissions in Aotearoa

Emissions budgets sit at the core of the transition to a thriving, climate-resilient and low emissions Aotearoa. They chart the course for Aotearoa to step down emissions to meet its emissions reduction targets. After the first three emissions budgets are set, further emissions budgets will be set ten years in advance of the start of the emissions budget period. Laying out a clear path of where emissions need to get to will help increase predictability for communities, businesses and investors.

Under the Climate Change Response Act, we are required to consider:

- technologies and practice changes available now for reducing emissions in each sector, the technologies on the horizon and the costs and constraints of making these changes
- ambition needed to contribute to the global goal of limiting warming to 1.5°C above pre-industrial levels
- potential impacts of meeting emissions budgets on the economy, society, culture, environment and ecology, including on different regions, communities and generations
- how emissions budgets could be met and the direction of policy for achieving them.

The impact of COVID-19 on society and the economy has been factored into our emissions budgets.

Under the Climate Change Response Act, we must provide the Minister for Climate Change with advice on the level of the first three emissions budgets. The first emissions budget covers the 4-year

period from 2022 – 2025, while the second and third budgets are both 5 years, covering 2026 – 2030 and 2031 – 2035. Our proposed emissions budgets are provided in Budget recommendation 1.

We are required under the Act to provide emissions budgets that include all greenhouse gases expressed as a net quantity of carbon dioxide equivalent. In the next section, we also provide the breakdown by gas and for biogenic methane and long-lived gases. Providing the breakdown of biogenic methane and long-lived gases allows us to make important distinctions between the different greenhouse gases and to align with the country's domestic emissions reduction targets.

Long-lived greenhouse gases, and our proposed all gases emissions budgets, are expressed in units of Mt CO_2e, based on the GWP_{100} metric from the IPCC's AR4. Net emissions and removals by forestry are calculated using the modified activity-based approach (see chapter 7).

Budget recommendation 1
Emissions budget levels

We recommend the Government set and meet the emissions budgets as outlined in the table below. The Government should adopt emissions budgets expressed using GWP_{100} values from the IPCC's fifth assessment report (AR5) for consistency with international obligations relating to Inventory reporting.

	2018	Emissions budget 1 (2022 – 2025)	Emissions budget 2 (2026 – 2030)	Emissions budget 3 (2031 – 2035)
All gases, net (AR4)		271 Mt CO_2e	286 Mt CO_2e	223 Mt CO_2e
Annual average	69.2 Mt CO_2e	67.7 Mt CO_2e/yr	57.3 Mt CO_2e/yr	44.6 Mt CO_2e/yr

Consultation question 2
Emissions budget levels

Do you support budget recommendation 1? Is there anything we should change, and why?

2.4 Contribution of different gases, and domestic emissions reductions and domestic removals

We have assessed the contribution of the different greenhouse gases and the proportions of domestic emissions reductions and domestic removals needed to meet the emissions budgets and targets. At the core of this assessment is the need to set Aotearoa up to meet the 2050 emissions reduction targets and sustain them beyond 2050.

The split-gas nature of the 2050 target means that forestry removals cannot be used to offset biogenic methane emissions, and they must be reduced to those levels stipulated in the target. Gross biogenic

methane emissions need to be reduced by at least 10% below 2017 levels by 2030 and 24-47% below 2017 levels by 2050.

Budget recommendation 2
Break down of emissions budgets

We recommend that the Government implement policies that will meet emissions budgets based on the balance of emissions and removals as outlined in the table below.

	Emission budget 1 (2022 – 2025)	Emission budget 2 (2026 – 2030)	Emission budget 3 (2031 – 2035)
Total net emissions budget *Annual average*	271 Mt CO_2e 67.7 Mt CO2e/yr	286 Mt CO_2e 57.3 Mt CO2e/yr	223 Mt CO_2e 44.6 Mt CO2e/yr
REMOVALS Forestry carbon removals *Annual average*	 26 Mt CO_2e 6.5 Mt CO_2e/yr	 49 Mt CO_2e 9.8 Mt CO_2e/yr	 68 Mt CO_2e 13.6 Mt CO_2e/yr
EMISSIONS – LONG-LIVED GASES Gross long-lived gases	 174 Mt CO_2e	 190 Mt CO_2e	 153 Mt CO_2e
Carbon dioxide	133.7 Mt CO_2e	143.2 Mt CO_2e	110.8 Mt CO_2e
Nitrous oxide	29.4 Mt CO_2e	35.3 Mt CO_2e	33.1 Mt CO_2e
F-gases	7.3 Mt CO_2e	8.1 Mt CO_2e	6.7 Mt CO_2e
Non-biogenic methane	3.4 Mt CO_2e	3.1 Mt CO_2e	2.2 Mt CO_2e
EMISSIONS – BIOGENIC METHANE Gross biogenic methane*	 4.92 Mt CH_4	 5.83 Mt CH_4	 5.53 Mt CH_4

* Note that biogenic methane numbers are provided in megatonnes of methane (Mt CH_4). Megatonnes of methane do not equate to megatonnes of carbon dioxide equivalent (Mt CO_2e). As a result, the numbers in this table cannot be summed to give the total net emissions budget. However, the methane volume can be converted into a CO_2e amount by multiplying by 25, the IPCC AR4 GWP_{100} value for methane.

Consultation question 3
Break down of emissions budget

Do you support our proposed break down of emissions budgets between gross long-lived gases, biogenic methane and carbon removals from forestry? Is there anything we should change, and why?

Budget recommendation 3
Reductions by greenhouse gas to meet the emissions budgets

We recommend that the Government implement policies that deliver emissions reductions of each greenhouse gas as outlined in the table below.

	2018	Emission budget 1 (2022 – 2025)	Emission budget 2 (2026 – 2030)	Emission budget 3 (2031 – 2035)
Total net emissions				
Annual average	69.2 Mt CO_2e	67.7 Mt CO_2e	57.3 Mt CO_2e	44.6 Mt CO_2e
Reduction from 2018		1.5 Mt CO_2e (2.1%)	11.9 Mt CO_2e (17.2%)	24.6 Mt CO_2e (35.5%)
Total gross emissions				
Annual average	78.6 Mt CO_2e	74.2 Mt CO_2e	67.1 Mt CO_2e	58.2 Mt CO_2e
Reduction from 2018		4.4 Mt CO_2e (5.6%)	11.5 Mt CO_2e (14.7%)	20.4 Mt CO_2e (25.9%)
Broken down by:				
Carbon dioxide (gross)				
Annual average	35.1 Mt CO_2e	33.4 Mt CO_2e	28.6 Mt CO_2e	22.2 Mt CO_2e
Reduction from 2018		1.6 Mt CO_2e (4.7%)	6.4 Mt CO_2e (18.3%)	12.9 Mt CO_2e (36.8%)
Nitrous oxide				
Annual average	7.7 Mt CO_2e	7.3 Mt CO_2e	7.1 Mt CO_2e	6.6 Mt CO_2e
Reduction from 2018		0.4 Mt CO_2e (4.9%)	0.7 Mt CO_2e (8.6%)	1.1 Mt CO_2e (14.2%)
F-gases				
Annual average	1.9 Mt CO_2e	1.8 Mt CO_2e	1.6 Mt CO_2e	1.3 Mt CO_2e
Reduction from 2018		0.1 Mt CO_2e (3.5%)	0.3 Mt CO_2e (15.3%)	0.6 Mt CO_2e (29.7%)
Non-biogenic methane				
Annual average	1.0 Mt CO_2e	0.8 Mt CO_2e	0.6 Mt CO_2e	0.4 Mt CO_2e
Reduction from 2018		0.2 Mt CO_2e (8.0%)	0.4 Mt CO_2e (39.0%)	0.6 Mt CO_2e (56.1%)
Biogenic methane				
Annual average	1.32 Mt CH_4	1.23 Mt CH_4	1.17 Mt CH_4	1.11 Mt CH_4
Reduction from 2018*		0.09 Mt CH_4 (6.5%)	0.15 Mt CH_4 (11.4%)	0.21 Mt CH_4 (15.9%)

* Note that the percentage reduction is for the annual average over the budget period. The biogenic methane target for Aotearoa is a 10% reduction by 2030 compared to 2017 levels. Under our emissions budget path, Aotearoa would reduce biogenic methane emissions by 13.2% by 2030 relative to 2017.

Gross emissions of long-lived gases need to be reduced to the maximum extent possible to set Aotearoa up to meet and sustain the target of net zero by 2050. Our analysis in chapter 3 shows that, in many sectors, there is a clear path for reducing gross emissions of long-lived gases. This means setting a path that would achieve near complete decarbonisation of low and medium temperature heat used in industry, electricity generation, energy use in buildings and land transport.

Relying too heavily on forestry removals to offset emissions carries risks. It would require ongoing conversion of land to continue offsetting emissions and put the burden of reducing gross emissions on future generations.

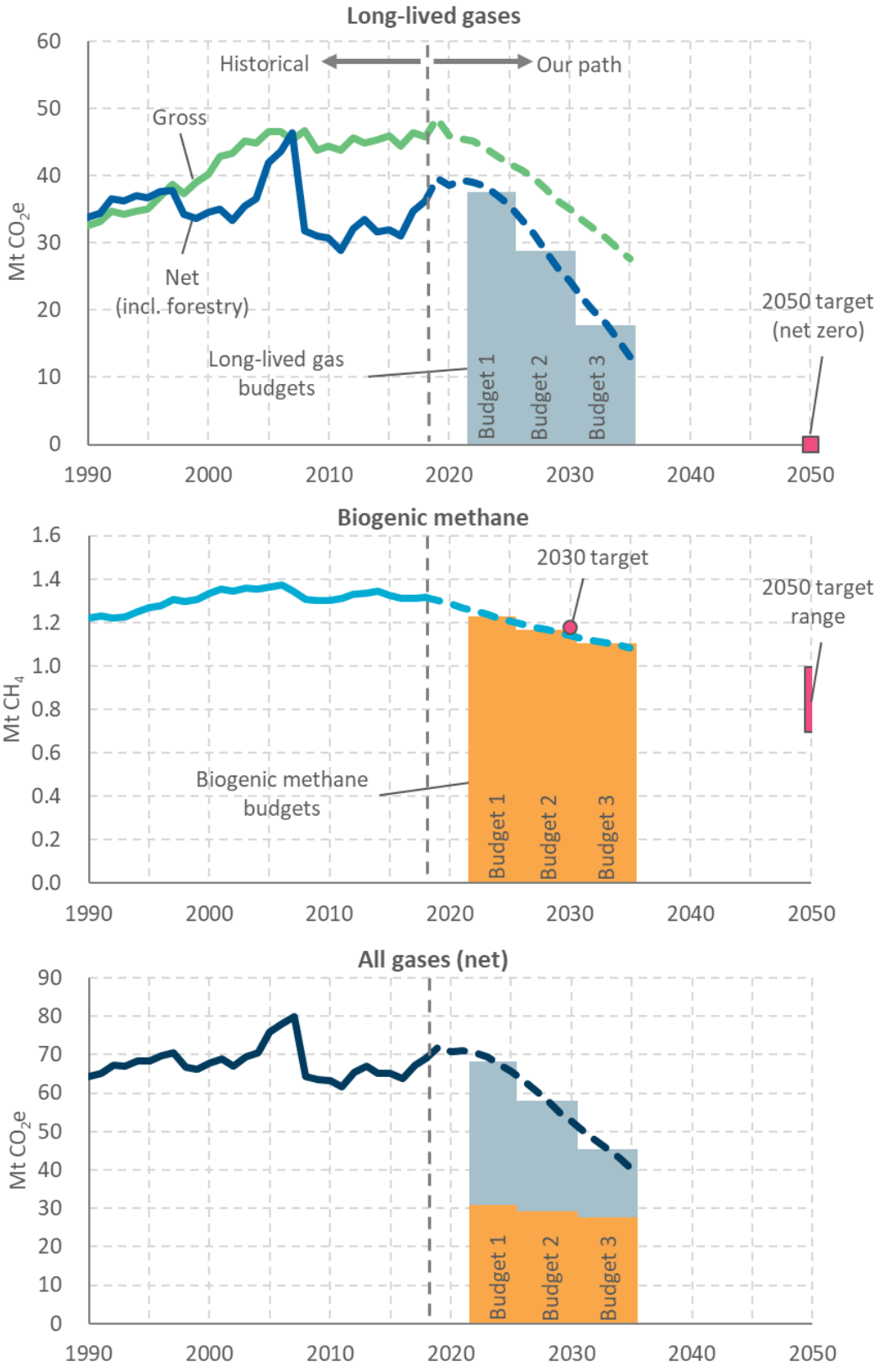


Figure 2.2: These three figures show how our proposed emissions budgets would step Aotearoa towards its emissions reduction targets. The top figure shows long-lived gases, the middle figure shows biogenic methane, and the bottom figure shows all gases combined as CO_2-equivalent.

Source: Commission analysis.

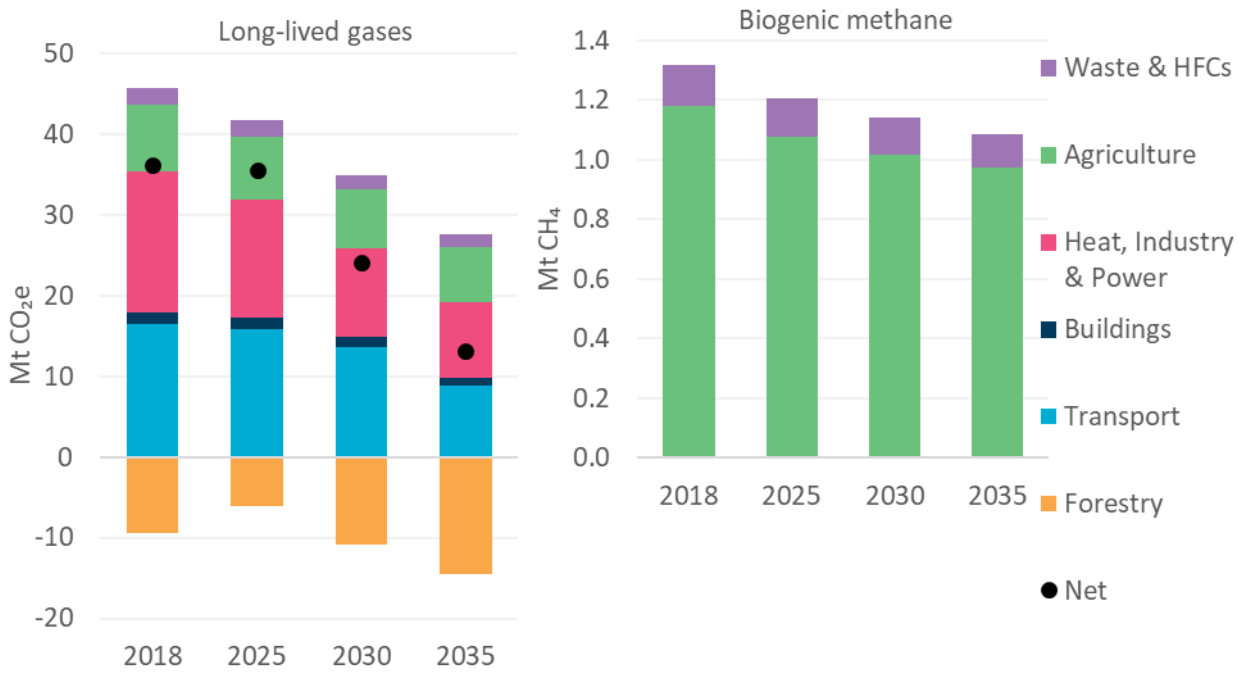


Figure 2.3: Emissions of long-lived gases (left) and biogenic methane (right) by sector at the end of each budget period in our path, compared to 2018.

Source: Commission analysis.

2.5 Limit on offshore mitigation and when it should be used to meet emissions budgets

The Climate Change Response Act requires the Minister to set emissions budgets for Aotearoa that can be met domestically. The use of offshore mitigation – buying emissions units or emissions reductions and removals from overseas – should only be used as a last resort for the purpose of meeting emissions budgets. As a result, our proposed emissions budgets are possible to achieve domestically. However, there is always uncertainty when projecting forward in time. There will be elements of the emissions reduction transition that do not play out quite as we expect, particularly when looking ahead ten years to the start of the third emissions budget.

More discussion on the use of offshore mitigation for meeting the Nationally Determined Contribution can be found in Chapter 8.

2.5.1 Borrowing

The Climate Change Response Act allows some domestic flexibility in how emissions budgets are met. Up to 1% of the volume from the next emissions budget can be borrowed to help meet the current emissions budget. Borrowing brings emissions forward in time and increases risks that subsequent budgets will be more difficult to meet. The Government's emissions reduction plans must be set to meet the budget. Therefore, borrowing should only be used when the Government finds itself in a position where there is insufficient time in the budget period to adjust policies to ensure emissions are below the budget level.

Many of the uncertainties in meeting emissions budgets can still be factored into our analysis. For example, we cannot be certain about how much electric vehicles will cost over time and what this will

do to demand. However, as we have factored these unknowns into our analysis, we consider this kind of uncertainty does not provide justification for using offshore mitigation to meet the country's domestic emissions budgets. In planning how to meet emissions budgets, the Government must plan for these uncertainties and aim to overachieve the budgets.

2.5.2 Offshore mitigation

There may also be exceptional circumstances – such as force majeure events – which are unpredictable, unpreventable, outside the control of the Government and which cause a large one-off increase in emissions. Examples include disasters such as earthquakes, a volcanic eruption, or a major fire that prevents transmission lines bringing electricity north and therefore requires fossil generation to be used.

If such events occur, the timing and scale of the emissions increase may be so large that it cannot be made up for domestically. We consider that only these circumstances justify using offshore mitigation for the first three emissions budgets. Even if this happens, we should exhaust domestic options first, with offshore mitigation the last resort.

As emissions reduce, however, it may become harder and more expensive to reduce emissions further. If there were consistent barriers in the known areas of uncertainty or if technologies were to repeatedly deliver fewer emissions reductions than expected, it could become more difficult to stay on track to meet the 2050 target. This is why we may revisit the possibility of offshore mitigation for later emissions budgets as Aotearoa approaches 2050.

By their nature, the exceptional or force majeure circumstances that would justify using offshore mitigation are unforeseeable and unquantifiable. It is not possible to predict the scale of offshore mitigation that might be needed if they occur. Therefore, we recommend a limit on offshore mitigation of zero for the first three emissions budgets except in the case of force majeure events.

Budget recommendation 4
Limit on offshore mitigation for emissions budgets and circumstances justifying its use

We recommend that, given that emissions budgets must be met as far as possible through domestic action, for the purposes of meeting emissions budgets:

a. **The limit on offshore mitigation should be zero for the first three emissions budgets.**
b. **The only circumstances that at this stage would justify the use of offshore mitigation is as a last resort in exceptional circumstances beyond the Government's control, such as force majeure events, where domestic measures cannot compensate for emissions impacts.**

Consultation question 4
Limit on offshore mitigation for emissions budgets and circumstances justifying its use

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

2.6 Enabling an enduring climate transition

Climate change is an intergenerational and cross-system issue. Taking actions to address it will require unprecedented coordination, an inclusive approach and a step change in climate policy in Aotearoa to drive emissions reductions.

Many of the changes that will need to be made will take time to implement. It will, therefore, require Aotearoa to look forward not just to the next few years, but to 2050 and beyond. Taking a long-term view and sending signals early will help to provide communities, businesses and investors with the predictability that they need to plan.

Climate change touches on the lives of everyone that lives in Aotearoa. This means all New Zealanders, businesses, industries, communities and regions will need to play their part in addressing it. Ensuring that the actions Aotearoa takes to reduce emissions are enduring will require an inclusive and transparent approach with all New Zealanders working together.

This section contains five recommendations that will be crucial for ensuring that the climate transition is enduring.

2.6.1 Cross-party support for emissions budgets

There will be ten elections between now and 2050. Abrupt changes of course as government changes would not give businesses and individuals the predictability they need to make decisions.

It is critical that emissions budgets are non-partisan and set transparently to ensure enduring progress. While the Minister is already required under the Act to consult with other political parties on emissions budgets before they are notified, debating the budgets in parliament is important to ensure transparency and to ensure that cross-party deliberations are on the parliamentary record.

Enabling recommendation 1
Cross-party support for emissions budgets

We recommend the Minister for Climate Change seek cross-party support on emissions budgets. We note that the Minister must consult representatives of political parties on emissions budgets before they are notified but, in addition to this, the Minister should also seek to ensure that the emissions budgets are debated in the House of Representatives so that the positions of each political party are on the parliamentary record.

Consultation question 5
Cross-party support for emissions budget

Do you support enabling recommendation 1? Is there anything we should change, and why?

2.6.2 Coordinate efforts to address climate change across government

The Government is increasingly asking government agencies to work together to deliver on cross-economy issues like climate change. There will need to be coordination across a number of government departments and agencies including the Ministry for the Environment, Treasury, Ministry for Primary Industries, Ministry of Business, Innovation and Employment, Ministry of Transport, Ministry of Health, Ministry of Housing and Urban Development, Waka Kotahi, Energy Efficiency and Conservation Authority, Ministry of Foreign Affairs and Trade, Te Puni Kōkiri, Department of Conservation, Ministry of Social Development, Inland Revenue, Department of Internal Affairs, Ministry of Education and the Tertiary Education Commission. The roles and expectations of each of these, and other agencies in addressing climate change will need to be clearly set out. The accountability mechanisms for delivery will also need to be defined.

The Climate Change Response Act requires the Government to publish an emissions reduction plan outlining the policies and strategies it will put in place to meet the first emissions budget. The Act also allows the Government to include policies and strategies for meeting the second and third emissions budgets, but this is not a requirement. It will take time for government actions to take effect. Signalling longer term policy well in advance will support both public and private investment decisions in line with target outcomes. For this reason, it is crucial that the Government focuses not only on policy for delivering on the first emissions budget, but to look out to future emissions budgets to 2050 and beyond.

There is currently no separate appropriation in the Crown accounts and annual budget for climate change. Rather climate change sits under the broader Vote Environment appropriation for the Ministry for the Environment. In addition, numerous levers for addressing climate change sit outside of the Ministry for the Environment and expenditure on climate change actions sits in many other government agencies.

A separate appropriation for climate change is appropriate given the gravity of the issue and the scale of response required from government and the whole of society. Without a specific appropriation for climate change, it will be difficult to assure the Government and society that action across departments and agencies is synchronised in its delivery and to get the most effective and efficient outcome. Having all expenditure under one appropriation will increase the transparency of how this funding is being used and protect it from being re-directed to other areas.

There is precedent in Aotearoa for integrated work programmes across government agencies, which could be used as a reference in establishing a dedicated cross-agency climate change work programme. An example is the Joint Venture for Family Violence and Sexual Violence. Integrating climate change initiatives across government would be strengthened by consolidating funding for these initiatives within a dedicated Vote Climate Change.

Enabling recommendation 2
Coordinate efforts to address climate change across Government

We recommend that the Government:

a. **In each emissions reduction plan, include policies and strategies for meeting both the next and future emissions budgets (as recommended but not required under the Climate Change Response Act).**

b. **In each emissions reduction plan, nominate specific Ministers and agencies with accountability for implementing policies and strategies in line with emissions budgets.**

c. **Assess and meet funding requirements for implementing each emissions reduction plan in line with emissions budgets.**

d. **Establish Vote Climate Change as a specific multi-agency appropriation which consolidates existing and future government funding for core climate change mitigation and adaptation activities.**

Progress indicators

a. **The Government to include in its first emissions reduction plan, due by 31 December 2021, policies and strategies that will set Aotearoa up to deliver the second and third emissions budgets and 2050 targets.**

b. **The Government to include in its first emissions reduction plan, due by 31 December 2021, the Government agency and Minister that will be responsible for delivering on each of the policies adopted.**

c. **The Government to establish, by no later than 31 March 2022, Vote Climate Change.**

Consultation question 6
Coordinate efforts to address climate change across Government

Do you support enabling recommendation 2? Is there anything we should change, and why?

2.6.3 Genuine, active and enduring partnership with iwi/Māori

We heard through engagement that many cultural and commercial Māori-collectives operate in accordance with the tikanga values that are relevant to them. Within the He Ara Waiora framework (described in more detail in Chapter 6 of the Evidence Report), tikanga is considered as a "means" which, combined with the "ends", can achieve waiora or wellbeing. This is consistent with how iwi/Māori described the way tikanga applies to decision-making on their whenua. We will continue to work with the He Ara Waiora framework to develop our understanding of wellbeing from a mātauranga Māori perspective.

Iwi/Māori we engaged with talked about intergenerational kaitiaki obligations to their whenua, inherited through their whakapapa relationship with the whenua. The Commission serves in more of a tiaki or a stewardship capacity. Acknowledging our respective roles and maximising our ability to work collaboratively in partnership is essential for the transition to a thriving, climate-resilient and low emissions Aotearoa.

This can be achieved through a genuine partnership with iwi/Māori that emphasises rangatiratanga and prioritises a kaitiaki approach to resource management. In more recent times, engagement and advocacy within the Crown/Māori partnership have improved. However, further effort should be made to remove barriers and progress actions that give real effect to a genuine and enduring Treaty partnership.

Enabling recommendation 3
Genuine, active and enduring partnership with iwi/Māori

We recommend that, in transitioning Aotearoa to a thriving, climate-resilient and low emissions future, central and local government take action to ensure genuine and enduring partnership with iwi/Māori that gives effect to:

a. **Tiakitanga and manaakitanga by acting as good stewards and demonstrating equitable and mana enhancing behaviour within the Treaty Partnership. This requires real acknowledgement of rangatiratanga and enables iwi/Māori to exercise their role as kaitiaki.**

b. **Tikanga and kotahitanga by working in partnership with iwi/Māori, through the right decision-makers and following the right process, to ensure Māori communities can prepare for and transition to a climate-resilient, low emissions Aotearoa. This is premised on iwi/Māori aspirations for intergenerational wellbeing; aspirations that are shared by many New Zealanders.**

c. **Whanaungatanga by enhancing relationships within whānau and communities and with the whenua (land) or taiao (environment).**

Progress indicator

The Government to have published, by 31 December 2022, a plan to partner with iwi/Māori and local government to implement emissions reducing pathways and actions that:

- **Gives effect to the He Ara Waiora tikanga.**
- **Includes pathways and actions (which could include regional outcomes and actions frameworks) to remove barriers to participation for iwi/Māori.**
- **Enables iwi/Māori to exercise rangatiratanga and kaitiakitanga.**
- **Promotes equal access to new information, technology, employment and enterprise opportunities.**

Consultation question 7
Genuine, active and enduring partnership with iwi/Māori

Do you support enabling recommendation 3? Is there anything we should change, and why?

2.6.4 Central and local government working in partnership

Local government plays an important role in facilitating the transition to a thriving, climate-resilient and low emissions Aotearoa. Councils make decisions on land use, urban form, road and transport services, provision of housing and the three waters (stormwater, wastewater and water supply), waste management, flood risk management and coastal management. These decisions affect how New Zealanders live, work and run businesses.

We heard consistently in our engagement about the importance of coordination between central and local government. Delivering on emissions budgets and targets will require central and local government to work in partnership. Policy alignment and funding will be important for delivering low emissions outcomes. Alignment will be needed across the Local Government Act, the Building Act and Code, the Resource Management Act (RMA), national direction under the RMA, proposed RMA reforms and the infrastructure plan.

Enabling recommendation 4
Central and local government working in partnership

We recommend that, in transitioning Aotearoa to a thriving, climate-resilient and low emissions future, central and local government work together to:

a. **Align legislation and policy to enable local government to make effective decisions for climate change mitigation and adaptation, including aligning the Local Government Act, the Building Act and Code, national direction under the RMA, the proposed RMA reforms, implementation of the freshwater management framework and the 30-year infrastructure plan.**

b. **Implement funding and financing mechanisms to enable the emissions reduction plans to be implemented effectively and to address the distributional effects of policy change today and for future generations.**

Progress indicators

a. **Government to have, by 30 June 2022, outlined its progress on developing the necessary partnerships between central and local government.**

b. **Government to have published a work plan by 31 December 2022 outlining how alignment and funding will be addressed and the milestones for achieving this plan.**

Consultation question 8
Central and local government working in partnership

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

2.6.5 Ensuring inclusive and effective consultation, engagement and public participation

Taking action on climate change inevitably involves making choices, judgements and trade-offs that touch on the lives of all New Zealanders. These include, for example, how we want our future landscapes to look and how much we want to pay to reduce emissions here or overseas.

In making these decisions, it is helpful to understand a wide range of perspectives, not just of the highly engaged. Many representative groups have knowledge and capacity to engage with and influence government. They have the ability to access leaders and shape conversations. Their perspectives in the transition, and the actions they take to reduce emissions, will be crucial.

However, a collective and coordinated response will require the views and perspectives of people from all parts of society. It is important that the voices of all New Zealanders have the opportunities and resources to input into judgements and decisions on how Aotearoa addresses climate change. Government needs to engage with audiences in ways that suit them, are culturally appropriate and ensure they can contribute.

At the same time, there is a need to avoid over-consultation. This is already becoming an issue with the response to climate change as it increases in prominence. It is also a particular issue for iwi/Māori. The risk is that back-to-back consultation will lead to engagement and consultation fatigue. Aotearoa needs to ensure consultation is genuine collaboration or co-design between government and citizens rather than a tick box exercise.

There are a number of tools that could be used to address these issues. In the past, the Government operated an online consultation hub for all policies relating to climate change to give stakeholders a clear view of upcoming and closed consultations. This provided a source of information for stakeholders, allowing them to plan, allocate time and develop a high-level view of a collaborative government.

In our engagement, some stakeholders suggested that an ongoing public forum or citizens' assembly for climate change should be established. A citizens' assembly would allow the Government or Parliament to work with a randomly selected group of citizens, to inform them on climate change issues and to get their views on the direction Aotearoa should take to reduce emissions and address climate change. Public participation in discussion of how Aotearoa addresses climate change provides a different perspective from the evidence-based analysis that we put forward. Taking action on climate change inevitably involves making judgements and trade-offs. Citizens of Aotearoa should be intimately involved in making such judgements.

Enabling recommendation 5
Establish processes for incorporating the views of all New Zealanders

We recommend that central and local government develop new and more effective mechanisms to incorporate the views of all New Zealanders when determining how to prioritise climate actions and policies to meet emissions budgets over the next 30 years, to create more inclusive policy development. One possible mechanism is funding and establishing an ongoing public forum for climate change to bring forward the views and perspectives of all New Zealanders.

Progress indicator

Government publishes a proposal, no later than 31 December 2022, on the mechanisms it will use to incorporate the views of all New Zealanders when determining how to prioritise climate actions and policies to meet emissions budgets over the next 30 years.

Consultation question 9
Establish processes for incorporating the views of all New Zealanders

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

Chapter 3: The path to 2035

In this chapter, we describe how Aotearoa could meet our proposed emissions budgets. We have developed this by looking closely at the emissions reductions that are technically and economically achievable over each of the first three emissions budget periods. We have looked at both existing and emerging opportunities, technologies and behaviour or practice change. We bring these changes together in a bottom-up modelling framework that captures the key interactions across sectors and allows us to investigate different scenarios for the future.

Emissions can be reduced through either adopting lower emissions technologies and practices, or through reducing production. Our approach has prioritised adopting lower-emission technologies and practices. We have only considered reducing production if there are no alternative ways to reduce emissions.

We have also considered the impact of COVID-19 in producing our path.

The assumptions we used in these scenarios are outlined in detail in chapter 8 of the Evidence Report. For each potential emissions reduction opportunity, we have researched:

- the potential scale of the emissions reductions it could deliver
- how it is applicable for Aotearoa
- the costs, key risks and uncertainties over time that could affect its uptake.

We explored different paths for meeting our proposed emissions budgets to ensure they are achievable and to ensure they would put Aotearoa on track to meet the 2030 and 2050 emissions reduction targets. At the same time, we considered the constraints that could prevent Aotearoa from a faster transition to ensure our proposed emissions budgets are as ambitious as possible.

There is inherent uncertainty when assessing the potential for future emissions reductions. Some technologies could end up reducing in cost faster than we expect, while other technologies could be slower. To meet the emissions budgets we have proposed, Aotearoa needs to make decisions now that open up options in the future. This will provide some contingency in the case that options do not play out as expected.

3.1 Current policies do not put Aotearoa on the right track

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

We formalise 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 gas emissions (Figure 3.1) and biogenic methane emissions (Figure 3.2) are both projected to fall. However, the level of emissions reductions would not be sufficient to meet the 2030 and 2050 emissions targets.

Net long-lived gas emissions are projected to fall from 36.3 Mt CO_2e in 2018 to 6.3 Mt CO_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 the price of units in the Emissions Trading Scheme (NZ ETS) staying constant at $35.

Gross long-lived gas emissions also reduce, primarily through widespread adoption of electric vehicles expected after 2035 and the assumed closure of aluminium and methanol production during the 2020s. Other sources of long-lived gas emissions are largely unchanged.

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 12% 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.

We have tested a variation to the current policy reference case assuming a slightly higher NZ ETS unit price of $50. In this variation, new forest planting increases to around 1.3 million hectares by 2050, allowing net zero emissions to be reached with minimal further reductions in gross emissions. The results suggest that Aotearoa could meet the net zero target for long-lived gases with relatively little additional change.

This variation to the current policy reference case demonstrates a likely path that focuses purely on net emissions reductions. This approach would fail to drive meaningful decarbonisation and instead use up land resources for the purpose of offsetting avoidable emissions. This is not sustainable 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.

As described below, our scenarios for meeting the 2050 target represent a profound shift away from this approach.

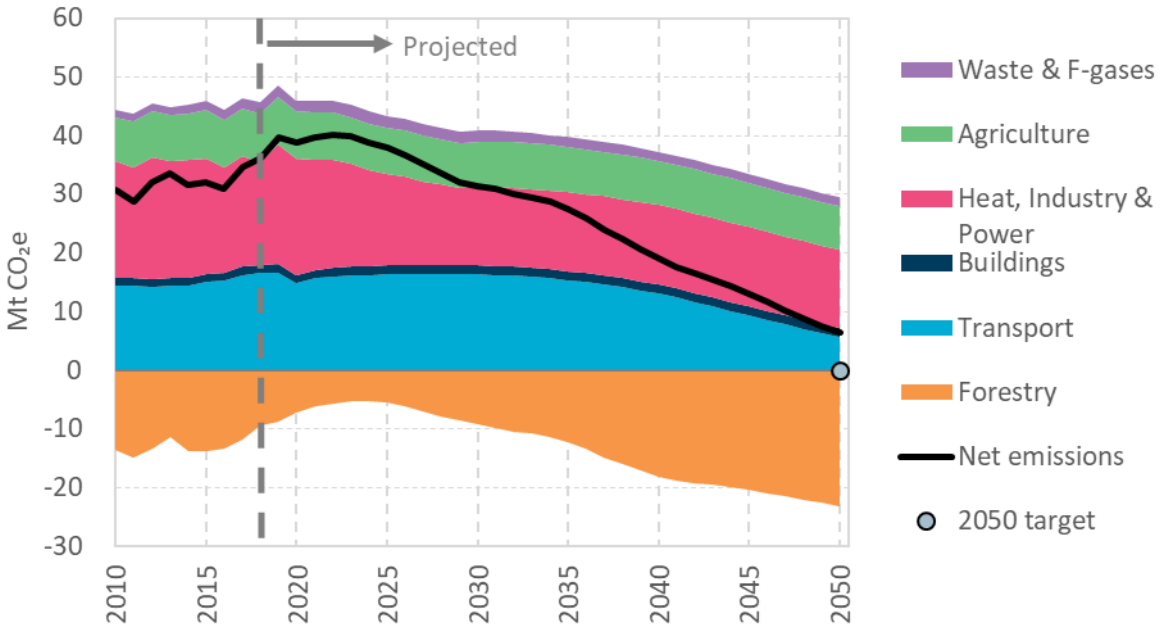


Figure 3.1: Long-lived gas emissions to 2050 projected under current policies.

Source: Commission analysis.

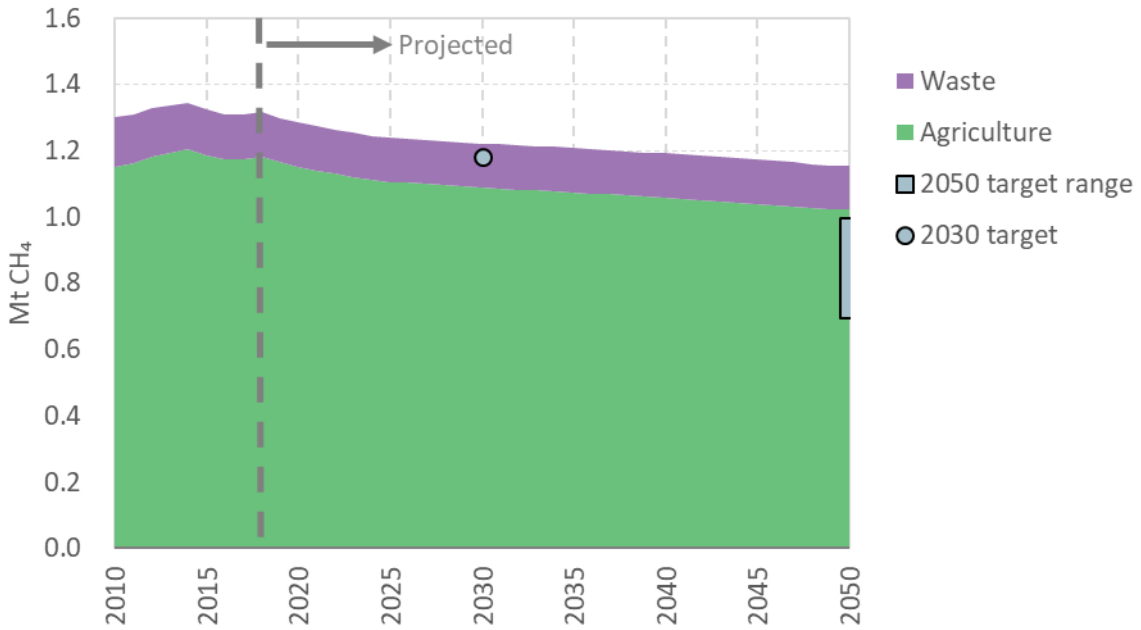


Figure 3.2: Biogenic methane emissions to 2050 projected under current policies.

Source: Commission analysis.

3.2 Our approach suggests a different, but important role for forestry

Core to our advice is the need to reduce gross emissions to prevent the atmosphere warming further and meet the 2050 targets. There are risks associated with the permanence of carbon emissions removals using forestry, especially as climate change exacerbates forest fires, heavy winds, storms, droughts, pests and pathogens. We take the approach of reducing gross emissions where it is feasible and leave carbon removals to offset the hard-to-abate sectors.

Our approach suggests a different, but important role for forestry in meeting the 2050 target than has been outlined in previous analyses by the Productivity Commission and Ministry for the Environment.

New exotic plantation forests absorb carbon quickly, but much of this is released when these are harvested. To keep adding to the amount of carbon stored in forestry, new land will need to be converted to forestry. We consider that the role of exotic plantation forestry should be to support net emissions reductions prior to 2050. However, these should not be at the expense of progress to reduce gross emissions of long-lived gases in those sectors where there are already clear decarbonisation pathways. Exotic forestry will also play an important role in providing biomass feedstock for the bioeconomy, allowing biomass to be used as a replacement for fossil fuels.

New permanent native forests absorb carbon more slowly but will continue to do so for centuries until they reach maturity. Because of this, we consider that carbon removals from new permanent native forests have a role to offset the remaining long-lived gas emissions in sectors with limited opportunities to reduce emissions from 2050. For instance, this could include offsetting nitrous oxide emissions from agriculture and residual industrial process emissions.

3.3 We need to avoid pushing the burden to future generations

In analysing how we can meet the 2050 targets, we have designed pathways that avoid pushing the burden to future generations. We call this ‘locking in net zero’. This aligns with the requirement in the Climate Change Response Act to consider the impacts on future generations, and the need for Aotearoa to contribute to the global goal to limit warming to within 1.5°C of pre-industrial levels and reduce the cumulative emissions of long-lived gases as far as possible.

Focusing on reducing gross long-lived gas emissions and seeking to ‘lock in net zero’ by 2050 requires two key transformations.

- **Decarbonise the sources of long-lived gas emissions wherever this is feasible.** This means setting a path that would achieve near-complete decarbonisation in a number of areas. This includes low and medium temperature heat used in industry, electricity generation, energy use in buildings and land transport. For each of these sectors there are already available technologies that can be widely used to reduce or completely avoid gross emissions.

- **Build a long-term carbon sink large enough to offset residual long-lived gas emissions without ongoing land use conversion.** This means starting now to grow new native forests on relatively less productive land so that carbon removals can be used to offset the remaining long-lived gas emissions from 2050 onwards. Establishing new native forests on less productive land offers a way for Aotearoa to build up an enduring carbon sink while delivering wider benefits for erosion, soil health, water quality and biodiversity.

Achieving both of these key transformations will require strong, accelerated and sustained action to 2050. Strong action on decarbonisation allows time to build market capacity and to transition to low emissions technologies, as long-lived capital assets such as boilers and vehicles are naturally replaced. This helps to minimise costs and the impacts on businesses and New Zealanders. Strong action to scale up native forest planting or reversion is needed in order to plant a sufficient area by mid-century.

Consultation questions 10 & 11
Locking in net zero

Do you support our approach to focus on decarbonising sources of long-lived gas emissions where possible? Is there anything we should change?

Do you support our approach to focus on growing new native forests to create a long-lived source of carbon removals? Is there anything we should change, and why?

3.4 International aviation and shipping

Emissions from international aviation and shipping are not currently part of the 2050 emissions reduction target in Aotearoa. We have heard from stakeholders that this is an important issue. As required by the legislation, we will review whether these should be included in the 2050 target in 2024. We have tested to make sure that our path could allow Aotearoa to meet the 2050 net zero long-lived gas emissions target including international aviation and shipping emissions in case a decision is made in future to include these in the 2050 target.

3.5 Scenarios to reach 2050 targets – understanding the changes required

We have developed a range of scenarios to look at possible futures to 2050 and beyond to understand the changes that are possible and required. Our scenarios have been designed to look at how Aotearoa could meet the 2050 target if future conditions were more, or less, favourable. We present the main scenarios here:

- Headwinds is our least optimistic scenario. It examines a future where there are more barriers to adopting both technology and behaviour changes in the future.
- Tailwinds is our most optimistic scenario. It examines a future where there are fewer barriers to technology and behaviour changes.

More information on these scenarios can be found in chapter 8 of the Evidence Report.

3.5.1 Key insights from our scenarios for long-lived gases

Aotearoa could achieve net zero long-lived gases sometime in the 2040s through changes in technology and behaviour (Figure 3.3). Our Tailwinds scenario achieves this by 2040. Even in our Headwinds scenario net zero long-lived gases could still be achieved by 2048, with a greater reliance on carbon removals by forestry (Figure 3.4).

Key insights into emissions reductions from our scenario analysis include:

- Wider electrification of energy use is an essential part of the transition and will require a 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 the generation of electricity can reduce considerably relative to today.

- Through switching to electric vehicles, road transport, including heavy vehicles, can be almost decarbonised by 2050. This requires a rapid increase in electric vehicle sales so that nearly all vehicles entering the country's fleet are electric by 2035. The switch to electric vehicles is expected to deliver significant cost savings while also reducing air and noise pollution and replacing imported fuels with local renewable electricity.
- Low and medium temperature heat in industry and buildings could be decarbonised by 2050 through a switch away from coal, diesel and gas to electricity and biomass. Our analysis indicates that these costs could range up to $250 per tonne CO_2e reduced but would be less than this where heat pumps or biomass can be used.
- 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 are difficult to reduce but will be addressed somewhat through supporting farmers to implement emissions reducing practices and by the development of technology such as inhibitors.
- New native forests can be established on steeper, less productive land to provide an enduring source of carbon removals. 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 plantation 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 means the 2050 target could be met with a significantly smaller area of new exotic forestry than would occur under current policy settings.

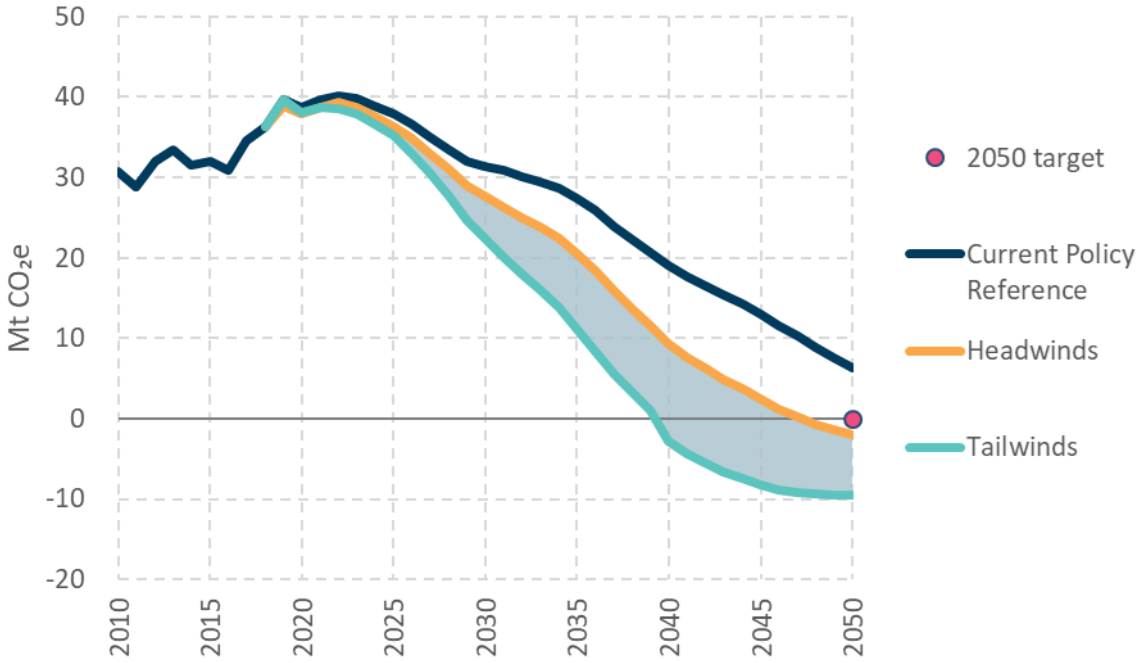


Figure 3.3: The pathway for net long-lived greenhouse gas emissions in the Headwinds and Tailwinds scenarios, compared with under current policies.

Source: Commission analysis.

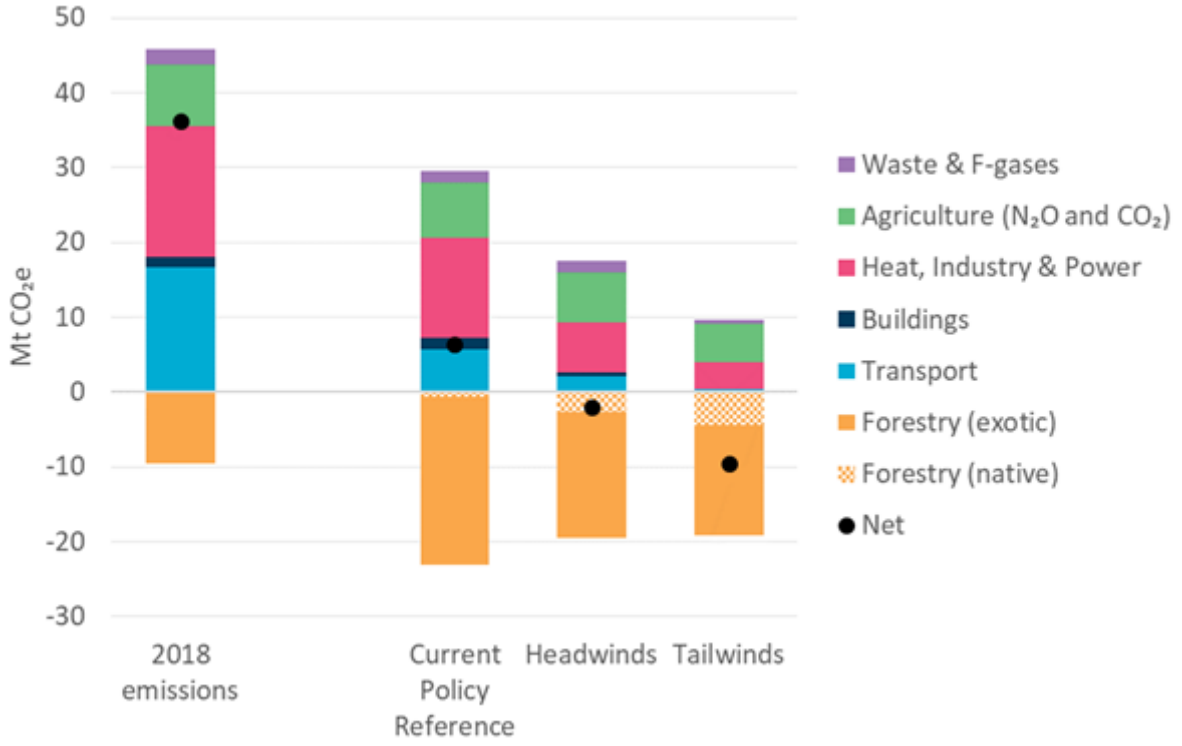


Figure 3.4: Long-lived gas emissions by sector in 2050 in the Headwinds and Tailwinds scenarios, compared with under current policies and with 2018 emissions.

Source: Commission analysis.

3.5.2 Key insights from our scenarios for biogenic methane

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.

Under the Tailwinds scenario, major technology and behaviour changes mean biogenic methane could reduce 59% below 2017 levels by 2050. This scenario assumes that methane inhibitors, methane vaccines and low emissions breeding are developed and widely adopted. Under the Headwinds scenario, slower changes in technology and behaviour still allow biogenic methane to reduce to 25% below 2017 levels by 2050 (Figure 3.5).

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 existing farm management practices and a combination of waste reduction and diversion from landfills.
- Developing and widely adopting new technologies to reduce livestock methane emissions would enable Aotearoa to reach the more ambitious end of the 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.

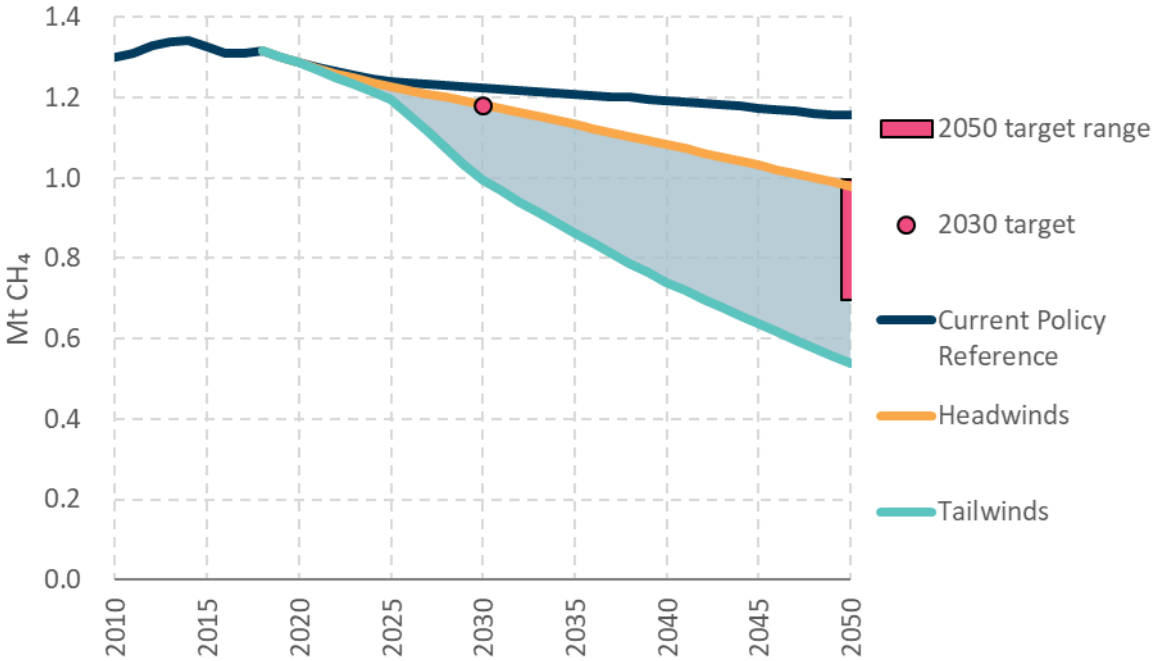


Figure 3.5: The pathway for biogenic methane emissions in the Headwinds and Tailwinds scenarios.

Source: Commission analysis.

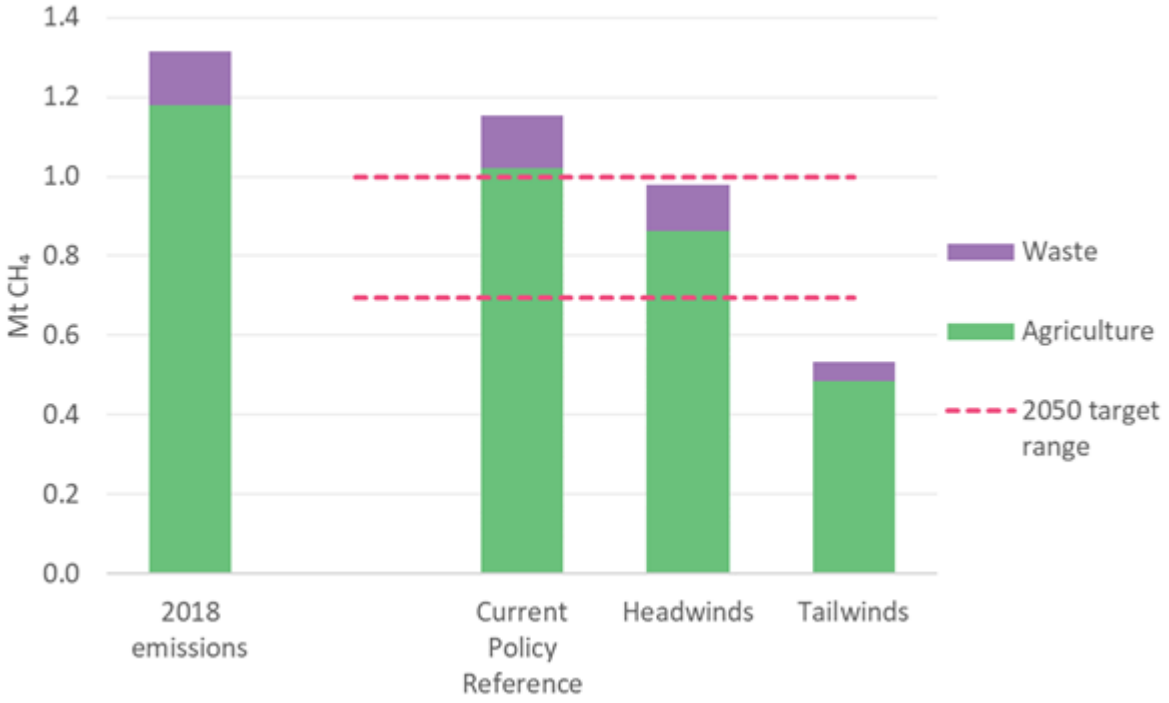


Figure 3.6: Biogenic methane emissions by sector in 2050 in the Headwinds and Tailwinds scenarios, compared with under current policies and with 2018 emissions.

Source: Commission analysis.

3.6 Creating a path to 2035

To arrive at our proposed emissions budgets, we have created a path to 2035. This was developed by looking at all the available options for reducing emissions, their possible deployment in the next 15 years and whether this would put Aotearoa on a path to meet the domestic 2030 and 2050 targets.

There is uncertainty around how fast technology will develop and how behaviours could change in the next 15 years. We would like to see Aotearoa being ambitious in reducing emissions. However, it is not prudent to propose emissions budgets that could only be met if new technologies were developed and deployed. Doing so would undermine the purpose of emissions budgets to set a credible path for medium-term emissions reductions.

The path that we illustrate below shows one way in which our proposed emissions budgets could be met. There are alternative paths that would also deliver our proposed emissions budgets. However, this path provides a balanced portfolio of actions across the economy that would set Aotearoa up to achieve and sustain its 2050 emissions targets. This is in line with our principle to create options and keep them open for as long as possible. Doing this allows actions in some areas to be increased if actions in other areas were slower than expected.

3.7 Summary of our path

Table 3.1 below provides a summary of key actions in our path across the first three budget periods. In the following section we give a more detailed description of the changes that would happen within each sector.

In relation to our long-term scenarios described in the previous section, our path would see reductions in long-lived gas emissions near the most ambitious end of the range (Figure 3.7). Net long-lived gas emissions would fall by 33% by 2030 and 64% by 2035 compared to 2018. Emissions reductions would mostly come from road transport and heat, industry and power, with gross carbon dioxide emissions roughly halving by 2035 (Figure 3.9). This path would set Aotearoa up to achieve net zero long-lived gas emissions in the early 2040s. If this was chosen, Aotearoa would be able to meet a net zero long-lived greenhouse gas target by 2050 that includes its share of international aviation and shipping.

For biogenic methane, our conservative approach to new technologies means that we have not assumed any adoption of a methane inhibitor or other methane reducing technologies that are not already available. Because of this, our path sees biogenic methane emissions towards the high end of the scenario range as all scenarios assumed some adoption of new technologies (Figure 3.8). Our path would push hard on driving changes to low emissions farm practices, alongside strong action to reduce methane emissions from landfills.

Table 3.1: Key transitions along our path.

		Budget 1	Budget 2	Budget 3
Transport	*Road transport*	Accelerate EV uptake Improve average efficiency of new ICE vehicles		Phase out new light ICE vehicles Electrify medium and heavy trucks
	Reducing travel demand	Encourage remote working for those who can Encourage switching to walking, cycling and public transport		
	Non-road transport	Electrification of rail	Biofuel blending Start electrification of ferries and costal shipping	
Heat, Industry and Power	*Buildings*	No new gas heating systems installed after 2025 Improve thermal efficiency		Start phase out of gas in buildings
	Electricity	Phase out fossil base-load generation	Transmission and distribution grid upgrades Reduce geothermal emissions	Expand renewable generation base Achieve ~95% renewable generation
	Industrial process heat	Replace coal with biomass and electricity		Replace gas with biomass and electricity
	Agriculture	Adopt low emissions practices on-farm	Adopt low emissions breeding for sheep	Encourage the adoption of new low methane technologies when available
Land	*Native Forests*	Ramp up establishing new native forests		Establish 25,000 hectares per year
	Exotic Forests	Average 25,000 hectares per year of new exotic plantation forests		Ramp down planting new exotic plantation forests for carbon storage
Waste and F-gases	*Waste*	Divert organic waste from landfill Improve and extend landfill gas capture		
	Hydrofluorocarbons (HFCs)	Reduce import of HFCs in second-hand products Increase end-of-life recovery		

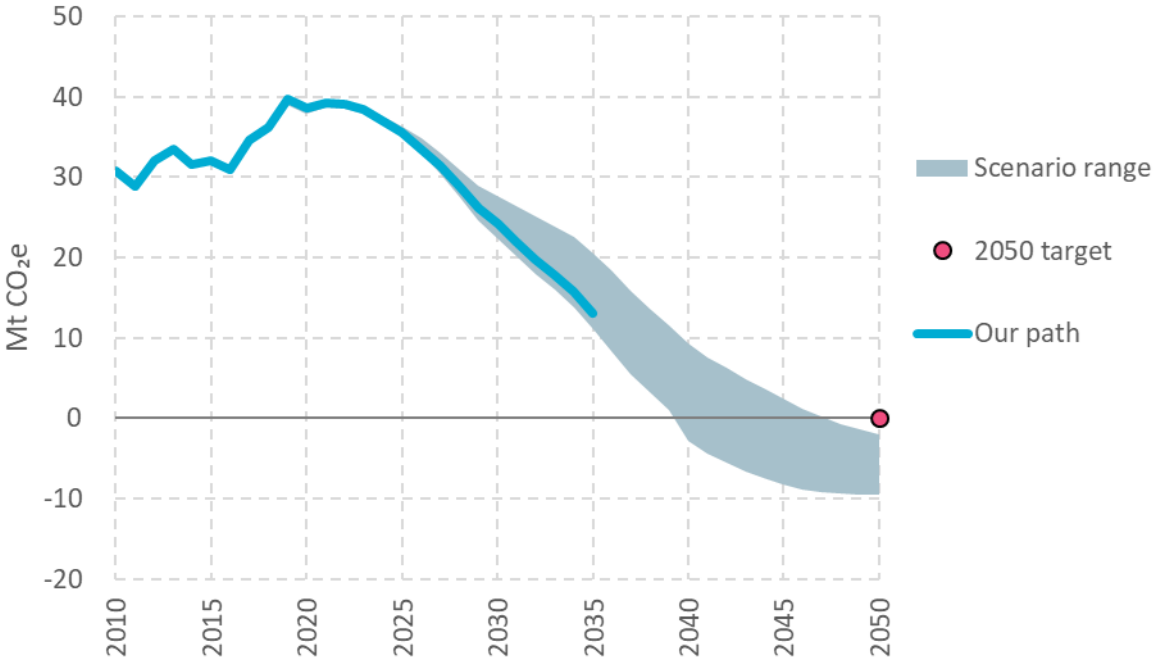


Figure 3.7: Long-lived gas emissions in our path to 2035 compared with our scenario range.

Source: Commission analysis.

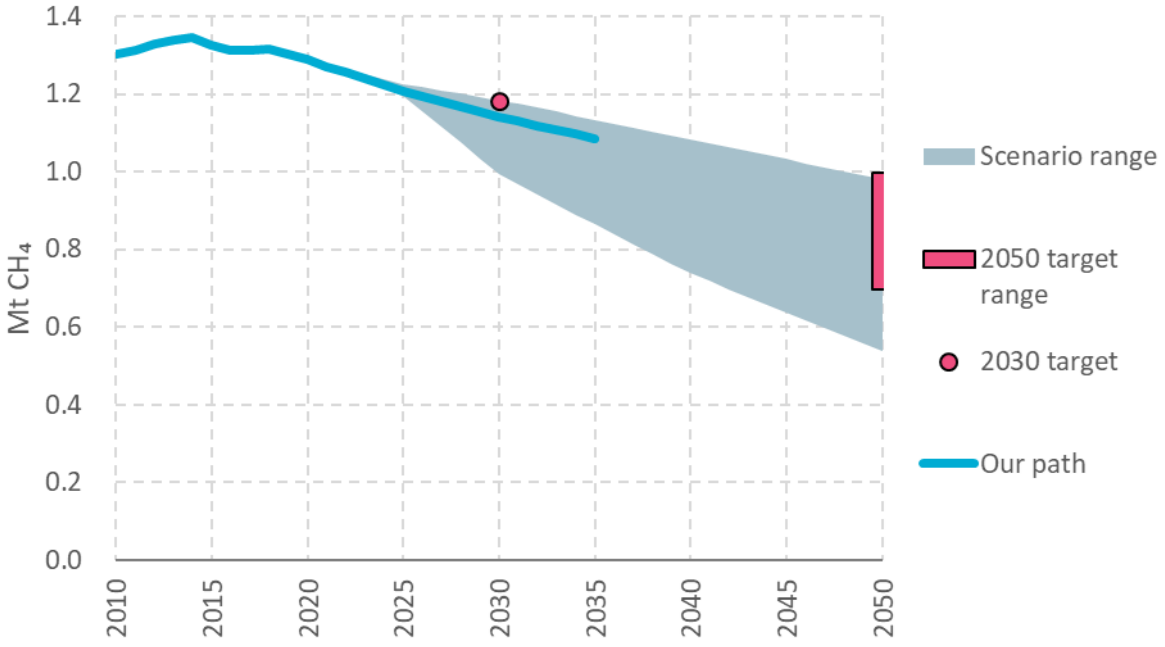


Figure 3.8: Biogenic methane emissions in our path to 2035 compared with our scenario range.

Source: Commission analysis.

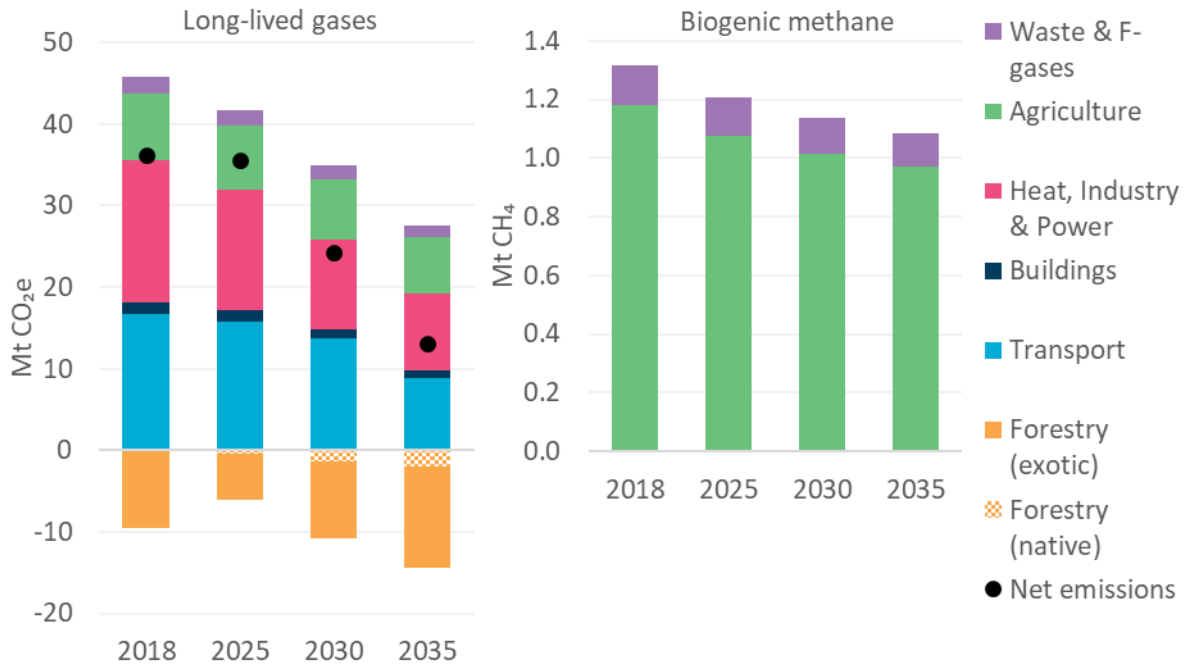


Figure 3.9: Snapshots of emissions in 2025, 2030 and 2035 in our path, compared with 2018.

Source: Commission analysis.

3.8 What a path to 2035 looks like in each sector

This section outlines measures and actions within each sector that would deliver our proposed emissions budgets.

3.8.1 Transport

Under our approach to meeting the 2050 targets, Aotearoa would need to almost completely decarbonise land transport. This means changing how most vehicles are powered, including heavy vehicles.

Electric vehicles are currently more expensive to purchase than internal combustion engine vehicles but are cheaper to run. Their upfront costs are expected to fall further leading to significantly lower lifetime costs. In addition to saving emissions, they also improve local air quality and reduce noise pollution. For these reasons, our path sees ambitious adoption of light electric vehicles, including cars, vans and utes, with no further internal combustion engine light vehicles imported after 2032. This would mean more than half of all light vehicle travel would be in electric vehicles by 2035 and 40% of the light vehicle fleet would be electric vehicles by 2035 (Figure 3.10).

In our path medium and heavy trucks are slower to electrify. This is because the current battery technology does not allow for the greater daily distances they need to travel. Of the trucks imported in 2030, 15% of medium trucks and 8% of heavy trucks would be electric. By 2035, these would increase to 84% and 69% respectively.

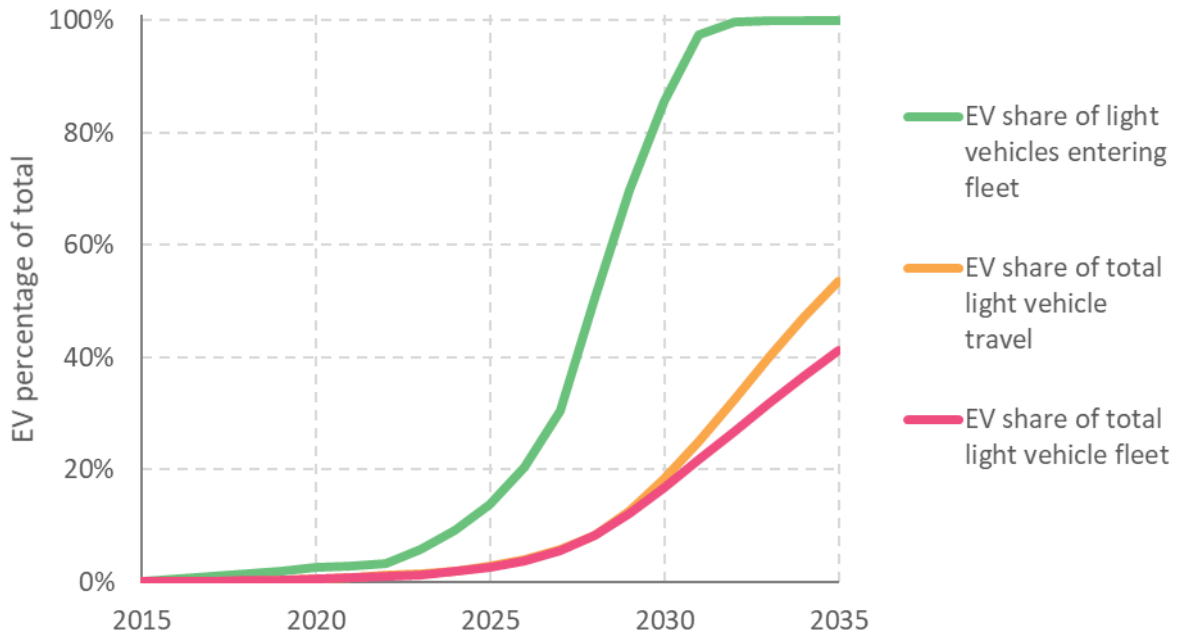


Figure 3.10: Uptake of light electric vehicles in our path.

Source: Commission analysis.

To meet our proposed emissions budgets Aotearoa would need to phase out imports of light internal combustion engine vehicles sometime between 2030-2035. Achieving this phase out is ambitious, but achievable with strong supporting government action. This timeframe is consistent with the phase out dates being set by a growing number of countries.

While electric vehicle supply grows, there would also need to be a focus on importing more efficient internal combustion engine vehicles, including increasing the share of conventional hybrids. Our path assumes the average efficiency of light internal combustion engine vehicles improves by 15% by 2035, or around 1% per year.

In addition to changing the vehicles we drive, changes to how and how much New Zealanders travel play an important role in our path. We assume the average household travel distance per person can be reduced by around 7% by 2030, for example through more compact urban form and encouraging remote working. We also assume that the share of this distance travelled by walking, cycling and public transport can be increased by 25%, 95% and 120% respectively by 2030. Overall, this would see total household vehicle travel staying relatively flat despite a growing population (Figure 3.11).

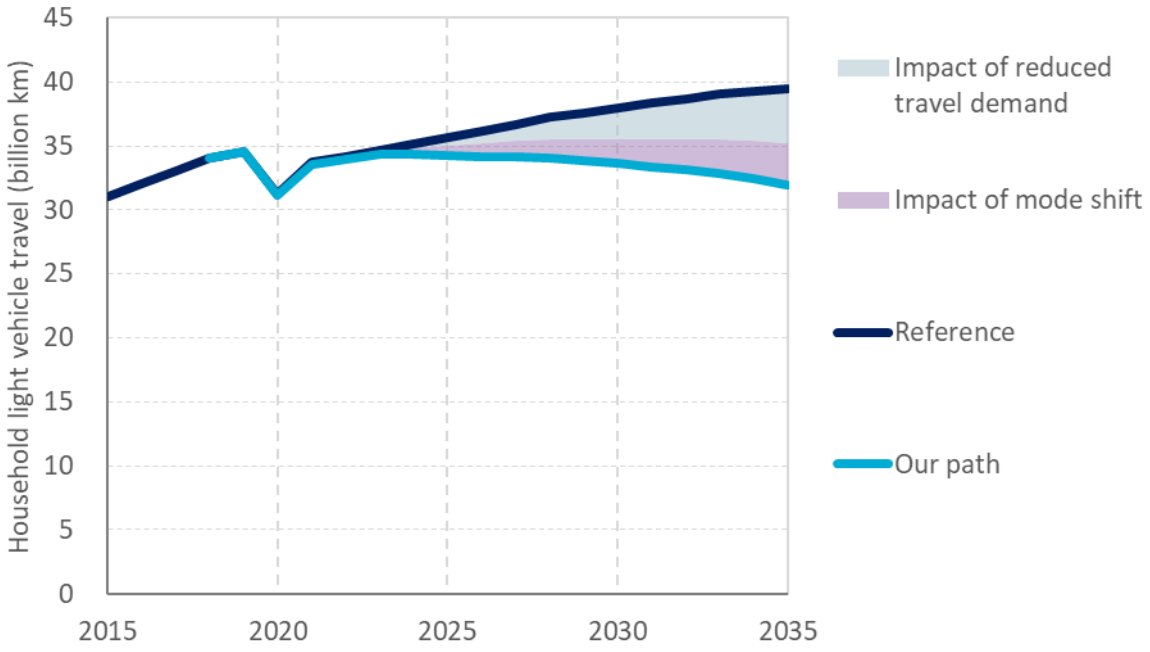


Figure 3.11: Household light vehicle travel in our path compared with under current policies.

Source: Commission analysis.

Emissions from freight can be reduced by switching some freight movements from road to rail and coastal shipping. Our path assumes 4% of freight tonne-kilometres can switch by 2030. Further reductions in freight emissions could be achieved by completing the electrification of the Auckland to Wellington railway line and electrifying the Hamilton to Tauranga railway line.

There will continue to be a need for liquid fuels for some transport uses, such as off-road vehicles and equipment, aviation and shipping. Aotearoa should take action to scale up the manufacture of low emissions fuels like biofuels or hydrogen-derived synthetic fuels in the first three emissions budget periods. Our path assumes 70 million litres per year of low emissions fuels could be made by 2030 and 140 million litres per year by 2035. This equates to roughly 3% of total domestic liquid fuel demand in 2035, or 1.5% of total fuel demand including international transport, under our path.

3.8.2 Buildings

Under our approach to meeting the 2050 targets, Aotearoa would need to improve the energy efficiency of buildings, alongside decarbonising the energy used for heating, hot water and cooking.

Improving the energy efficiency of homes reduces emissions and can improve the occupants' health, particularly for low-income households. Because homes in Aotearoa are typically underheated in winter, households may choose to heat their home more after improving energy efficiency, rather than reducing their energy use or emissions (see chapter 5). We assume that existing homes' energy intensity improves by 6% by 2035. We assume newly built homes are 35% more energy efficient compared to today's performance.

It is already feasible to transition away from heating homes with coal and natural gas. Heat pumps already offer a lower cost way to heat homes than natural gas. For hot water, where feasible, electric

resistive hot water cylinders offer an alternative to natural gas systems with comparable costs. Heat pumps will offer a lower cost option to heat most new commercial and public buildings. For existing buildings, renovations offer an opportunity to replace fossil fuel heating systems, such as gas central heating, with lower emissions alternatives such as heat pumps or biomass.

Commercial and public buildings offer large opportunities to improve energy efficiency through improved insulation and greater control of energy use. New commercial and public buildings can be built to higher standards, and existing buildings retrofitted to achieve these improvements. Our path assumes a 30% improvement in commercial and public buildings' energy intensity is possible by 2035 compared to today's performance.

Commercial and public buildings can quickly transition away from coal to alternatives such as biomass which could use existing boilers. Our path assumes that by 2030 coal use in commercial and public buildings has been eliminated. The Government announcement in 2020 that all coal boilers in public sector buildings will be phased out is a step towards this.

Fossil fuel heating systems will typically last for 20 years or longer. Our path looks to avoid new heating systems having to be scrapped before the end of their useful lives. This means that our path assumes all new space heating or hot water systems installed after 2025 in new buildings are either electric or biomass. For existing buildings, the phase out begins in 2030 (Figure 3.12). No further natural gas connections to the grid, or bottled LPG connections occur after 2025. This would allow time for a steady transition, to be on track for a complete transition away from using natural gas in buildings by 2050.

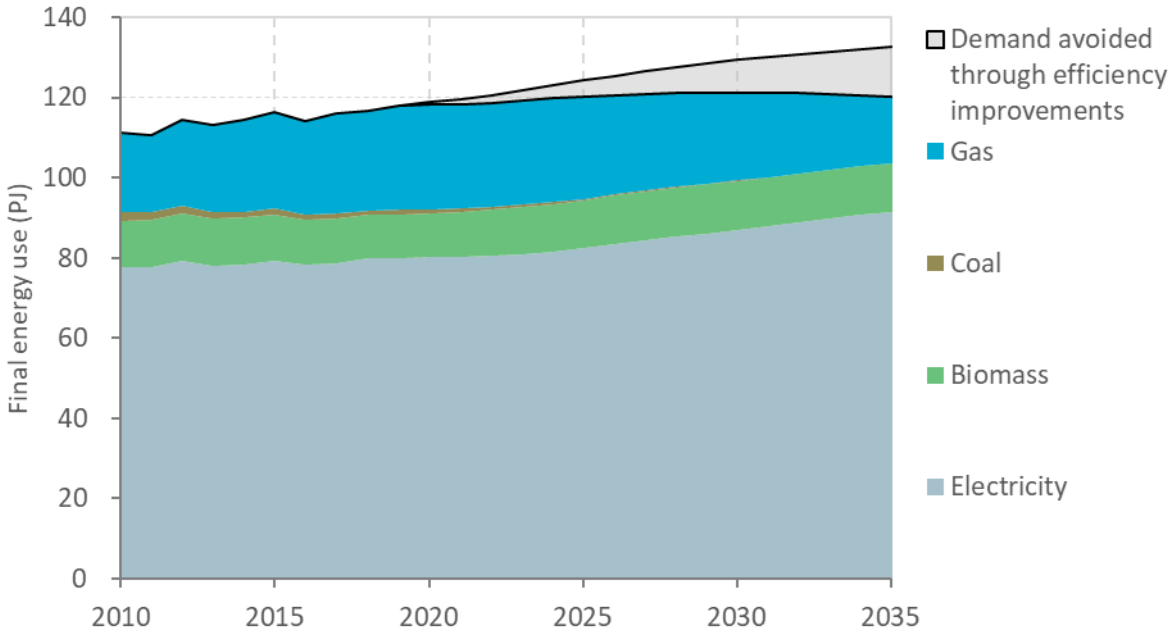


Figure 3.12: Energy use in buildings in our path.

Source: Commission analysis.

3.8.3 Electricity

The use of low emissions electricity allows other sectors to reduce emissions. Electrifying light passenger vehicles will require significant expansion in electricity generation capacity. Demand for electricity will also increase as buildings and process heat switch away from fossil fuels. Increased demand will need to be accompanied by expanding transmission and distribution infrastructure.

Our path requires rapid expansion of renewable wind and solar generation in the 2030s and beyond to meet increased electricity demand as electric vehicles are widely adopted (Figure 3.13 and Figure 3.14). However, in the short term, electricity generation companies may not commit to this expansion in capacity while there is uncertainty around the future of the New Zealand Aluminium Smelter at Tiwai Point.

The New Zealand Aluminium Smelter is the single largest consumer of electricity. Over the last 5 years it used on average around 13% per year of the country's electricity. During the course of the Commission preparing its advice the future of the Smelter was under review. If it leaves, this electricity would be available for other uses. In our path the Smelter closes gradually, coming to a full close in 2026. In January 2021 the New Zealand Aluminium Smelter reached a deal to extend its operations until 2024.

Wind, solar and geothermal offer low cost and low emissions ways of generating electricity. Our path assumes renewable generation is built in the early 2020s. Then building further renewables pauses due the closure of the New Zealand Aluminium Smelter, resuming in the late 2020s. This is illustrated in Figure 3.13 and 3.14.

Some geothermal fields have high emissions from their geothermal fluid, with an equivalent emissions intensity as gas generation. In our path these high emitting geothermal fields would close before 2030 reducing geothermal emissions by around 25% while only reducing generation by 6%.

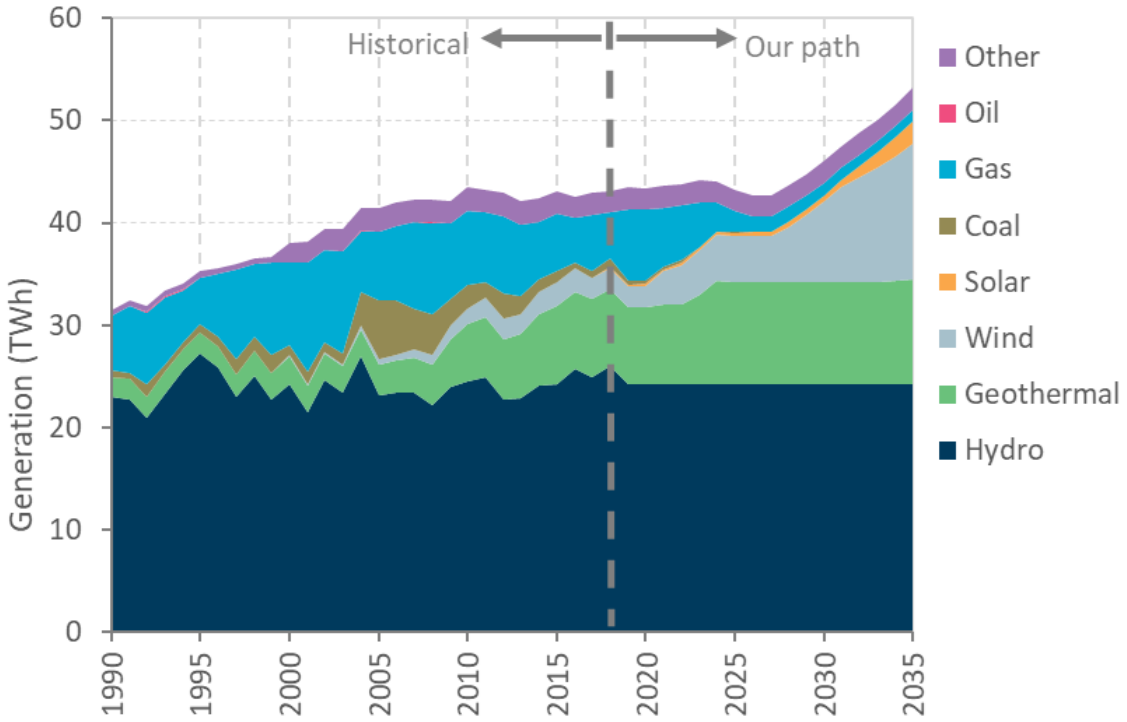


Figure 3.13: Electricity generation by fuel in our path.

Source: Commission analysis.

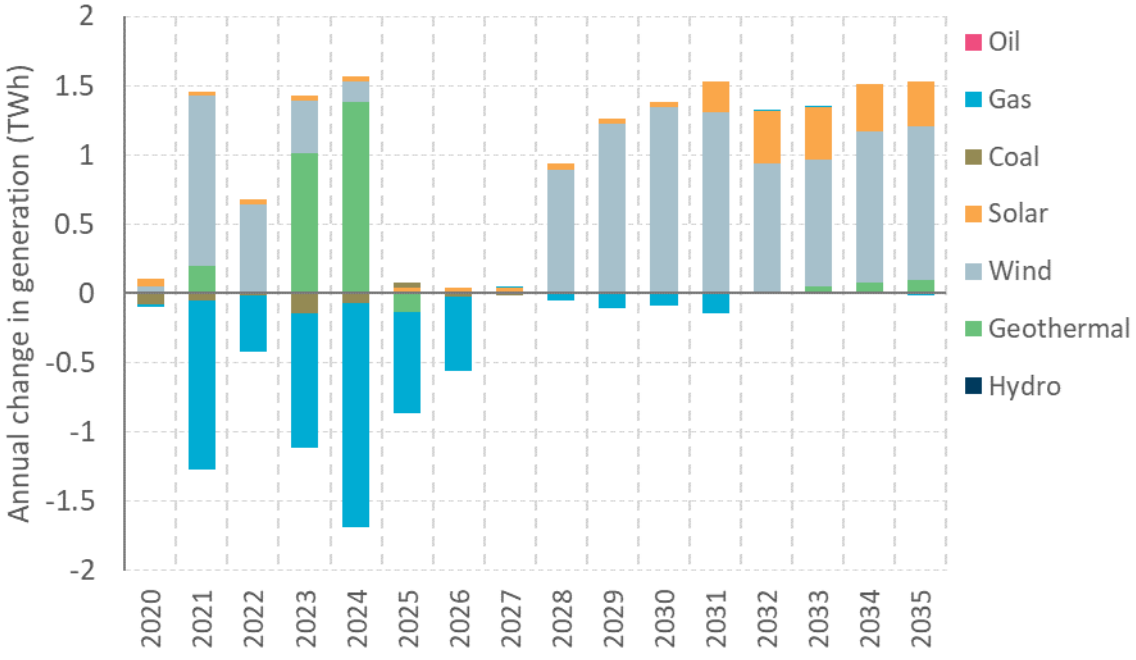


Figure 3.14: Annual increase (positive) or decrease (negative) in electricity generation compared to the previous year.

Source: Commission analysis.

There is also uncertainty around the solution to the dry year challenge – solutions for generating sufficient renewable electricity in years when hydro lake levels are low. Multiple options are being considered under the NZ Battery project that could offer a fossil fuel free solution to providing electricity in dry years where hydro lake levels are low. There are questions over the technical and economic feasibility and public support of the proposals.

Gas generation provides flexibility to meet daily and seasonal peaks in demand and backs up renewable generation. While our path would see reductions in gas generation, some gas is still required to provide this flexibility until 2035 at least. In our path, coal fired generation at Huntly closes in the 2020s.

The challenge is delivering a timely, reliable and affordable build out of the electricity system, while managing the opposing risks of under or over-investing in the system. Continuing to build new electricity generation and transmission infrastructure throughout the 2020s would avoid construction bottlenecks and potential delays to wider decarbonisation in the 2030s.

Over-investment could result in sunk assets or increase the delivered cost of electricity and disincentivise electrification. Underinvestment could delay progress on wider decarbonisation efforts in transport, industry and buildings.

3.8.4 Natural gas use

The total amount of natural gas used in Aotearoa needs to reduce in order to achieve the 2050 targets. Much of the natural gas currently used for process heat, heating and cooking in buildings, and electricity generation will need to convert to low emissions technologies.

Natural gas currently plays a significant role in the electricity system by backing up renewable generation, particularly in dry years when hydro lake levels are low. Using gas in this way supports the reliability and affordability of the country's electricity system.

There are options to eliminate the use of natural gas for electricity generation. However, these are likely to be expensive for the size of the emissions reductions they deliver. In addition, the transition away from gas across the economy would need to occur without compromising the affordability and security of the electricity supply or increasing total emissions.

There is a critical dependency between domestic gas supply and the company Methanex. Methanex produces methanol from natural gas and consumes around 40% of the total gas supply. Their demand incentivises natural gas producers to continue to invest to sustain production. Methanex has provided flexibility by reducing its demand when natural gas is constrained, benefitting all other gas users and reducing methanol production. Without continued exploration and development, the country's natural gas fields are likely to reach the end of their economic life. This will reduce the amount of gas available for all users. In the medium term, it may become uneconomic for Methanex to continue operating in Aotearoa in its current form. A reduction in gas used by Methanex could have flow on cost and supply implications for other gas users including electricity generation and domestic users of gas.

The impact on the electricity and gas system and the potential for large changes in supply and demand from industries exiting the market are discussed further in chapter 6 of this report.

3.8.5 Industry and heat

There are proven options for decarbonising low and medium temperature process heat. These include switching fuel use from coal and natural gas to biomass and electricity. There are also opportunities to improve energy efficiency.

Some coal boilers in the the food processing sector are already being replaced with biomass or electricity. Our path assumes a steady, but reasonably rapid, rate of conversion to be on track to eliminate coal use for food processing by 2037 (Figure 3.15). This is roughly equivalent to converting one to two very large dairy processing plants away from coal each year or converting a larger number of smaller plants. Along with boiler conversion, our path assumes significant improvements in energy efficiency across the food processing sector.

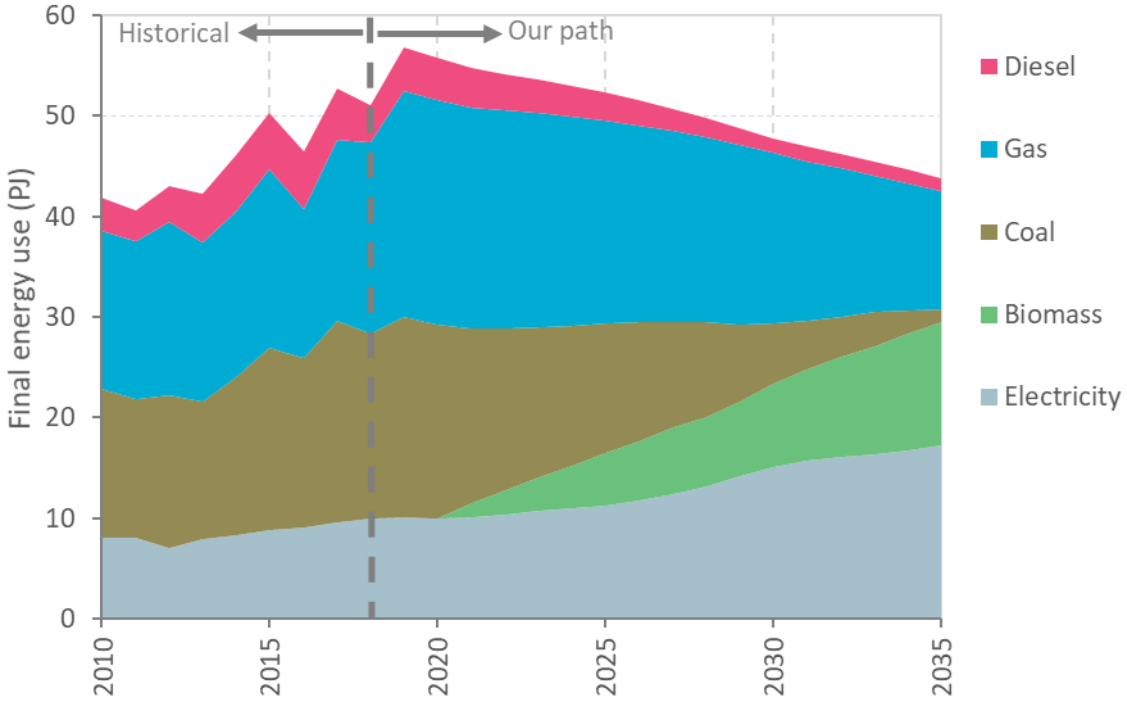


Figure 3.15: Food processing energy use in our path.

Source: Commission analysis.

Where available, biomass from forestry and wood processing residues are a low cost fuel switching opportunity. There may be constraints on biomass supply in some regions where there is not significant forestry. In these regions, electric boilers will be needed, but at a significantly higher operational cost. Electrification of process heat will also require expansion of the electricity transmission and distribution grids. This will add to the total cost.

In our path, fuel switching to biomass also occurs in some other energy-intensive industries such as pulp and paper production.

Overall, our path takes advantage of the country's currently under-used biomass resource, moving towards a more circular economy. Achieving this uptake will require the development of supply chains for gathering and processing biomass along with the establishment of local markets.

In our path, we assume all of the country's heavy industries continue to produce at current levels, except aluminium and methanol production which are assumed to close in our reference case. High temperature process heat is more challenging to decarbonise and our path sees continued use of gas and coal in these sectors. While there is potential to further decarbonise a range of industrial processes through emerging technologies, we do not assume these are available for uptake before 2035.

3.8.6 Agriculture

The two main agricultural greenhouse gases are biogenic methane and nitrous oxide. Biogenic methane has a different target to other gases, while nitrous oxide is included in the long-lived greenhouse gas target. The agriculture sector has focused in recent years on making productivity improvements that have also decreased their emissions intensity. The sector is addressing water quality issues through actions that can also reduce emissions. These efforts need to increase to reach the 2030 and 2050 emissions targets.

There are changes that farmers can make now to reduce emissions on their farms, if given sufficient support. These can improve animal performance while reducing stock numbers, reducing the number of breeding animals required, and moving to lower input farm systems. The Biological Emissions Reference Group found that, when successfully implemented, these changes could be made while not significantly reducing production and while maintaining or even improving profitability.

In setting our path and emissions budget levels, we have conservatively assumed that no new technologies to reduce methane emissions from agriculture are available before 2035. As a result, our path involves changes in farming practices that start pushing towards the limit of what we are confident can be delivered.

Overall, our path would see dairy and sheep and beef animal numbers each reduced by around 15% from 2018 levels by 2030. This compares with an 8-10% reduction projected under current policies. In this, we have included transforming a small amount of dairy land into horticulture, at a rate of 2,000 hectares per year from 2025 (Figure 3.17). With these changes, the 2030 biogenic methane target could be met without relying on new technologies. If farmers can continue to achieve productivity improvements in line with historic trends, these outcomes could be achieved while maintaining total production at a similar level to today (Figure 3.16).

Selective breeding for lower emissions sheep is a proven option which is in the early stages of commercial deployment. Our path assumes that this can be progressively adopted, reducing total biogenic methane emissions from sheep and beef farming by 1.5% by 2030 and 3% by 2035. No adoption has been assumed for the first budget period. Breeding for low emissions cattle is a future possibility but the research is in an earlier stage. We have not assumed any contribution from this by 2035.

Methane inhibitors and vaccines are being researched. These could reduce the amount of methane that is released from cattle and sheep. While there has been progress on inhibitors, these are not yet commercially available. There is uncertainty around when inhibitors will be available, what their costs could be and how effectively they could reduce emissions. Therefore, as mentioned, our path has been set so that the budgets can be achieved without the use of either methane inhibitors or vaccines.

However, if any of these technologies could be brought to market before 2035, they would provide additional options for meeting the emissions budgets. We will be reviewing progress on the developing these technologies and will consider changes to the emissions budgets if we believe they can be widely adopted in the future.

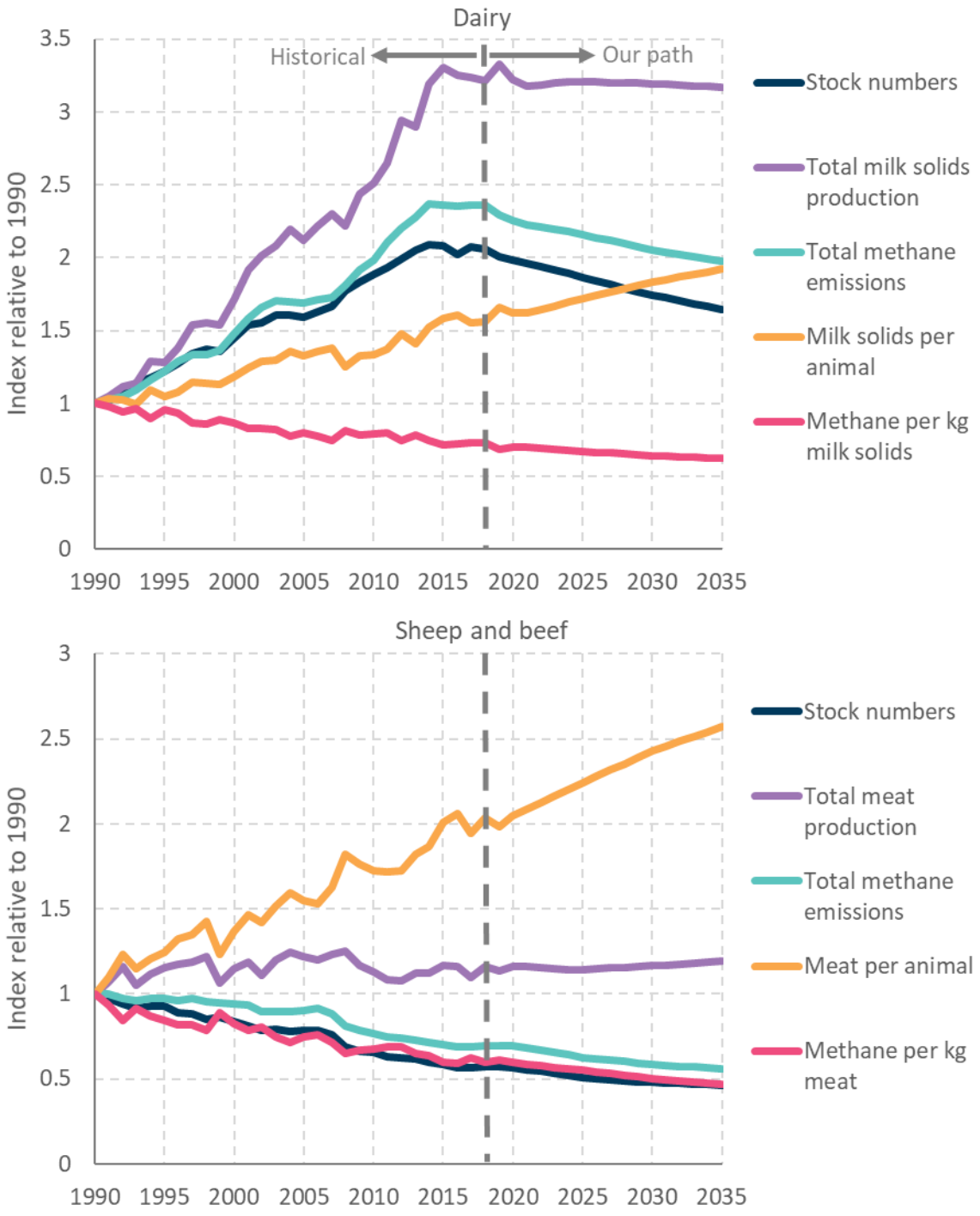


Figure 3.16: Changes in livestock numbers, production and emissions since 1990 and in our path for dairy farming (top) and sheep and beef farming (bottom).

Source: Commission analysis.

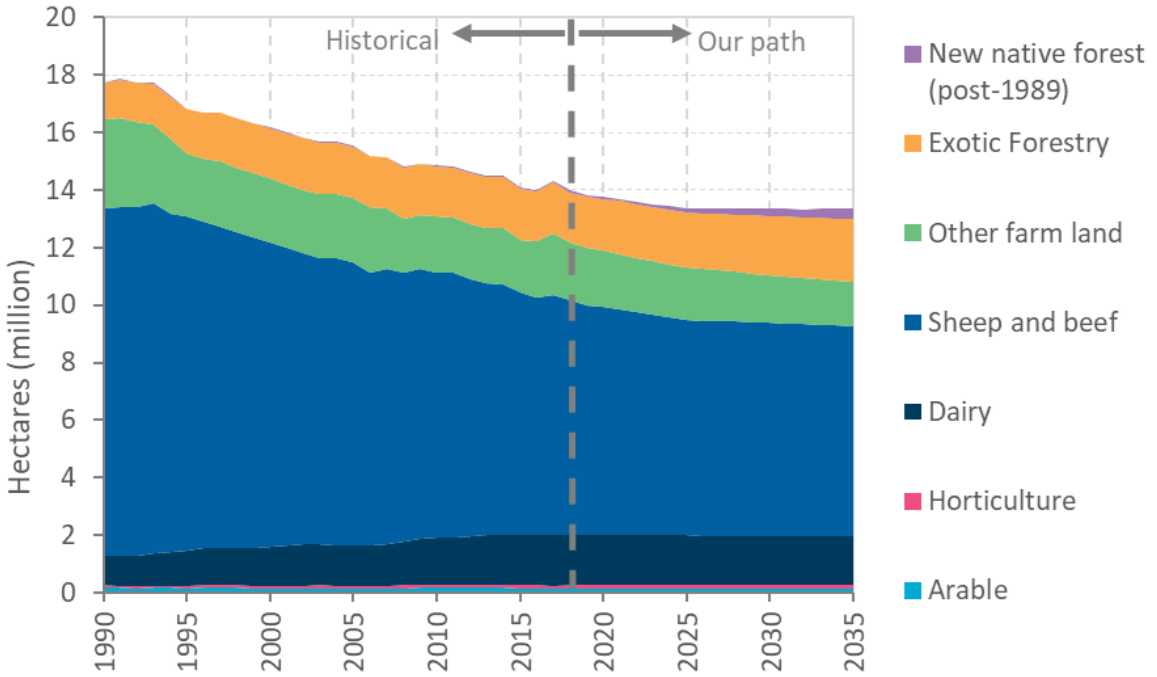


Figure 3.17: Land use for agriculture and forestry in our path

Source: Commission analysis.

3.8.7 Forestry

Our path would see a significant increase in new native forests established on less productive land. The Ministry for Primary Industries forecasts that there will be around 12,000 hectares of new native forests established in 2021. Our path would see this ramp up to 25,000 hectares per year from 2030 (Figure 3.18). In total, close to 300,000 hectares of new native forests would be established by 2035 (Figure 3.17 above). The rate that we can plant or revert native forest would likely be limited by nursery capacity, pest control and fencing.

Estimates from recent studies suggest there is on the order of 1,150,000 to 1,400,000 hectares of marginal land that could be planted in forestry. As much of this land is steep and prone to erosion, we consider that it would be more suitable for permanent forests, particularly native forests.

In our path, exotic afforestation would continue the trajectory expected under current policies up until 2030, averaging around 25,000 hectares per year. From 2030 onwards, the rate of afforestation for carbon removals would reduce. In total, around 380,000 hectares of new exotic forestry would be established by 2035.

We have not assumed any change in the percentage of permanent exotic forest above Ministry for Primary Industries projections as this is not required to reach emissions targets.

As well as planting new forests our path would reduce deforestation, which is still a considerable source of emissions in Aotearoa. Our path assumes that no further native deforestation occurs after 2025.

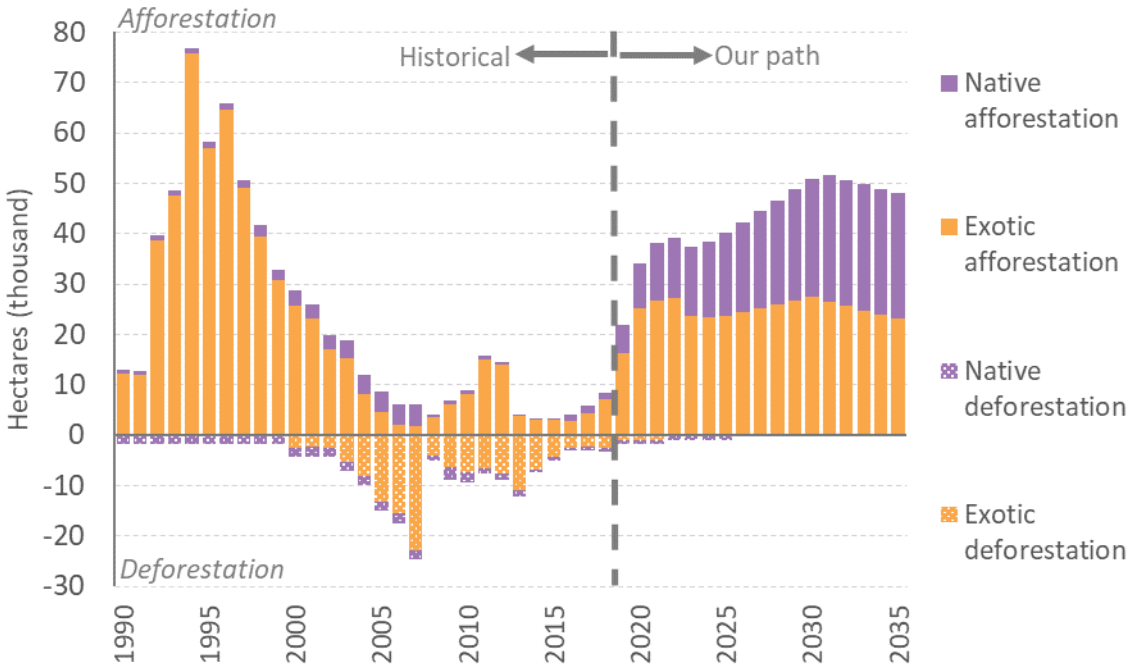


Figure 3.18: Afforestation and deforestation by year in our path.

Source: Commission analysis.

Trees can help in the transition a low emissions Aotearoa in other ways.

Bioenergy offers a low cost route for decarbonising some sectors, including process heat. Overall, there appears to be a large potential biomass supply from collecting and using waste from forestry and wood processing. However, the availability is likely to vary across the country due to regional mismatches in supply and demand of biomass, and the cost of transporting biomass. While the supply of biomass residues may appear to be abundant in some regions, trade-offs may also need to be made when deciding what parts of the economy to decarbonise using biomass first.

Timber can displace emissions intensive materials such as steel and cement in buildings. This reduces embodied emissions and can lock up carbon for several decades.

3.8.8 Waste

Reusing and recovering waste materials is a key part of a circular economy. Our path would see a reduction in the amount of waste generated and a focus on reducing the amount of organic waste, such as food, wood and paper, that go into landfills. Our path would see the total amount of organic waste going to landfills decrease by at least 23% from 2018 to 2030 (Figure 3.19).

Waste emissions can also be reduced by increasing the amount of biogenic methane which is captured and destroyed from landfills, through either upgrading landfill gas capture systems, or diverting organic waste from sites without landfill gas capture to those with capture. In our path we assume minor improvements in landfill gas capture through increasing site coverage and efficiency reduce total methane emissions from waste by an additional 4% by 2030.

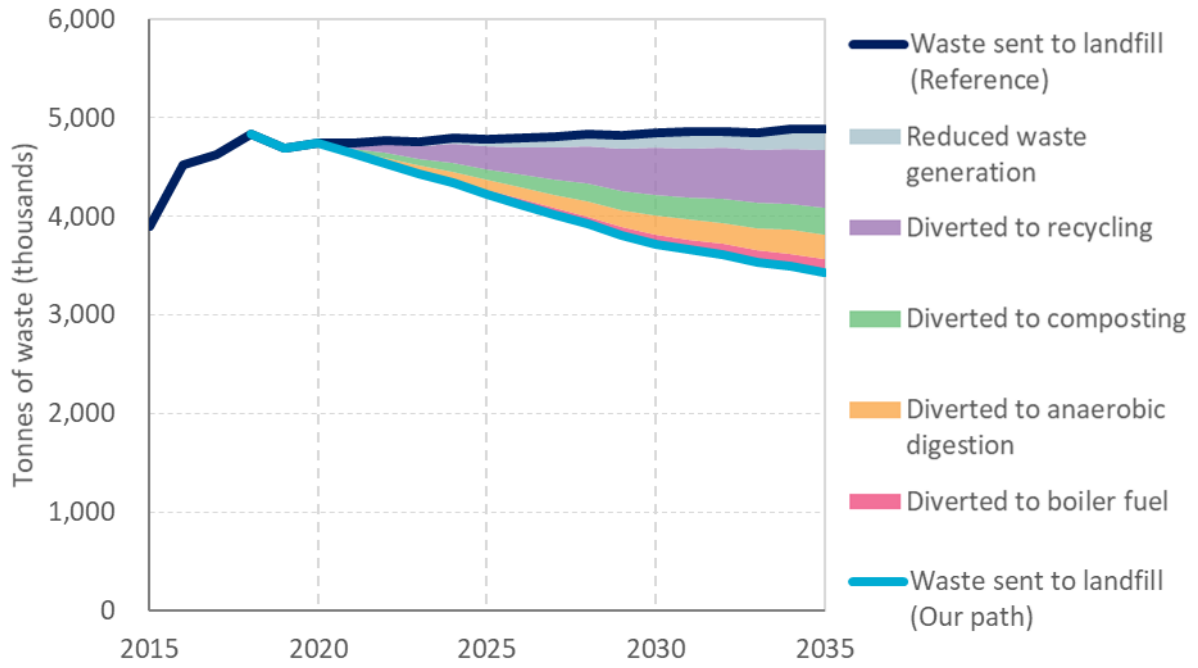


Figure 3.19: Total organic waste sent to landfill in our path.

Source: Commission analysis.

3.8.9 F-gases

Fluorinated gases, including hydrofluorocarbons (HFCs), are greenhouse gases that are primarily used as refrigerants in fridges, freezers and air conditioning systems. Our path assumes emissions from HFCs reduce by at least 18% by 2030 and 33% by 2035 in line with the actions Aotearoa takes under the Kigali amendment to the Montreal Protocol. This can be achieved through reducing the import of HFCs in second-hand products, reducing equipment leakage and increasing end-of-life recovery of products that contain these gases.

Box 3.1: Different ways to meet our emissions budgets

We are required to advise on emissions budgets that are ambitious but achievable. We have tested to understand whether it would be possible to meet our recommended emissions budgets in different ways.

Being able to meet the budgets in different ways gives us confidence that there is enough flexibility in how the proposed emissions budgets can be met. If we set the budgets so they are very easy to achieve, they would not have enough ambition to drive change. However, if we make them too hard, there is no flexibility if things do not turn out how we plan.

We have tested whether our proposed emissions budgets could still be met through a slower uptake of electric vehicles and with less emissions reduction achieved through changes in farm management practices. In this case, the emissions budgets could be met through:

- further reducing travel or shifting to lower emissions type
- further land use change from livestock agriculture into horticulture and exotic forestry
- further reducing the amount of organic waste sent to landfill
- phasing out F-gas refrigerants faster
- an earlier switch away from gas use in the wood processing sector.

We have also tested whether our proposed emissions budgets could be met if people do not change behaviour as fast as we have anticipated. In this case, the emissions budgets could be met through:

- further accelerating uptake of electric vehicles so that by 2030 all new light vehicles entering the fleet are electric
- a methane inhibitor being widely adopted on dairy farms, reducing methane emissions from dairy cattle by around 5% in 2030 and 15% by 2035
- further increases to landfill gas capture.

Consultation questions 12
Our path to meeting the budgets

Do you support the overall path that we have proposed to meet the first three budgets? Is there anything we should change, and why?

Chapter 4: Contributing to the global 1.5°C goal

A key purpose of the Climate Change Response Act is for Aotearoa to contribute to the global effort under the Paris Agreement to limit the global average temperature increase to 1.5°C above pre-industrial levels.

Under the Paris Agreement, Aotearoa has committed alongside other nations to:

- "Hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognising that this would significantly reduce the risks and impacts of climate change"
- "Increase the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production."

Aotearoa has chosen to play its part in pursuing the more ambitious 1.5°C goal.

This chapter lays out our assessment of whether our proposed emissions budgets and the path for achieving them is consistent with contributing to the global 1.5°C goal. This chapter also outlines the science of the different greenhouse gases and how the different nature of the gases impacts the extent to which each gas needs to be reduced.

4.1 The science of the different greenhouse gases

The impact a greenhouse gas has on the climate depends on its 'strength' on a molecule-by-molecule basis and its concentration in the atmosphere. This impact can be expressed as the 'radiative forcing' of that gas – a measure of how much that gas is driving the changes in the global climate.

Carbon dioxide is responsible for the majority of human-driven warming to date. Although it is not a relatively powerful greenhouse gas in itself, carbon dioxide is very long-lived. This means carbon dioxide released today can still be causing warming centuries or millennia into the future.

Methane is the second most important greenhouse gas and is responsible for around a fifth of human-driven warming. Molecule for molecule, methane is much more powerful than carbon dioxide. However, methane is a short-lived greenhouse gas. It has an intense warming effect for the first few decades after it is emitted, but this effect dissipates as methane breaks down in the atmosphere. Figure 4.1 shows the relative warming of a tonne of methane compared to a tonne of carbon dioxide. This makes it important to factor in the different nature of methane's warming impacts when considering global and domestic pathways for reducing emissions. In our path analysis, we have done this by applying a split-gas framework that avoids the use of metrics to compare methane with other gases or trade off effort across the different gases.

Nitrous oxide is a powerful greenhouse gas and is relatively long-lived in the atmosphere. However, emissions of nitrous oxide are much lower than carbon dioxide or methane. As a result, it contributes less to human-driven warming – around 5% globally.

The other greenhouse gases include small levels of F-gases such as hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. Some of these F-gases have very powerful warming effects.

Continuing to emit long-lived gases, like carbon dioxide and nitrous oxide, results in these gases accumulating in the atmosphere. They are effectively being added faster than they are being removed. Therefore, a constant rate of carbon dioxide and nitrous oxide emissions year to year leads to increasing concentrations and more warming.

As methane breaks down at a faster rate, a constant rate of emissions will stabilise within about 50 years. As methane does not accumulate as much, its emissions do not need to drop to zero to stop adding to global warming.

Ultimately, long-term warming depends on how much:

- Carbon dioxide, nitrous dioxide and other long-lived greenhouse gases are in the atmosphere
- Methane is emitted each year
- Carbon dioxide is removed each year.

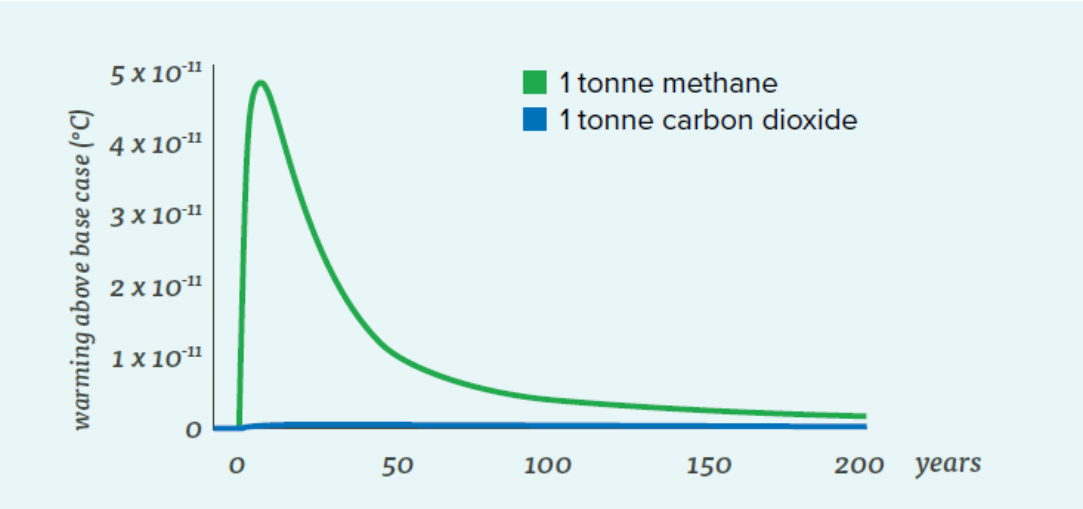


Figure 4.1: The warming effect of a tonne of methane and a tonne of carbon dioxide.

Source: Interim Climate Change Committee.

Figure 4.2 shows the contribution to warming of the country's yearly emissions of carbon dioxide, methane and nitrous oxide. Methane emissions cause the most warming over the first few decades. However, as methane breaks down more quickly, the longer lasting warming from carbon dioxide dominates beyond that.

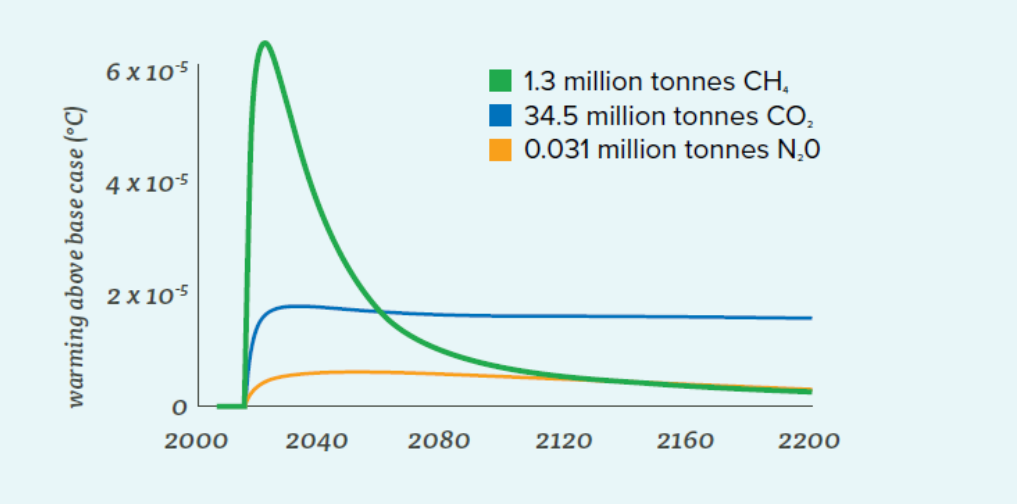


Figure 4.2: The effect of the country's yearly emissions of carbon dioxide, methane and nitrous oxide on warming. Note: This figure is based on 2016 emissions in Aotearoa.

Source: Interim Climate Change Committee.

4.2 The global 1.5°C goal

The central objective of the Paris Agreement is for countries to contribute to "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels."

So far, nearly all countries in the world have signed up to the Paris Agreement and put up targets to reduce their emissions. However, assessments of the current global effort show that the world is not on track to meet the Paris Agreement's temperature goals. The 2020 United Nations Environment Programme Emissions Gap report warns that warming will increase to around 3°C this century based on current pledges.

Reducing emissions takes a global effort – every country needs to do their part and contribute to ambitions under the Paris Agreement. More and more countries are strengthening their international climate change commitments, particularly in the lead up to the next international climate change conference in 2021. In the last 18 months, many of the world's largest emitters have already stated they would move to more ambitious emissions targets:

- In September 2020, China announced it would reach net zero emissions before 2060
- In October 2020, Japan and South Korea announced they were setting net zero domestic targets for 2050
- In December 2020, the United Kingdom announced it would reduce emissions by at least 68% by 2030, compared to 1990 levels. This is an increase from its previous commitment under the EU of 55% by 2030 compared to 1990 levels.
- In January 2021 the United States of America rejoined the Paris Agreement and is expected to make a new emissions reduction commitment shortly.

In Aotearoa, Parliament has set out its intention to contribute to limiting warming to 1.5°C in the purpose of the Climate Change Response Act.

In the previous chapter, we have outlined the emission reductions that are technically and economically achievable for Aotearoa. Two additional factors must be considered to determine how Aotearoa should contribute to the global 1.5°C goal:

- Global pathways that are compatible with limiting warming to 1.5°C
- The principle of common but differentiated responsibilities and respective capabilities

Understanding these elements requires a mixture of quantitative and qualitative analysis. However, in the end, the Government will need to consider what is equitable and make a judgement as to what contribution Aotearoa should make globally.

The Commission takes a systems view of Aotearoa and its place internationally. The world needs not only a functioning atmosphere, but to eradicate poverty and safeguard food security. This must be considered in both the context of reducing emissions and adapting to more severe and costly impacts of climate change if the world does not act to reduce emissions.

Careful consideration is required when considering trade-offs, where to concentrate efforts and how the impacts and consequences are spread across countries, people, place and time. Judgement needs to be framed from a perspective within Aotearoa, which includes a Te Ao Māori view. Efforts to reduce emissions must consider society, economy and environment, while giving consideration to the broader wellbeing of Aotearoa.

Our judgements in these matters are guided by an overarching approach that draws on our tikanga concepts. These lead us towards our vision, guiding what good looks like. They have an emphasis on the kotahitanga aspect of this mahi – the need to work collaboratively and inclusively.

4.3 Global 1.5°C pathways

The Intergovernmental Panel on Climate Change (IPCC) outlined a number of different global pathways that would limit warming to within 1.5°C of pre-industrial levels. These pathways are drawn from peer-reviewed modelling studies. They are not based solely on atmospheric science, but also the feasibility and costs of reducing emissions across sectors and gases and consider a range of socio-economic scenarios.

These global pathways all have differing rates of reduction for each greenhouse gas and rely on varying levels of emission removal technologies. For all these pathways, limiting warming to 1.5°C requires rapid emission cuts of all greenhouse gases between now and 2030. Slower reductions are then needed out to the end of the century. All these pathways have several other features in common:

- Net emissions of carbon dioxide and other greenhouse gases peak in the 2020s, then rapidly reduce through the 2030s and 2040s.
- Emissions of methane reduce significantly through the next 20 years, but do not need to reach zero by 2050 or 2100, due to the short-lived nature of the gas.
- Emissions of nitrous oxide peak in the 2020s and then reduce, but do not reduce to zero due to the difficulty eliminating nitrous oxide emissions from agriculture.
- Gross emissions of long-lived greenhouse gases will be near zero by 2050. Most pathways have some remaining gross emissions in 2050 from hard-to-abate sectors. This includes things

like carbon dioxide from cement manufacturing. As a result, emission removals are required to ensure emissions reach and remain at net zero.

Most 1.5°C pathways also require ongoing levels of carbon dioxide removals beyond keeping emissions to net zero to bring temperatures back to 1.5°C after a temporary overshoot. There are questions about whether the globe can still limit warming to 1.5°C. The longer countries wait to act, the harder it gets, and the more the world will need speculative emissions removal technologies. Later this year the IPCC will release its sixth assessment report which will provide the most up-to-date science on this.

4.4 Common but differentiated responsibilities and respective capabilities

In line with the tikanga values of whanaungatanga and kotahitanga, we must be mindful of the interrelationship, our connections to each other, and work collaboratively and inclusively to address climate change. All countries need to act; through the United Nations Framework Convention on Climate Change and the Paris Agreement, nearly all countries have agreed they will do so.

It is well acknowledged internationally that developed nations have a greater responsibility to take the lead in reducing emissions and support developing countries to transition. Developed countries have emitted more cumulative emissions than developing countries and for longer. They have benefited as a result. The principle of 'common but differentiated responsibilities and respective capabilities' was enshrined in the United Nations Framework Convention on Climate Change in 1992. It was reiterated and expanded in the Paris Agreement to reflect the national circumstances of all countries.

In terms of Gross National Income per capita, Aotearoa ranks as a wealthy, highly developed country.

The historic contribution Aotearoa made to warming came from a mix of carbon dioxide released when native forests were first cleared and ongoing emissions of carbon dioxide from fossil fuel use, methane and nitrous oxide. The vast majority of warming to date comes from historical forest clearance and land use change. Much of this occurred when humans first settled Aotearoa and before the industrial revolution (Figure 4.3).

It has been estimated that Aotearoa has contributed just under 0.3% of the 1°C warming since pre-industrial times.

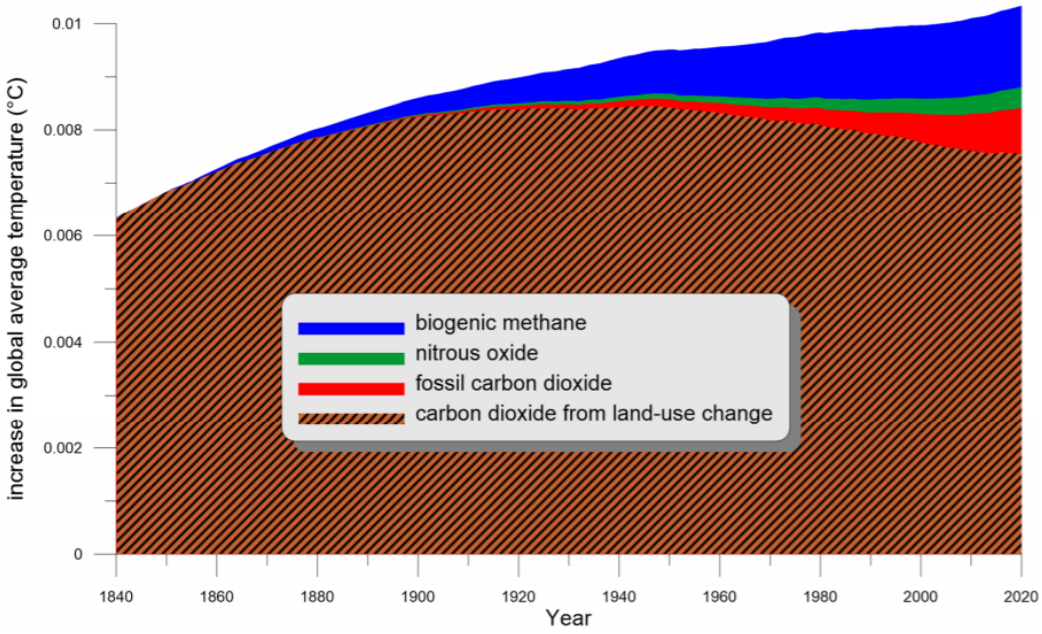


Figure 4.3: The contribution Aotearoa made to warming since 1840.

Source: New Zealand Agricultural Greenhouse Gas Research Centre.

4.5 Assessing how our proposed emissions budgets contribute to the 1.5°C global goal

The Climate Change Response Act requires emissions budgets be set with a view to contributing to the global goal to limit warming to within 1.5°C of pre-industrial levels. At the same time, emissions budgets must be ambitious but achievable and have a focus on domestic actions.

To assess how our proposed emissions budgets would contribute to the 1.5°C global goal, we have looked at how emissions of the different gases would change compared to the IPCC's modelling of global 1.5°C pathways (see Figure 4.4).

The key features driving global reductions in emissions in the IPCC's 1.5°C compatible scenarios are:

- Deep cuts in coal use between 2020 and 2030 (by about ~75% from 2010 levels)
- Reductions in gas use, except where it replaces coal use
- Oil use peaking between 2020 and 2025 and declining steadily thereafter
- Ongoing but more moderate reductions in livestock methane emissions
- Stabilisation or moderate reductions in nitrous oxide.

When comparing our path outlined in chapter 3 against the global 1.5°C pathways, we can make the following observations:

- Our path focuses on large reductions of carbon dioxide emissions with as little reliance on emission removals by forestry as possible.
- Our path sees gross nitrous oxide emissions reducing by 16% by 2035 relative to 2017.
- Together, the reductions in carbon dioxide and nitrous oxide would put Aotearoa on track to meet net zero long-lived gases by 2050.
- Our path sees biogenic methane reduce by 17% by 2035 relative to 2017 levels, putting Aotearoa on track to meeting the biogenic methane target of reductions of at least 24%-47%

by 2050. If some of the more uncertain methane reducing technologies come to fruition, biogenic methane emissions could reduce further.

Figure 4.4 shows that our path would achieve reductions in the use of coal, oil and gas that are consistent with the reductions seen in the IPCC's global pathways. However, our path would fall short when comparing overall reductions in carbon dioxide emissions from energy and industrial processes. In part, this reflects the country's different energy profile compared with the world as a whole. Globally, coal power generation accounts for a much larger share of emissions and it is here the sharpest early reductions occur in the IPCC pathways. It also likely reflects significant deployment of carbon capture and storage occurring in the IPCC pathways.

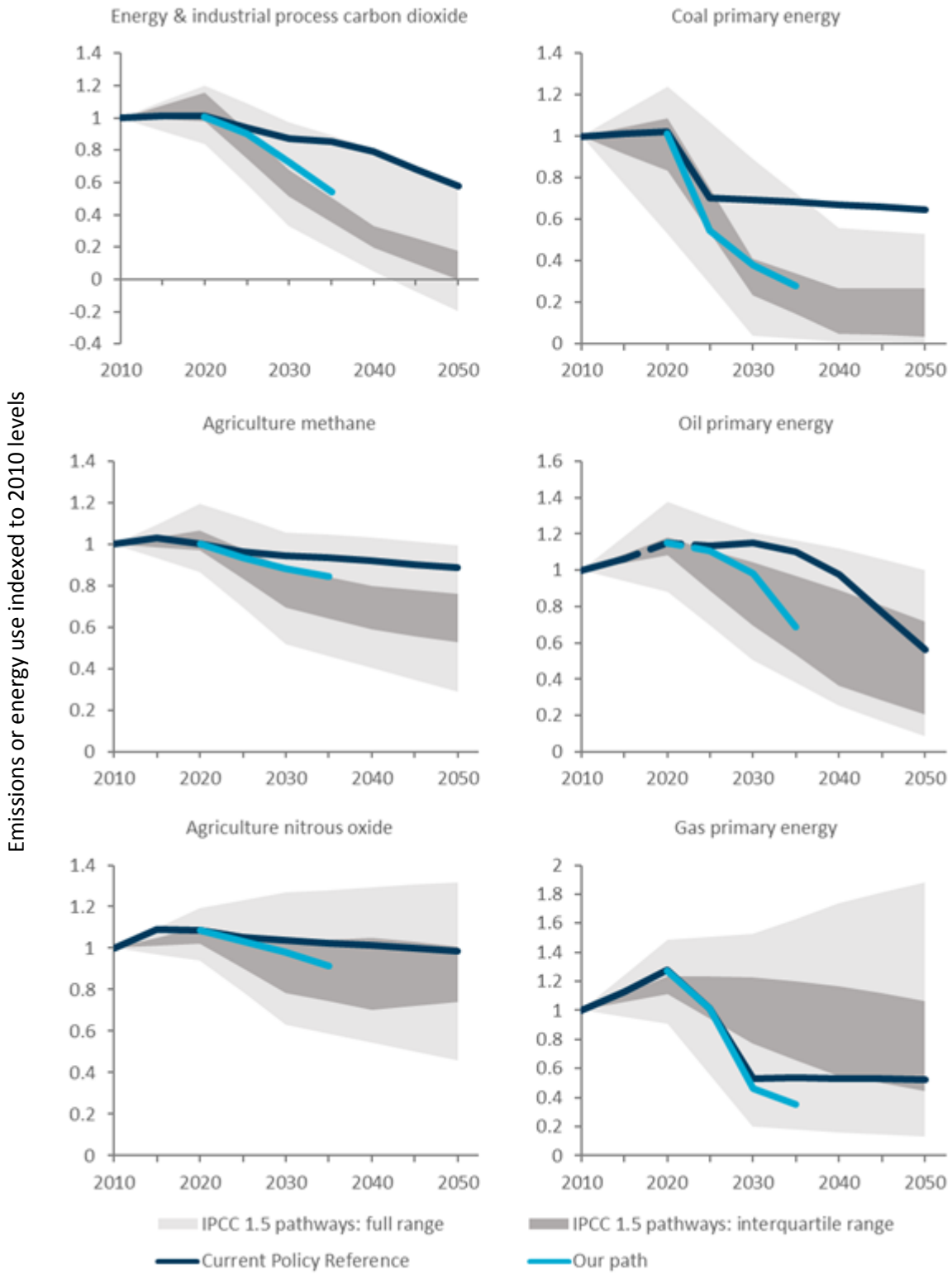


Figure 4.4: How our path to 2035 aligns with the IPCC 1.5°C pathways. In these figures, the emissions over time are indexed to the emissions in 2010.

Source: Commission analysis.

Chapter 5: The impacts of emissions budgets on New Zealanders

When we look at our proposed emission budgets and the policies to achieve them, we also need to consider how these impact the people of Aotearoa. To do this we need to understand that all things are connected: the people, the land, the atmosphere, the oceans. This connectivity – material and non-material – is central to Te Ao Māori, or the Māori world view.

It is also essential to understanding how to guide a transition that is fair and equitable for people and the environment. The transition must reduce emissions with pace while allowing the country to continue to grow so that future generations inherit a thriving, climate-resilient and low emissions Aotearoa.

This chapter considers the impacts of meeting our proposed emissions budgets and what actions can be taken to manage these impacts. It looks at households and communities, how Aotearoa earns its way in the world, businesses, industry and workers. It outlines impacts and mitigation for iwi/Māori, land use, the environment, and government taxation and spending.

5.1 Looking at the opportunities – and the challenges

The transition to a thriving, climate-resilient and low emissions Aotearoa will bring a mix of opportunities, benefits, challenges and inevitable costs. Aotearoa has the opportunity to transition in a way that considers the broader wellbeing of people, the land, and the environment, both now and in the future.

The transition needs to be both accelerated and predictable. Acting too hastily will result in abrupt and disruptive changes akin to the changes many New Zealanders experienced from the economic reforms in the 1980s. Delaying action carries the risk of a sharper and more disruptive transition later, locking in emissions intensive infrastructure that could become stranded and contribute to more severe climate change.

The transition must reduce emissions with pace while allowing the country to continue to grow so that future generations inherit a thriving, climate-resilient and low emissions Aotearoa.

A lack of global action to reduce emissions or taking an approach that solely focuses on adaptation will cause more severe climate change in every country.

We have heard consistently through our engagement that working alongside people to maximise the benefits and reduce the negative impacts will be vital. Placing tikanga values at the forefront of the transition will ensure it is inclusive, equitable, and improves the wellbeing of everyone that lives here now – and in the future.

In our work we have not attempted to sum up the positive and negative impacts of the transition. Instead, we have addressed each potential impact in turn, considering where impacts could compound on particular groups of society and how any negative impacts could be managed. This is summarised in the following sections. More detail can be found in chapters 11 – 15 of the Evidence Report.

5.2 How Aotearoa creates a fair, equitable transition for people

In line with our principles in chapter 2, creating a fair, equitable and inclusive transition means:

- Honouring the principles of Te Tiriti o Waitangi.
- Working collaboratively and inclusively when planning the transition and developing and implementing policy, in line with kotahitanga and tikanga.
- Ensuring the low emissions transition takes opportunities to reduce inequalities, builds strong communities, and meets the needs of current and future generations over time.
- Prioritising support to those most adversely impacted and least able to adjust.
- Sending clear and stable policy signals to provide predictability for communities and businesses, and allow time to plan and respond.
- Investing in people, their skills, and providing opportunities for transitioning to viable work that is environmentally and socially sustainable.
- Acting now to ensure a thriving, productive and climate-resilient economy.

Te Ao Māori recognises the need to consider the connectedness of all things including the past, present and future. In considering how our people would be impacted by the climate transition, we must consider where we have come from, as well as the wellbeing of current and future generations.

Intergenerational equity is reflected in He Ara Waiora, part of the Government's wellbeing framework, through the dimensions of wellbeing ('ends') and the tikanga ('means') both of which are essential to intergenerational wellbeing. This aligns closely with the concept of tiakitanga and encourages Aotearoa to carefully consider the pace of the transition.

Climate change will disproportionately affect future generations. However, if Aotearoa transitions too quickly, this group will also bear the brunt of costs of disruptive change.

Many of the actions Aotearoa could take to address climate change will have broader health co-benefits. New Zealanders will benefit from warmer drier homes, better air quality, and from more active local travel. This will reduce burden on the health system. These benefits will be immediate and add to the case for taking action to reduce emissions.

Global action to reduce emissions would also reduce negative health impacts from a changing climate. The health system will see increased heat stress from warmer temperatures and temperature extremes and changing patterns of infectious disease. The health of more vulnerable groups of society will be hit the hardest.

The transition to a low emissions society will bring a mix of opportunities, benefits, challenges and costs. Actions and approaches to reducing emissions should ensure the benefits of climate action are shared across society. It is important that certain individuals and sectors do not unfairly bear the cost-burden of the climate transition.

Maintaining the principle of equity is important to make sure the policy response is enduring, and emissions reductions can be sustained.

5.3 How the transition could impact the cost of living and access to transport

Energy and petrol costs are key expenses for households. We analysed the potential impact of our proposed emissions budgets on household bills, and access to transport. We found that our proposed emissions budgets would not increase bills for most households. Most households would see a reduction in household bills, particularly if they switched to lower emissions heating and transport.

However, not all households would benefit equally. Some low-income households, older people, people with disabilities, Māori and Pasifika households or households that live in remote areas could struggle to access lower emissions technologies. These are also the groups that would benefit the most from these lower emissions technologies. Targeted assistance will be needed to ensure these groups can access new technologies and are not disproportionately affected by the climate transition.

5.3.1 Electricity bills

Our analysis suggests that overall household electricity bills for heating, cooking and lighting are unlikely to increase as a result of our proposed emissions budgets. However, exactly how they could change is highly uncertain. Household electricity bills depend on both electricity prices and household electricity demand.

Electricity prices

Future electricity prices are uncertain due to a range of factors, such as the weather, gas availability, future infrastructure requirements and pricing structures. Our modelling suggests that, by taking action to meet our proposed emissions budgets, wholesale electricity prices across the country would initially fall and then return to close to 2021 levels by 2035 (Figure 5.1).

One of the reasons for the decrease in wholesale electricity price, is that we assume that the Tiwai Point Aluminium Smelter closes, deferring the need for investment in new generation. However, there are uncertainties around the timing of the Smelter's closure and gas supply for electricity generation. Some of these factors have been discussed in chapter 3, and could cause different price outcomes from what has been modelled.

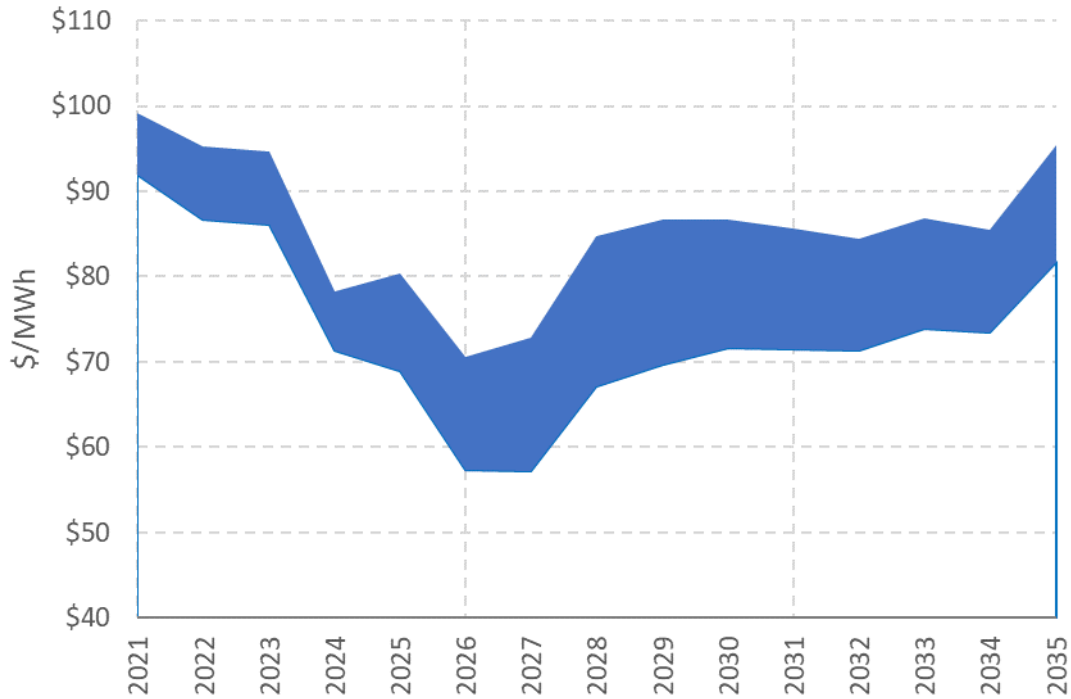


Figure 5.1: In our modelling path, wholesale electricity prices in Aotearoa decrease and then return to close to 2021 levels by 2035. The shaded area shows the range between the maximum and minimum price for different regions.

Source: Commission analysis.

Household electricity prices are influenced by wholesale prices but also depend on several other factors. Based purely on taking actions to meet our proposed emissions budgets, household electricity prices may follow the same trends as wholesale prices. However, projecting future electricity prices is uncertain. For example, the Government is currently making changes to electricity pricing structures, such as transmission and distribution pricing, which may change how costs are allocated to consumers.

Regional electricity prices

Our emissions budgets are unlikely to change regional electricity prices beyond the level of regional variation that already exists. However, there are numerous factors outside of the factors included in our emissions budgets that make future electricity prices highly uncertain.

Households electricity bills vary from region to region, and even within regions. Different areas already face varying electricity prices. This reflects the cost of not only generating electricity, but also of transmitting and distributing it. Communities further away from where electricity is generated often pay higher electricity prices. For example, electricity pricing surveys show that households in Kerikeri and the West Coast pay more for electricity than the national average. There can be as much as a 50% variation between regions.

Average household electricity demand varies across Aotearoa and depends on climatic conditions, personal choice about heating levels for example, and whether the household uses gas, electricity or

wood to heat their homes. For example, the average household electricity consumption is twice as much in Queenstown as in Westport.

Electricity bills

Households bills not only depend on residential electricity prices, but also on demand. Households that are able to make energy efficiency improvements may be able to reduce demand or improve the level of comfort in their homes. Households should be able to reduce their household electricity bills by, for example, switching to heat pumps, or installing insulation or LED lightbulbs.

Making energy efficiency improvements can also reduce energy use at peak times – in the mornings, evenings and in winter. Reducing demand at peak times helps the entire energy system as there is less need to upgrade electricity lines, avoiding potential additional costs for all households. This would require both the adoption of technologies for demand response, and innovative business and pricing models. Electricity pricing incentives, such as low cost night rates, combined with smart charging technology could be an effective way to address this issue.

Household electricity bills could also increase if a household purchases an electric vehicle. However, if that electric vehicle is replacing a petrol car, then overall household energy bills could decrease.

Assisting lower income households

Lower income households, some Māori and Pasifika households, elderly and people with disabilities will benefit more from making energy efficiency improvements. These groups are more likely to live in older, poorly insulated homes, and would therefore benefit more from cost savings, or improved health from being able to use savings for additional heating.

An evaluation of the Warm Up New Zealand programme found that the health benefits from insulating lower income households were substantial, resulting in savings in health costs of more than $800 a year on average. However, there were small benefits in terms of cost savings as households continued to heat their homes.

How this can be managed?

Assistance will be needed to help those on lower incomes with the upfront cost for energy efficiency improvements.

The Government's Warmer Kiwi Homes programme continues to provide funding to those on low incomes who own their own home to install insulation or more efficient heating. The Government has also introduced healthy home standards for rental homes that include standards for insulation and heating.

Continued intervention will be needed to ensure that lower income households can access these benefits. The Government will need to assess whether the existing programmes are delivering at an appropriate pace and scale, and in particular consider whether these programmes have any impact more broadly on rental prices and affordability.

5.3.2 Natural gas

Households that use natural gas for heating and cooking are likely to see an increase in their natural gas bills as a result of our proposed emissions budgets. In 2035, the impact of our emissions budgets could increase the average household gas bill by up to $150 a year. This would affect homes with reticulated natural gas and liquified petroleum gas.

However, natural gas prices are hard to predict as the gas industry is at the beginning of a transition partly because of climate policy. This introduces considerable uncertainty into future gas prices.

The transition away from natural gas may mean that, over time, many households would benefit from replacing gas appliances. This could happen as households naturally need to replace appliances and heating systems, reducing the cost to households.

How this can be managed?

As part of the transition, the Government will need to pay particular attention to low income households who use natural gas, who may not have the money for the upfront conversion cost, or who may rent homes with natural gas appliances or heating. Landlords that own properties with natural gas may not have any incentive to replace them with lower emissions options and therefore low cost options, as they would not benefit from the savings in running cost. There may be some efficiencies and cost savings from replacing old gas heating systems with modern electric systems.

Portable gas heaters are still used by some households in Aotearoa. They are used proportionately more in the North Island, particularly in Gisborne and Northland. These heaters tend to be used by lower income households due to the low upfront cost and the ease of budgeting for heating bills. However, they contribute to mouldy homes and cause health problems. Although the number of these heaters is decreasing, replacing them with more efficient low emissions options will take continued government support.

5.3.3 Fuel costs and access to transport

Transport is crucial to our livelihoods, wellbeing and economy. It connects us to our families, allows us to participate in wider society, and ensures we can access work, education, healthcare, supermarkets, banks and local activities.

The current system in Aotearoa tends to prioritise travel by car. This disadvantages those who do not have easy access to vehicles. This may include some of the country's youth, older people, people with disabilities, Māori, Pasifika and low-income communities.

Improving fuel efficiency, a shift to electric vehicles and more public transport, walking and cycling are all important parts of meeting our proposed emissions budgets.

Our modelling indicates petrol and diesel prices could have increased by up to 30 cents per litre in 2035 as a result of our proposed emissions budgets. Travel costs, including the cost of petrol and vehicle maintenance, are expected to increase for an average household.

However, there are a number of ways to offset this increase. It could be offset by households purchasing more fuel efficient cars, or reducing travel by around 10%.

Our path shows that, by 2035, 40% of the entire light passenger fleet would need to be electric. Households that replace an internal combustion engine vehicle with an electric one could be $1000 a year better off. This is because electric vehicles are likely to be cheaper to buy and will be cheaper to operate. Although electricity bills will increase, the total household energy bill will decrease for these households. The total energy costs for households with and without an electric vehicle are shown in Figure 5.2.

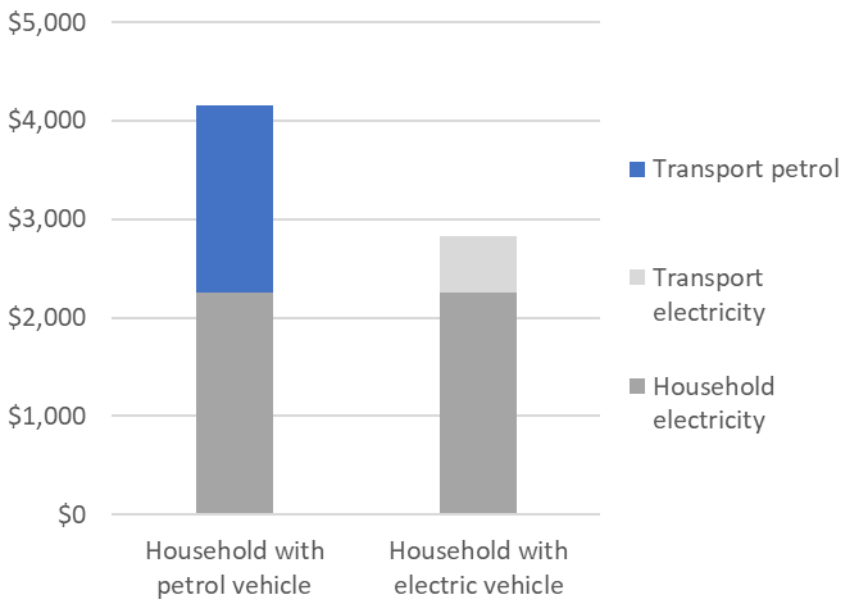


Figure 5.2: Total household energy cost in 2035 for a single car household.

Source: Commission analysis.

However, lower income and rental households may be less able to afford electric vehicle than wealthier households due to the upfront cost of electric vehicles. It may also be challenging for those who cannot charge an electric vehicle at home, for example people living in apartments. We have heard throughout our engagement that this challenge is particularly relevant for people with disabilities who often rely on a vehicle to get around, and for some Māori households who are disproportionately represented among those with low incomes.

Access to transport is a particular issue for some Māori. Transport is hugely important for Māori to connect to their whānau, haukāinga, and tūrangawaewae. About a quarter of Māori in Aotearoa live in Auckland. However, many have whakapapa connections outside of Auckland and may need to travel long distances to participate in iwi, hapū, and whānau activities and events. Some Māori households are large or intergenerational and require larger vehicles. Transport, particularly utes, is also a key enabler for the haukāinga to collect resources and provide services to the marae.

Some people and businesses have specific transport needs the transition will need to address. Farmers, contractors and others in rural communities need vehicles that can carry heavy loads or access rugged or remote locations. Single- or double-cab utes, farm bikes and quad bikes are an essential part of farming and rural landscapes. Cost-effective and low emissions solutions for these vehicles are available now, or will be in the next few years.

How this can be managed?

Targeted assistance will be needed to ensure an equitable transition. More public transport, walking and cycling will have a positive impact, particularly on those who live in cities and larger urban areas. Central and local government will need to provide more and better transport options to increase access to transport for people with disabilities or on low incomes. Currently public transport is not always a realistic option for people with disabilities and many therefore rely on cars. Good policy and planning will be needed to ensure that transport systems are integrated and accessible.

The Government will also need to provide proactive, targeted support to help lower income households reap the benefits of electric vehicles and bring down costs. Policies that encourage a second-hand electric vehicle market, car sharing and leasing, and support to purchase an electric vehicle or electric bike could help.

We have also heard through our engagement the importance of integrating transport into urban form. It will be important that central and local government factor this into their planning and decision-making.

5.4 How Aotearoa earns its way in the world

How the economy grows as Aotearoa transitions to a climate-resilient, low emissions economy will depend on the pace with which Aotearoa acts, the costs to transition and the action from the rest of the world.

With the technologies and practice changes available to Aotearoa, our modelling suggests that what Aotearoa produces and exports for the most part would not need to change significantly to meet our proposed emissions budgets. However, some sectors such as mining and natural gas would reduce significantly.

The pace the world acts to reduce emissions will define how much climate change Aotearoa and other countries will need to adapt to. While there are estimates of the damages from more severe climate change, there is a growing body of research showing that these estimates significantly underestimate the true cost. This is because it is challenging to quantify many of the most serious consequences of climate change as they lie outside of human experience. However, researchers note that these risks provide a compelling reason for the world to work together to reduce emissions.

International and domestic research also suggests there are significant benefits to reducing emissions in the more immediate term. Benefits to health, productivity and incomes all tip the balance further in favour of acting to reduce emissions.

Our economic modelling indicates the economy would continue to grow under our proposed emissions budgets. Under current policy settings, GDP is projected to grow to $396 billion by 2035, and $512 billion by 2050. This does not include the climate impacts that would be more severe if Aotearoa and other countries did not act to reduce emissions. We have also heard consistently from the food and fibre sector that Aotearoa businesses will lose access to some international markets if we fail to take timely action to reduce emissions.

Our modelling suggests that meeting the 2050 targets for biogenic methane and long-lived gases would result in GDP growing to about $508 billion by 2050. This the equivalent of taking another 6 to 7 months to get to the same level of GDP as under current policy settings.

Looking out to 2035, our modelling suggests that reducing emissions to meet our proposed emissions budgets would cost Aotearoa no more than $190 million each year over emissions budget 1, $2.3 billion each year over emissions budget 2, and $4.3 billion each year over emissions budget 3. It is difficult to estimate the benefits of action with any accuracy as there is significant uncertainty in how the benefits will actually be realised.

These findings are in line with international estimates, such as those by the United Kingdom Committee on Climate Change and European Commission (see Chapter 12 of the Evidence Report). Internationally, the cost of deploying technology to meet emissions reduction targets is decreasing faster than expected. As a result, countries like United Kingdom have re-assessed cost estimates of greenhouse gas emissions targets downwards over time.

The economy will continue to experience external shocks over time. The COVID-19 pandemic is an example of this. While these can be difficult times, they also provide opportunities to bring forward investment that stimulates the economy and accelerate the climate transition.

What will the overall impact be?

Our modelling shows that Aotearoa can decarbonise the economy while continuing to grow GDP. The overall costs of meeting the country's targets and our proposed emissions budgets are estimated at less than 1% of projected annual GDP. This is significantly lower than what was estimated when the 2050 targets were set (see Chapter 12 of the Evidence Report). International experience shows that estimated costs are often overstated because technologies improve faster than expected.

While the overall costs are small relative to the size of the whole economy, they will not be evenly felt. Some sectors of society will experience greater impacts, both positive and negative. Government must put in place policies to support those most disadvantaged and those least able to adjust, and to ensure an equitable and inclusive transition. This is discussed elsewhere throughout this chapter.

Taking the recommended actions now will avoid unnecessary costs. Aotearoa will need to make significant investments now, but these will pay dividends in the future. These investments can stimulate the economy and support the post-COVID-19 recovery. Some of these investments, such as investments in energy efficiency, can pay for themselves through savings in energy use.

5.5 Business, industry and workers

Many businesses in Aotearoa are connected to the global economy and compete in international markets. We have heard from businesses that they want to transition, but they need strong stable and predictable policy to allow them to plan. If not managed well, climate policy could potentially increase costs and reduce their competitiveness. At the same time, there are risks to market access if businesses do not reduce emissions as international markets are increasingly seeking low emissions products. It will be important to monitor global markets and actions by competitors to understand the impacts. This is an important ongoing task for the Commission.

Aotearoa has built up thriving industries that have provided New Zealanders with livelihoods and been significant contributors to our economy. Our country has benefited from working the land, with the food and fibre sector a major employer and providing 35% of the country's exports. Mining, oil and gas, and other industries have been important for regional economic development, providing many with jobs. These industries were not built with the knowledge of their emissions, and helped Aotearoa thrive.

5.5.1 Food and fibre production

As part of the climate transition, the food and fibre sector will need to reduce on-farm biogenic methane and nitrous oxide emissions, and carbon dioxide emissions from transport and processing plants. Farmer innovation and competing in markets against subsidised producers means that the country's pasture-based agriculture has one of the lowest emissions footprints in the world.

However, Aotearoa may lose market access as global markets increasingly seek lower emissions products such as low emissions alternative and synthetic proteins. There is good reason to believe that production in Aotearoa will be competitive in a low emissions future where meat and dairy products are still consumed.

Farmers are already taking action to improve water quality. Many of these actions also reduce greenhouse gas emissions. This has also been identified and prioritised by government.

Meeting our proposed emissions budgets through to 2035 could result in little change to the level of agricultural production as there are practices changes that can be made on-farm to reduce emissions without reducing production. However, the output of milk solids would increase slightly and meat output reduce slightly compared to what would happen under current policy settings (Figure 5.3). The impacts on production beyond 2035 would depend on the availability of new technologies such as a methane inhibitor or vaccine.

How can this be managed?

Farm businesses will need to adopt practice changes and take up new technology as it becomes available. Action could result in improved international market access. However, it may be challenging for the food and fibre sector to pass on any costs. Our path suggests that making these changes to reduce emissions on-farm will have little impact on how much food and fibre is produced in Aotearoa.

Approximately 20,000 to 30,000 farm businesses in Aotearoa will need to reduce their biogenic methane and nitrous oxide emissions by making on-farm practice changes. Many farmers are already making these changes but will need to push these changes further. Making these changes will require skilled farm management and high-quality data. Advisory services will need to work closely with farm managers to achieve this.

New technologies such as a methane inhibitor or vaccine would help to significantly reduce emissions from the sector without reducing production. These technologies are not yet available, and so research and development to help bring these technologies forward, and systems for deploying such technologies when they become available will benefit the sector and the economy (see chapter 6, time-critical necessary action 4).

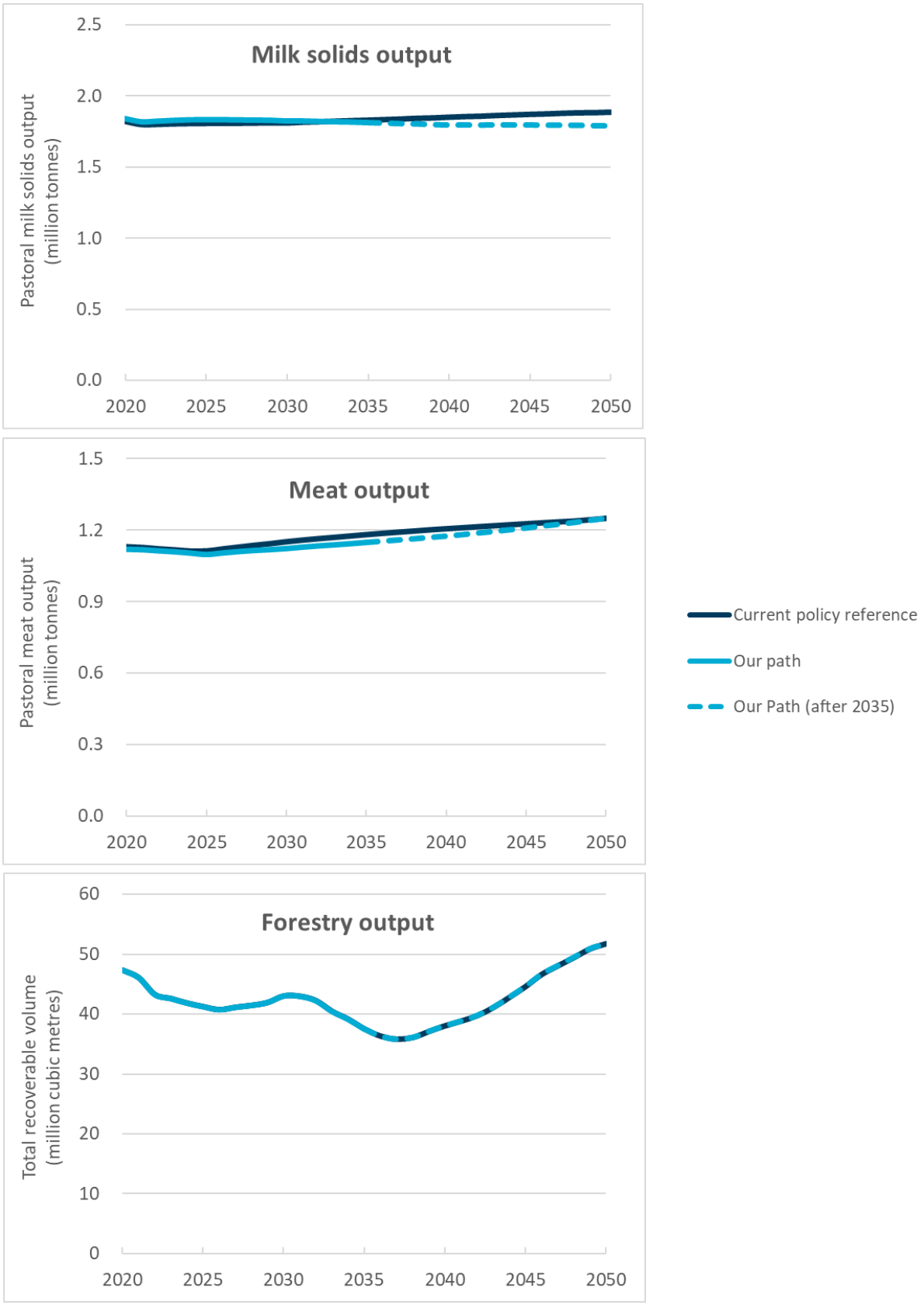


Figure 5.3: The changes in output of milk solids, meat and forestry that would occur in our path over the first three emissions budgets and out to 2050.

Source: Commission analysis.

5.5.2 Energy sector

Energy is a vital part of New Zealanders' day-to-day lives. As well as using energy at home and to power vehicles, it is also used to provide process heat to produce goods that are used here in Aotearoa and sold around the world.

Meeting our proposed emissions budgets would require a transformation of the country's energy system. Our path shows that annual electricity generation would need to increase by around 20% over 2018 levels by 2035 to meet industry and electric vehicles needs. Wind, solar and biomass would expand at a faster rate than expected under current policy settings to meet the country's energy needs and replace coal and natural gas (Figure 5.4).

The Government needs to ensure the electricity system can reliably generate enough supply as Aotearoa shifts away from fossil fuels and increase its dependency on electricity generation. Currently, natural gas and coal provide this security of supply, particularly at peak times and in dry years when hydro lake levels are low. Relying on electricity to meet much of the country's transport, heating, cooking and industry needs carries risk in a nation exposed to natural hazards and other potential disruptions.

In transport, Aotearoa currently relies on imported oil, exposing the country to oil price volatility. Moving to domestic sources of energy for transport could reduce oil imports. This would improve the country's security of supply and provide opportunities for new businesses and jobs. In the long-term the country's energy vulnerability could increase due to heavy reliance on electricity.

How can this be managed?

The Government needs to plan to manage the risk around affordability and security of supply as a result of moving to a low emissions energy system. It is currently investigating options for managing dry year risk under the NZ Battery project, including the proposed Lake Onslow pumped hydro scheme and alternative storage options. The aim is to provide a large amount of storage capacity to manage the risk of dry years where hydro lake levels are low. This project could displace the requirement for thermal generation and achieve an abrupt decarbonisation of the electricity sector. Any solution for managing the dry year risk could be expensive.

Other actions to increase resilience of the electricity grid and the system include building new generation in the North Island, reinforcing the transmission infrastructure, deploying new technologies such as batteries, and diversifying into new fuels such as biofuels and hydrogen that boost energy security.

All of this will need to be considered by the Government when it is developing a long-term national energy strategy. For more information, see chapter 6 and time-critical necessary action 3.

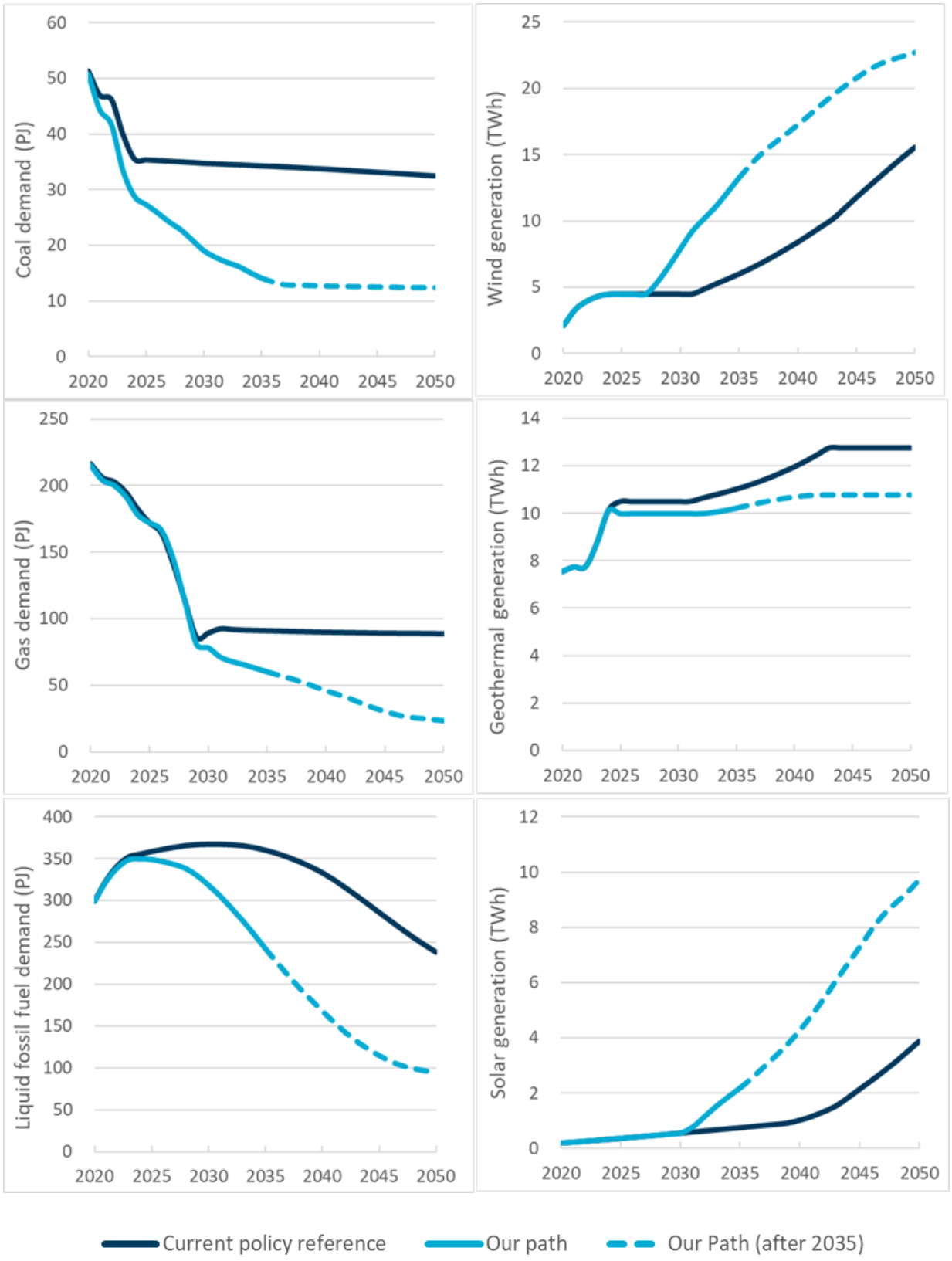


Figure 5.4: The changes in demand for coal, natural gas and liquid fossil fuels (in PJ), and in geothermal, wind and solar generation (in TWh) that would occur in our path over the first three emissions budgets and out to 2050.

Source: Commission analysis.

5.5.3 Small business

Businesses with fewer than 20 employees make up about 97% of Aotearoa businesses. They contribute about 30% of employment and over 25% of GDP. They play a crucial role in the economy, especially in supply chains and larger exporting businesses. Many have been particularly affected by the COVID-19 pandemic.

Our emissions budgets and the transition to a low emissions economy will affect all small businesses in some way. Most of this would come via electricity, natural gas and transport prices.

For most small businesses, the impact would likely be minor over the course of the first three emissions budgets. This is because our path suggests that wholesale electricity prices would decrease by about 30% by 2026 and then return to close to 2021 levels by 2035 (Figure 5.1), and commercial buildings would be 30% more energy efficient and vehicles 17% more fuel efficient by 2035.

However, there are a number of small businesses that currently rely on natural gas. For example, restaurants, cafes and bars often use natural gas for cooking. These businesses will need to move away from natural gas to lower emissions solutions. Our path described in chapter 3 assumes that businesses would replace natural gas appliances at the end of their natural lifetime. Avoiding replacing these appliances early avoids significant additional cost.

Most of the country's 20,000 to 30,000 farm businesses are also small businesses. The changes needed across this sector are discussed in the food and fibre section above.

How can this be managed?

The ability for small businesses to respond, adapt and innovate will depend on information and support, skills and capability, access to capital, and how well the transition is signalled and planned. By signalling early the changes that are needed, the Government will give small businesses time to respond. This will allow them to replace assets such as vehicles or natural gas appliances with low emissions options on normal replacement cycles, reducing the cost to those businesses.

The Government will also need to understand the barriers that small businesses face, and tailor policy to encourage behaviour change (chapter 6, necessary action on supporting behaviour change).

5.5.4 Emissions leakage

Emissions leakage is a risk created by the uneven implementation of climate policies around the world. Emissions pricing or other policies aimed at reducing emissions may increase costs for emissions intensive businesses and cause them to lose market share to international competitors who do not face similar costs. If this causes production and investment to shift in a way that increases global emissions, it would be counter to the intended effect of the policy as Aotearoa would be exporting emissions rather than reducing them.

In Aotearoa, emissions leakage risk is mitigated by providing potentially affected industrial activities with free allocation of NZUs. This substantially reduces the cost of the Emissions Trading Scheme (NZ ETS) for these businesses. It is also expected that when biogenic methane and nitrous oxide emissions are priced, agricultural activities will receive a high level of free allocation that is likely to protect

against emissions leakage. Chapter 12 of the Evidence Report goes into the issue of emissions leakage in more detail.

How can this be managed?

As noted above, current policy settings address emissions leakage risk connected with the NZ ETS.

The Commission will be undertaking further analysis on emissions leakage in the coming years. In relation to agriculture, we will consider the risk of emissions leakage when providing advice on the level of assistance that should be provided to participants in the agricultural emissions pricing system. We expect to provide this advice in 2022.

We will also advise on the phase out of industrial free allocation in the NZ ETS. If an ongoing and substantial risk of emissions leakage becomes evident, industrial free allocation phase out rates could be slowed down. The emissions associated with a slower phase out rate would then have to be compensated for by making further emissions reductions in other sectors.

Policies other than emissions pricing can also contribute to emissions leakage risk. In our ongoing role in advising on policy direction and monitoring the emission reduction plan, we will look at the design of policies with a view to minimising emissions leakage risks.

5.5.5 Making sure workers have opportunities

There will be inevitable changes to employment and jobs as Aotearoa moves towards a low emissions society.

Some regions and communities of Aotearoa will be more affected by the climate transition than others. Some communities may see the closure of large businesses that provide significant employment for the community. This would have a big impact as major job losses at a local level can lead to entire communities being left vulnerable and dislocated. Some affected workers may have the mobility and means to acquire new jobs in other industries and regions. Others may not. Affected communities can end up ‘stranded’, where workers with particular skills and expertise are no longer in demand.

Aotearoa has already seen the New Zealand Aluminium Smelter announce that it will close. Other emissions-intensive industries and large employers have also announced strategic reviews. There are many reasons for such industry closures besides climate change policy, with the Aluminium Smelter citing energy costs and a challenging aluminium outlook. Closure of these industries has an impact on those who work there.

To help understand the impact on employment, we commissioned a new model called the Distributional Impacts Microsimulation for Employment (DIM-E). We ran four scenarios through this model. However, in this section we have focused on two of these scenarios – transition pathway 3 (TP3) and transition pathway 4 (TP4) – that are in line with our proposed emissions budgets and key assumptions.

This model cannot tell us about the aggregate effect on jobs in Aotearoa, but provides insights on the flow of work across Aotearoa.

The coal mining and oil and gas sectors, and the services that support them, will be impacted by the transition away from fossil fuels. This would particularly affect regions in Aotearoa that have fossil fuel extraction industries.

Under current policy settings, our modelling indicates that Aotearoa would see about 600 net job losses from these fossil fuel sectors between 2022 and 2035. However, taking action to meet our proposed emissions budgets would result in 600-1100 more net job losses across the coal mining and oil and gas sectors by 2035 (Figure 5.5:). If Aotearoa reduced emissions at a faster rate in the first two emissions budget periods, job losses in these sectors would occur earlier.

The jobs that are lost from the oil and gas sector are likely to be highly skilled and therefore high paying jobs. The individuals affected are likely to have skillsets that could be valuable in other sectors, including sectors emerging as part of the transition to a low emissions economy.

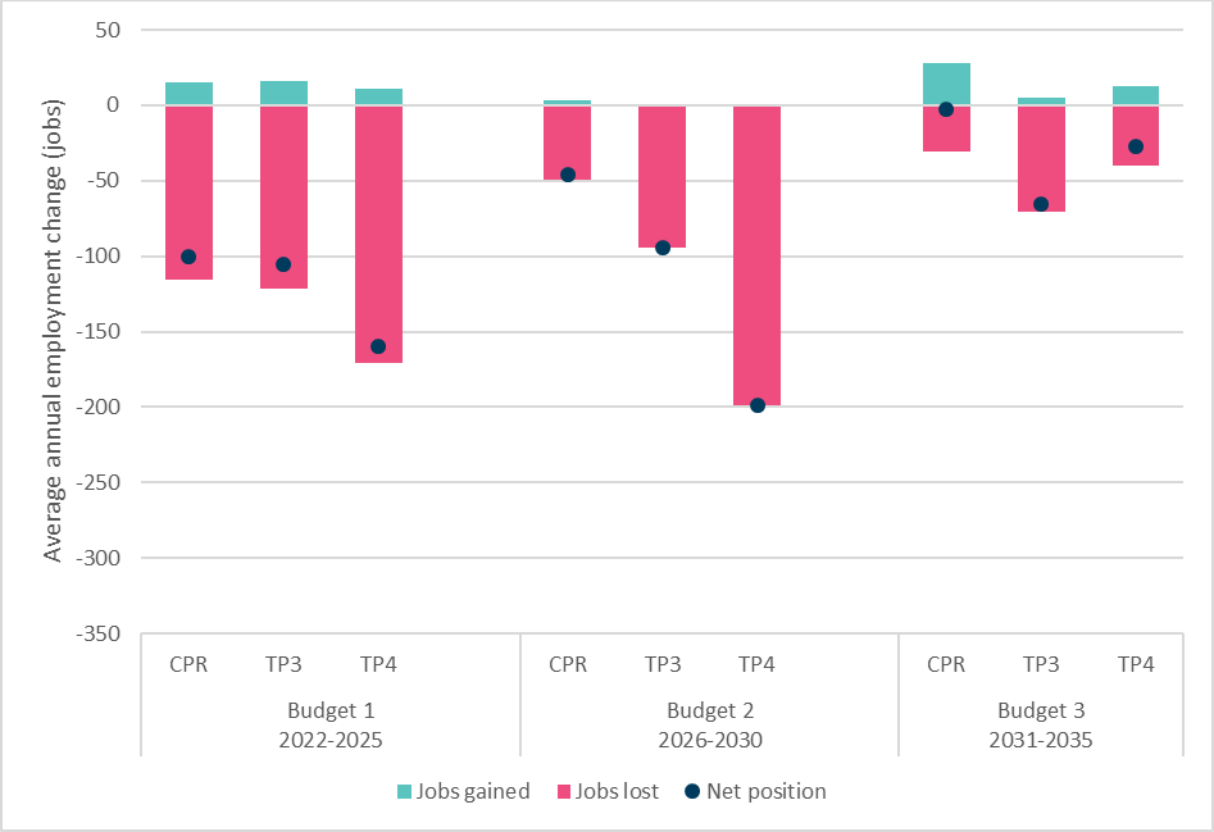


Figure 5.5: Simulation results of the average annual change in employment in the fossil fuel sectors in each emissions budget period under the current policy reference case (CPR) and transition pathways 3 and 4 (TP3 and TP4) that are in line with our proposed emissions budgets.

Source: Commission analysis – DIM-E results.

In some other sectors, our modelling indicates that there could be fewer job losses as a result of taking actions to meet our proposed emissions budgets. For example, our modelling suggests that, under current policy settings, there could be about 4,000 job losses in sheep, beef and grain farming by 2035. However, our modelling suggests that taking actions to meet our proposed emissions

budgets would result in 400-700 fewer job losses. This is largely because our proposed emissions budgets would result in less land use change from sheep and beef farming to forestry.

Figure 5.6: Simulation results of the average annual change in employment in the grain, sheep and beef cattle farming sectors in each emissions budget period under the current policy reference case (CPR) and transition pathways 3 and 4 (TP3 and TP4) that are in line with our proposed emissions budgets.

Source: Commission analysis – DIM-E results.

While our modelling is able to look at existing industries, there will also be new industries that arise as a result of the low emissions transition and from regional development that our modelling is not able to foresee. For example, there are opportunities to create new jobs associated with the circular economy, such as using wood waste for biofuels, and new industries, such as hydrogen. New jobs could also be generated in energy efficiency and home energy audits, advisory services for managing emissions on farm, and on deploying and supporting new technologies, for example. Generating jobs and taking advantage of these new opportunities will require investment and planning.

To take advantage of these opportunities and support workers affected by the climate transition, Aotearoa will need the transition to be well-signalled to allow time to plan and localised transitions planning that is tailored by the community for the community. Many of the workers affected will have important skillsets that will be in demand in new low emissions industries. Workers will need to be supported to redeploy into these new areas of work and provided opportunities to retrain and build new skillsets.

How can this be managed through localised transition planning?

Throughout our engagement, we heard about the importance of transition planning that is created for the local community, by the local community. Historically, government has come with more centralised interventions on top of the work being done at a community level.

Localised transition planning, where central government works alongside local iwi/Māori, businesses, workers, community groups and local government, will help ensure climate change policies are tailored to regional and local circumstances and address the needs and aspirations of different groups within the community. This kind of co-created and strategic transition planning is already underway in Taranaki.

Transparent and inclusive processes, and active social dialogue regarding the transition, are key to achieving a transition that is accepted and enduring.

Localised planning is also important for aligning central government, local government and business investment priorities. In some situations, businesses will only invest if they know that complementary investments are being made – for example to supporting infrastructure.

How can this be managed through improving productivity, education, skills and innovation?

The education, and science and innovation systems in Aotearoa are critical for ensuring low emissions economic growth.

Ensuring that people have the skills to move into new jobs, and businesses have the skills and capability to innovate, adopt new technologies and commercialise new ideas is central to an equitable transition. This will ensure more inclusive economic growth, create higher paying jobs and improve living standards.

The education system will need to ensure that New Zealanders are set up with the skills that are needed in the labour market. The system will need to focus not just on pre-employment training, but on lifelong learning. Young New Zealanders will need to be set up with the skillsets needed in the future, and workers that might be affected by business closures will need to be supported to upskill.

The education system will also need to be more flexible, and address barriers that restrict all New Zealanders from participating in education and training – particularly for Māori.

Setting workers up with skillsets needed by the labour market will allow them to pursue their interests, improve their employability and wages, allow them more autonomy in the workplace and enhance their overall wellbeing.

For businesses, having employees with the skills and capability to innovate will encourage new ideas and technologies. This will help businesses realise opportunities from the transition and soften any potential competitiveness impacts.

Aotearoa is known as a country of innovators and problem solvers. Being an early mover in researching new technologies and adopting existing technologies will benefit not just the climate, but the economy and wellbeing of New Zealanders. This is particularly true in sectors where Aotearoa is traditionally innovative, such as agriculture.

5.6 Specific challenges to address for Māori-collectives and Māori in the workforce

Regardless of the level at which emissions budgets are set, there are specific challenges for Māori-collectives and Māori in the workforce that the Government will need to address.

5.6.1 Māori-collectives

The Māori economy represents $50 billion or more in assets and is growing.

Iwi/Māori-collectives need flexibility to exercise their rangatiratanga and mana motuhake with regard to land use and emissions management. We heard through engagement that some Māori-collectives have received forested land through Treaty settlements. If these forests were established before 1990, they are encumbered with a deforestation liability. However, Māori-collectives may have alternative aspirations for the use of their culturally significant land such as papakainga development.

Consideration should also be given to any policies that could disadvantage Māori-collectives operating in the agriculture sector. When agricultural emissions are priced, free allocation should be provided in a way that does not disadvantage operators who were already managing resources in alignment with their kaitiaki values. In addition, some Māori-collectives may not operate intensively due to insufficient resource or being precluded from exercising their decision-making functions as a result of historic arrangements, such as perpetual leases. These Māori-collectives should also not be disadvantaged. Any approach that uses grandparenting is likely to be problematic.

These approaches have the potential to compound historic grievances, particularly for iwi with limited resource and where existing provisions are not sufficient. This could also add complexity for iwi where redress assets are returned through a range of settlement entities. Potentially this can limit the ability for iwi to exercise their rangatiratanga under the Treaty.

Access to reliable information and quality advice is a key enabler to enhance participation for Māori-collectives and ensure equitable outcomes. Establishing a Māori emissions profile will improve the ability for iwi/Māori-collectives to manage and monitor emissions within their takiwā in the context of their broader social, cultural, economic and environmental objectives.

5.6.2 Māori in the workforce

Māori individuals could experience greater changes. Our analysis suggests that 18-25% of those who gain jobs from the transition would be Māori, while 13-21% of those who lose jobs from the transition would be Māori. Māori in the workforce would see more job gains than job losses across all three emission budget periods.

BERL has estimated that the current income gap for Māori is $2.6 billion per year, equating to $140 less income per person per week for the working age Māori population. Over half of the working Māori population are in lower skilled jobs, and almost half are in jobs that have a high risk of being replaced by automation. While our analysis does not allow us to distinguish the specific effects on Māori incomes, across the whole population the jobs gained are on average similar or lower paid than those jobs that are lost. The Crown–Māori Economic Development Strategy, He kai kei aku ringa, also has a goal of growing the future Māori workforce into higher-wage, higher-skilled jobs.

How can this be managed?

Research indicates that current education and training providers are not serving Māori well and have low levels of engagement from Māori. Māori who need to retrain or learn new skills as employment changes may be particularly impacted. Education and training developed by Māori for Māori will be important for reducing existing inequities and in ensuring an equitable transition.

Care needs to be taken to ensure that actions needed to meet our proposed emissions budgets do not place disproportionate restrictions on iwi/Māori. Iwi/Māori need to be able to exercise their rangatiratanga and mana motuhake to make decisions on how to use or develop their land to meet their collective and culturally driven aspirations and needs.

These barriers will need to be addressed to enable Māori to fully participate in climate action, and ensure that Māori-collectives, businesses and workers are not disadvantaged. Any additional costs arising from climate policy could result in additional barriers for the continued development of iwi/Māori landholdings and businesses.

5.7 Impacts of land use change on communities

Increasing the amount of native and plantation forest – or afforestation – could play a role in helping achieve the country's emissions budgets and emissions reduction targets. However, we have heard through our engagement about concerns that the speed and potential extent of afforestation could have negative impacts on rural communities and provincial centres that are reliant on the food and fibre industry for employment. This would include not only those working on the land, but also those involved in transporting and processing food and fibre products.

We have factored this into our emissions budgets analysis. This is in line with our principle to focus on decarbonising the economy. There is a risk that forest sequestration could be used to offset emissions rather than making gross emissions reductions. This would make it difficult for Aotearoa to maintain net zero long-lived greenhouse gas emissions beyond 2050, in addition to the potential impacts on communities and the wider food and fibre sector.

The impacts of any afforestation will depend on the scale, pace and species of trees that are grown, the purpose for which the trees are grown, the type of land that is afforested, and the land use that is displaced.

5.7.1 Exotic forestry

Under current policy settings, the scale of afforestation that is expected to occur would in large part be driven by the emissions price in the Emissions Trading Scheme. Other financial incentives, such as the One Billion Trees programme, land and export prices, would also play their part.

Current policy settings and sector infrastructure heavily favour the planting of exotic *Pinus radiata* over other species. Increasing emissions prices would also incentivise greater establishment of permanent exotic carbon forestry.

We heard throughout our engagement about the concern that whole farms could be planted in exotic forests, either for production forestry or permanent carbon forestry. This could have impacts on rural communities and the wider food and fibre sector.

Analysis by PwC indicates that converting to production forest would probably generate more jobs across the value chain, while permanent carbon forestry would generate less (Table 5.1). Efforts to increase domestic timber demand by changing building policies could also stimulate the wood processing industry and increase the value chain employment of forestry.

Wholesale or large conversions of sheep and beef farmland to forestry would impact communities and reduce employment in the immediate area as forestry-related work is likely to be more concentrated in larger rural towns, particularly those involved in processing.

Table 5.1: The number of jobs generated across the value chain by production forestry, permanent carbon forestry, and sheep and beef farming.

Source: PwC.

	Full time equivalent jobs per 1,000 hectares
Production forestry	38
Permanent carbon forestry	1-2
Sheep and beef	17

Constraining this price incentive for afforestation through the Emissions Trading Scheme could help limit the overall scale of afforestation, including permanent exotic forests. However, it would not determine where this afforestation would occur, or remedy the relative disincentive for native species.

Limiting where afforestation happens would likely require a regulatory approach, through the planning rules or alternative interventions, that place restrictions on land use change.

Capacity building and extension services for landowners focused on integrating trees or forestry onto farms rather than wholesale land use change could limit the impacts of afforestation. This could be facilitated by developing carbon monitoring systems that allow for tracking and rewarding sequestration from smaller or dispersed areas of trees.

How can this be managed by changing the focus to permanent, native forests?

Changing the balance of incentives in exotic versus native afforestation would also alter the impact on rural communities, and the broader food and fibre sector. Native afforestation might generate fewer jobs than exotic forestry, particularly if it is not all planted and harvested, or if land is left to revert to natives.

However, native afforestation could be suitable for areas of less productive land where exotic afforestation is inappropriate. It would therefore not come at the expense of other economic activity.

Less productive land could be afforested with little impact on farming productivity or employment. Many sheep and beef farms have areas of land that are steep and susceptible to erosion. These areas could be particularly suitable for permanent forests. This would also include Crown owned land. Recent studies put the potential area at 1,150,000 to 1,400,000 hectares. The Biological Emissions

Reference Group estimated that approximately 6% of hill country sheep and beef farms could be afforested without negatively affecting production. This equates to approximately 250,000 hectares.

Efforts could also be made to promote a native forestry industry. This could have particular relevance for iwi/Māori. Native afforestation could be incentivised by extending grant schemes such as One Billion Trees or by developing ecosystem services payment schemes that could reward the other environmental benefits of native forests.

Policies for managing the scale of afforestation, whether it is exotic or natives, and where afforestation occurs is discussed further in chapter 6 and time-critical necessary action 5.

5.8 Environmental impacts

Moving to low emissions technologies and changing land practices to meet our proposed emissions budgets would also bring broader environmental impacts.

The move to electric vehicles, greater electricity use, and improved fuel efficiency would result in improvements to air quality, as well as the associated health benefits.

Many technologies important in the transition to a low emissions economy – including wind turbines, solar panels, and batteries – require mineral and metal inputs. How these minerals and metals are sourced, recycled and disposed could have negative environmental impacts here and overseas. There could be opportunities for innovation in repurposing and recycling these materials.

These technologies can have high embodied emissions due to the energy requirements to produce some of these inputs. Additionally, when these technologies reach the end of their life, it can be difficult to dispose of them as they are not easily recycled. Supply chains need careful management and Aotearoa needs to ensure it has access to the latest advances internationally to reduce these adverse environmental impacts.

Building new small or large hydroelectric dams could help provide flexible capacity to meet peak electricity demand. Pumped hydro schemes would also provide capacity in dry years where hydro lake levels are low. Such schemes could have substantial landscape and ecological impacts. Flooding large areas of land for water storage could impact water flows downriver of the scheme. This could be to the detriment of nationally significant wetlands, archaeological sites, habitat for endemic bird and fish species, and in some cases endangered or threatened species. Hydro dams can also obstruct native freshwater fish from migrating up and down rivers. Our proposed emissions budgets could be met without the need for new hydroelectric or pumped hydro schemes.

Practice changes – such as careful balancing of stocking rates, pasture management and supplementary feed – could reduce emissions on farms and bring co-benefits to water quality and soil health. The scope for practice change and associated co-benefits depends on the farm, the farm's specific climate and soil conditions, the current management system, and the advice and skills that farm businesses could draw on.

Afforestation could also improve biodiversity, water quality, soil health and reduce erosion, if the right type of tree is planted in the right place at the right time. While pine forests can increase biodiversity, including for rare native species, native forests in Aotearoa host hundreds of threatened species and thousands of species. Native vegetation spread across the country's farms can also provide large

connected networks that can serve as stepping stones for birds that disperse tree seeds. Pest control, and fencing out grazing and browsing animals, would be important for both improving biodiversity and enhancing carbon stocks.

Land use change from dairy to horticulture on flatter and more productive land could reduce biogenic emissions per hectare. However, it could also cause water quality to deteriorate due to the increased use of fertiliser, and consequential nitrogen and phosphorus losses. Nutrient losses would vary depending on the crop, the site, weather conditions, the soils' physical and chemical properties, and how the land is managed. Increasing the area of horticulture could also increase water demand in Aotearoa. In light of the physical impacts of climate change, this increased need for water would need to be weighed up when considering converting to horticulture as a climate action.

Reducing how much waste is generated and recovered means that landfills will take longer to fill up, potentially reducing the amount of landfills needed in the future. Increasing Landfill Gas Capture at legacy and non-municipal landfills could also lessen the negative impacts on air quality.

5.9 Impact on government taxation and spending

The climate transition will also impact on taxation and spending. The Government will need to plan for this.

For example, revenue from fuel excise duties and road user charges – that is ring fenced to be spent on land transport – will change over time, though is something that is routinely monitored by the Government. The same would occur for the Waste Levy, which is recycled back into waste minimisation projects, as the amount of waste reduces over time. Reducing oil and gas production in Aotearoa will also result in less tax revenue and will affect the balance of exports as less oil is exported.

The Emissions Trading Scheme will generate income for the Government from selling emissions units. The income generated will depend on the volume of units sold, and the market price for units. The Government estimates this could equate to at least $3.1 billion over the next five years under current settings. The Government has options for how to spend these proceeds, including by recycling them back into climate change projects.

Government spending on social assistance for workers and families, and for health could also be affected. The impact on this spending will depend on the transition strategy the Government puts in place, the pace of the transition, and how well the Government plans and signals the transition.

5.10 Ensuring an inclusive, equitable and well-planned transition

The transition to a low emissions society will bring a mix of opportunities, benefits, challenges and costs. Actions and approaches to reduce emissions should ensure the benefits of climate action are shared across society. It is important that certain individuals and sectors do not unfairly bear the cost-burden of the climate transition. Not managed well, costs could disproportionately fall on those on lower incomes, some Māori and Pasifika, and people with disabilities.

An equitable transition also supports the principles of tiakitanga and intergenerational equity. Managing challenges and impacts for an equitable climate transition requires considering the impacts on society today, but also the impacts on our mokopuna, and on their mokopuna. The need to care for

and be active stewards and custodians of our whenua and taonga for future generations must be central to our approach.

Maintaining the principle of equity is important to make sure the policy response is enduring, and emissions reductions can be sustained.

Certain regions and communities of Aotearoa will be more affected by the climate transition than others. Some may see the closure of large businesses that provide significant employment. In some places, entire communities, ways of life and local identities are built around large businesses that may face closure. Such closures can have a big impact beyond the people employed directly. If unemployment rises and consumer spending falls, there will be a flow on effect to other businesses and workers within the wider community.

We have heard consistently through our engagement that localised transition planning will be needed where communities work together to tailor a transition plan to their particular needs and aspirations. We also heard that this localised transition planning will need to be proactive, inclusive and transparent, and co-developed through a bottom up approach that involves iwi/Māori, local government, local communities, businesses, civil society groups and other stakeholders.

As Aotearoa transitions to a thriving, climate-resilient and low emissions Aotearoa, new skills, knowledge and capability will be needed in the workforce. Ensuring the workforce's skills match what is required in the labour market is key to ensuring that businesses can innovate, adopt new technologies or commercialise new ideas. Flourishing businesses will create flow on benefits for workers and communities.

Current approaches to skills and training will need to change to prepare the current and future workforce for rapid change. This includes changes to support workers through the transition, and to prepare displaced workers for the new job opportunities that will emerge with it. Increasing New Zealanders' capacity to adapt, and ensuring that New Zealanders have transferrable skillsets that set them up for success will be crucial. Vocational education and training systems will need to be able to adapt quickly to changing skill demands. Barriers that restrict all New Zealanders from participating in education and training – including some Māori, Pasifika and low income groups – will also need to be addressed.

Time-critical necessary action 1
An equitable, inclusive and well-planned climate transition

The transition to a low emissions society needs to be well-signalled, equitable, and inclusive in order to maximise the opportunities, minimise disruption and inequalities, and be enduring as a result.

We recommend that in the first emissions budget period the Government develop an Equitable Transitions Strategy that is linked to the Government's Economic Plan and outlines:

- **How the Government will build the evidence base for assessing the distributional impacts of climate change policy decisions that align with tikanga values**
- **A process for factoring distributional impacts into climate policy and designing social, economic and tax policy in a way that minimises or mitigates the negative impacts**
- **Guidance for developing localised transition plans that are customised for and co-developed with local government and affected communities.**
- **How the Government will support affected workers to transition into new work**

Progress indicator

Government to have, by 31 December 2023, drafted an Equitable Transitions Strategy linked to their Economic Plan.

Necessary action 1
An equitable, inclusive and well-planned climate transition

We recommend that, in the first budget period the Government progress the following steps to meet emissions budgets:

a. **Identify communities and regions that may be particularly affected by climate change and the transition to a low emissions society, and initiating processes for localised transition planning in these areas. This would require the Government to work in partnership with local government and regional economic development agencies, iwi/Māori, local communities, businesses, civil society groups and stakeholders.**

b. **Develop policies for creating a workforce with the skills needed for accelerating the low emissions transition, including:**
    - **Assessing how the education system sets all New Zealanders up for the low emissions jobs of the future, with skillsets that enable workers to adapt and lifelong learning.**
    - **Upskilling and redeploying workers transitioning from high emissions sectors.**
    - **Developing skills and training into low emissions industries by Māori, for Māori.**

c. **Investigate the specific impacts of the climate transition on small businesses, and develop a plan for how to support them through the transition.**

d. **Assess the Government's current standards and funding programmes for insulation and efficient heating to determine whether they are delivering at an appropriate pace and scale, and how they could impact housing and energy affordability. The Government should give particular consideration to potential flow through costs to tenants, and to government owned housing stock.**

e. **Improve the evidence base and approach for factoring in co-benefits into climate policy, planning and investment decisions, including to health, transport accessibility, the environment.**

Consultation questions 13
An equitable, inclusive and well-planned climate transition

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

Chapter 6: Direction of policy in the Government's emissions reduction plan

The Government is required to develop an emissions reduction plan outlining how it will meet the emissions budgets. This needs to consider not only the actions needed to deliver the first emissions budget, but also the actions needed to set Aotearoa up to deliver on subsequent emissions budgets and the 2050 targets. It is important that policy directed at reducing emissions also focuses on creating an Aotearoa that is thriving and climate resilient. This chapter presents our advice on the policy direction needed in the emissions reduction plan.

As the Government develops its approach it needs to make the scale of action required to meet emissions budgets clear, and signal policy changes well in advance to give some predictability about the speed and direction of travel.

In preparing our advice on policy direction, we have taken a long-term perspective. We have considered how policies could support kotahitanga, manaakitanga, tikanga and whanaungatanga. As the Government develops its plan to reduce emissions, it also needs to consider how actions will align with these values. Partnership with iwi/Māori at every stage of the policy development process will be critical to support this.

A comprehensive and mutually reinforcing package of policies will be needed to achieve the deep emissions reductions required. Such a package should include three different types of intervention to enable change:

- Emissions pricing and other market incentives to influence choices.
- Regulation, education and other action to address barriers.
- Investments in technology, infrastructure to spur innovation and system transformation.

Figure 6.1 summarises the overarching approach we have used to develop our advice on the policy direction needed.

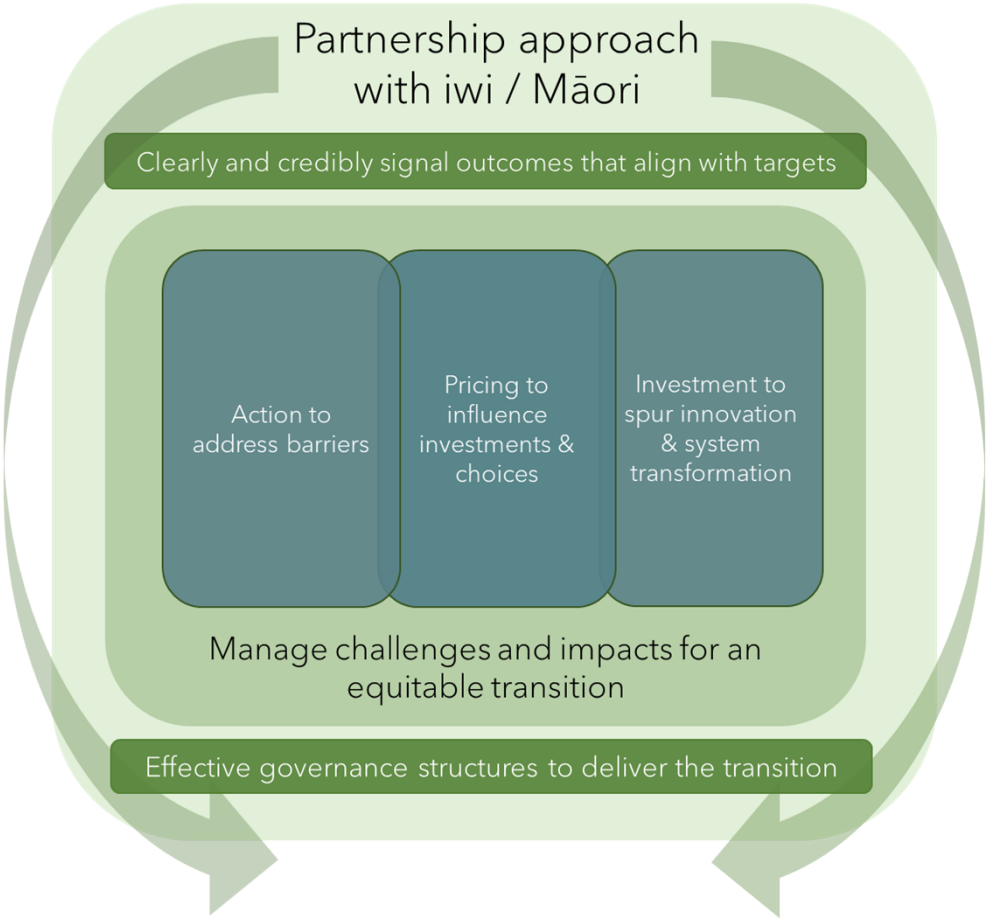


Figure 6.1: Elements of a comprehensive climate policy package.

Our advice is focused on identifying the goals and key interventions that policies need to deliver.

This advice is presented in line with the factors the Minister must consider when preparing the emissions reduction plan:

- sector specific policies
- a multisector strategy
- a strategy to mitigate the impacts of policies – our advice on this is covered in chapter 5.

6.1 Sector specific policies

6.1.1 Transport

Enhance national transport network integration to increase walking, cycling, low emissions public and shared transport, and encourage less travel by private car

Aotearoa currently has high rates of vehicle ownership and high rates of travel per person. Increasing the use of low emissions public transport, shared transport, and encouraging walking and cycling would reduce kilometres travelled by light vehicles.

This requires communities around the country to have access to safe, convenient, well-integrated, affordable and accessible public or shared transport (including national public transport like trains and coaches), and extensive, high quality cycling and walking infrastructure.

Transport options that connect communities and make it easy for people to get where they need to go will be important. End-to-end integrated transport planning is vital to make the system accessible and facilitate the scale of mobility shift required. This includes "first and last kilometre" solutions, operations that are coordinated so services function well together, convenient payment and booking options, secure car parking near public transport, and mobility as a service.

Decades of underinvestment in infrastructure and services for public transport, walking and cycling have often made these travel choices slower, less reliable and ultimately less attractive than travelling by private vehicle. Transport planning and funding is largely centered around private vehicle use. Of the approximately $4 billion spent on land transport in 2017, only around $600 million was spent on public transport and less than $100 million on walking and cycling. This may improve based on the strategic direction set out for transport in the new Government Policy Statement on Land Transport 2021 but there should be a large increase funding spent on public and active mobility, including for the national public transport network.

One of the main ways to decrease reliance on driving is by designing compact communities with the necessary infrastructure to enable easy access to alternative types of transport. Ensuring this happens at the planning stage is more effective than retrofitting transport needs.

There are significant co-benefits from increasing alternative types of transport. In particular, walking and cycling benefit health, and removing cars from the road improves air quality. These benefits are increased if clean public transport, such as electric buses are used.

Necessary action 2

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

We recommend that, in the first budget period the Government progress the following steps to meet emissions budgets:

a. **Deliver specific and timebound targets to increase low emissions public and shared transport and walking and cycling, and supporting infrastructure through strengthening the direction of the Government Policy Statement on Land Transport.**

b. **Significantly increase the share of central government funding available for these types of transport investment, and link funding with achieving our emissions budgets.**

c. **Improve mobility outcomes through measures including supporting public transport uptake nationally and locally by reducing fares for targeted groups (such as for those under 25 years of age), and improving the quality and integration of services.**

d. **Encourage Councils to implement first and last kilometre travel solutions in their transport networks, such as increased on-demand and shared vehicle and bike services, secure park and ride solutions at public transport, and encouraging micro-mobility options.**

e. **Further government encouragement for working from home arrangements.**

Accelerate uptake of electric vehicles

Light vehicles are a major source of emissions in Aotearoa and were responsible for almost 11 Mt CO_2e emissions in 2018. Most vehicles run on petrol or diesel. Our analysis shows that electrifying light vehicles will play a crucial role in meeting later emissions budgets and the 2050 target.

Electric vehicle (EV) ownership in Aotearoa is increasing but remains low. There are currently several supply and demand barriers to people choosing EVs, including higher up-front costs, lack of choice and supply volumes, and the country's limited leverage for accessing future supplies of EVs. Range anxiety, charging network access and expected battery life also affect demand.

An ambitious package of policies is needed to address these barriers. Fiscal incentives to lower the upfront costs of EVs will be an important part of this and should be introduced as a matter of urgency.

Other measures will also be needed. Vehicles in Aotearoa produce more emissions and cost more to run over their lifetime than in other countries. Vehicles that enter the country today will be on the road until they are almost 20 years old on average.

Conventional internal combustion engine (ICE) vehicles need to be rapidly phased out and replaced by EVs to put transport on track to meeting our proposed emissions budgets. If Aotearoa is to achieve a low emissions vehicle fleet by 2050, all light vehicles entering the country must be low emissions by 2035. Putting a restriction or ban on the import and manufacture of internal combustion engine vehicles should be made in the context of an equitable transition, with additional measures put in place, if necessary, to make EVs accessible to all New Zealanders.

One important constraint will be the availability of EVs, particularly those that are second hand. The country's vehicle market is small, remote, left-side driving, and heavily dependent on used vehicle imports from Japan. However, Japan is prioritising investing in hydrogen and conventional hybrids and has limited EV supply.

EV charging infrastructure is relatively well developed in Aotearoa for the number of EVs currently on the road. However, it will need to keep pace with the projected rapid uptake of EVs to ensure wide coverage. More community charging stations will be needed to ensure access for people who cannot charge at home. Action is also needed to build infrastructure to support refurbishment, reuse, recycling and responsible disposal solutions for EV batteries. Lithium-ion EV batteries can be highly polluting and pose a fire risk if not disposed of properly.

While EVs will make the biggest difference to the efficiency of the country's fleet, plug-in hybrids and more efficient petrol and diesel cars can also contribute. Inefficient vehicles use more fuel and therefore have higher emissions. The lack of regulations or restrictions to influence the fuel efficiency of light vehicles entering the country has contributed to the inefficiency of the light vehicle fleet. Clear guidance from the Government on emissions standards is needed to prevent Aotearoa from becoming a dumping ground for inefficient vehicles.

There are different international examples of how an intervention to increase the fuel efficiency of the vehicle fleet could be designed. Typically, suppliers would be required to meet an overall average fuel economy or emissions level, which would be weighted across all new vehicle sales in the country and would become more stringent over time. Suppliers would need to sell more efficient vehicles to meet

the efficiency target, or pay a penalty. They would be likely to lower the price of efficient vehicles to ensure they make sufficient sales.

Accelerating access to EVs is an important issue to consider as part of an equitable transition. Leasing and car share schemes targeted at low income communities should be considered to help address barriers to access.

Time-critical necessary action 2
Accelerate light electric vehicle uptake

Light electric vehicle uptake needs to be accelerated as fast as possible. To meet our proposed emissions budgets and be on track for 2050, at least 50% of all light vehicle (cars, SUVs, vans and utes) and motorbike imports should be electric by 2027 (both battery EV and plug-in hybrid EV). To achieve this, we recommend in the first budget period the Government:

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

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

c. **Improve the efficiency of the light vehicle fleet and stop Aotearoa receiving inefficient vehicles by introducing an emissions target for light vehicles new to Aotearoa of 105 grams CO_2 per kilometre by 2028.**

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

Progress indicators

a. **Government to have consulted, no later than 30 June 2022, on preferred policy options for accelerating EV uptake (including a date for placing a time limit on the import of ICEs).**

b. **Cabinet decisions on preferred policy options to be made, as soon as possible but no later than 31 December 2022, on accelerating EV uptake.**

c. **Government to have implemented regulations on improving the fuel efficiency by 30 June 2022.**

Necessary action 3
Accelerate light electric vehicle uptake

We recommend that, in the first budget period the Government make progress on the following:

a. **As part of a policy package introduce a fiscal incentive, such as a feebate or subsidy, to reduce the upfront cost of EVs until such time as there is price parity with ICEs.**

b. **As part of an equitable transition, evaluate and support interventions such as leasing, hire and sharing schemes to remove barriers and address some of the upfront capital costs of EVs.**

c. **Investigate ways to bulk procure and ensure the supply of EVs into Aotearoa and work with the private sector to do so.**

d. **Evaluate how to use the tax system to incentivise EV uptake and discourage the purchase and continued operation of ICE vehicles.**

e. **Work with the private sector to roll out EV battery refurbishment, collection and recycling systems to support sustainable electrification of light vehicle fleet.**

f. **Evaluate the role of other pricing mechanisms beyond the NZ ETS, such as road pricing, can play in supporting the change to a low emissions and equitable transport system.**

g. **In setting these policies the Government needs to mitigate impacts for low-income households and people with disabilities, regional and remote access, and with limited access to electricity.**

Increase the use of low carbon fuels for trains, ships, heavy trucks and planes

Low carbon fuels to power vehicles offer an alternative to conventional fossil fuels such as petrol and diesel. This section is focused on three low carbon fuel options – electricity, green hydrogen and biofuels.

Low carbon fuels will play an important role in reducing emissions from transport. Even if Aotearoa rapidly converts to EVs, biofuels or hydrogen are likely to be needed for ships, trains, aircraft and long-distance trucks. These heavy vehicles are more difficult to electrify, so the transition is likely to take longer.

Our analysis shows that Aotearoa is likely to need 3% of domestic liquid fuels to be low carbon by 2035, which is approximately 140 million litres per year. Achieving this would require building about another seven plants with similar capacity to Z Energy's existing Wiri plant – 20 million litres per year.

Low carbon fuels are more expensive than fossil fuels, and Aotearoa does not currently have incentives or regulations in place to help them become more competitive, or to increase demand. Aotearoa also currently lacks facilities to produce biofuels and hydrogen, limiting their supply.

Aviation is particularly challenging to decarbonise. There is currently no commercially viable sustainable aviation fuel supply in Aotearoa. In offshore ports where sustainable aviation fuel is being produced, its use has been supported by public funding and other policies. Aotearoa needs policies to address supply and demand, including measures like grants or tax credits to improve competitiveness with fossil fuels. Measures are also needed to create demand and help build a market for low carbon fuels in the long term.

There is potential for decarbonising rail through further overhead electrification or through the use of battery-hybrid or low carbon fuel locomotives. Significant parts of the freight rail network have been facing a state of managed decline due to lack of long-term investment and inadequate planning and funding frameworks. The Draft New Zealand Rail Plan sets out a remedial investment programme and a new planning and funding framework to maintain freight rail but does not establish clear targets, or an investment strategy, to increase the share of rail. There is also potential to shift freight from road to coastal shipping.

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

We recommend that, in the first budget period the Government take the following steps to support the use of low carbon fuels for heavy vehicles such as trucks, planes, ships, and off-road vehicles to meet emissions budgets:

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

b. **Introduce low carbon fuel standards or mandates to increase demand for low carbon fuels, with specific consideration given to aviation.**

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

d. **Place further emphasis on decarbonising the rail system, and establish an investment strategy and clear targets to increase the share of rail and coastal shipping.**

Consultation question 14
Transport

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

6.1.2 Heat, industry and power

Decarbonise energy

In 2018, the country's energy supply was 40% renewable. The remaining 60% came from oil, natural gas and coal. This energy is used across the economy in transport, electricity, for heating and by industry. In 2018, the country's energy use resulted in 32 Mt CO_2e.

The Government's aspirational renewable electricity target is part of a bigger energy picture. To meet the 2050 target of net zero long-lived gases Aotearoa needs to transition away from fossil fuels and rely more heavily on renewable electricity and low emissions fuels like bioenergy and hydrogen, and improve energy efficiency. Setting a broader, system-wide target for renewable energy would signal the scale of emissions reductions required across the whole energy system and encourage investment without locking in a prescribed pathway.

Developing a national energy strategy would help to ensure that the following aspects of the energy system in Aotearoa are considered in a coherent way:

- emissions reductions
- future energy developments
- infrastructure
- equitable industry transitions
- regional and national economic development planning

The objective of such a strategy would be to ensure a smooth and appropriately sequenced phase down of fossil fuels, and scale up of electricity generation and new low emissions fuels in the context of changing supply and demand requirements.

Government can provide industry with greater certainty by clearly signalling the timing and direction of travel as the energy system decarbonises, so that industry is able to plan.

There will be some nationally significant forks in the road as the energy system decarbonises, where choices will need to be made. For example, whether Aotearoa should keep its gas pipeline infrastructure long term as an option for low emissions gases, or whether a low emissions steel industry is critical for security of supply for the country's construction industry. Also, whether the skills of those who work in the oil and gas sector should be actively retained in Aotearoa for new low emissions industries. The country's current energy system is extensive, with a dedicated infrastructure and workforce behind it spread throughout the regions and the transition away from fossil fuels will need to be carefully managed in partnership with industry and communities (see time-critical necessary action 1 in chapter 5).

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

Setting a target for renewable energy enables the Government to signal the required emissions reductions across the full energy system. Within that context, the 100% renewable electricity target should be treated as aspirational and considered in the broader context of the energy system that includes electricity, process and building heat and transport. We recommend the Government:

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

b. **Under the framework of the national energy strategy, set a renewable energy target to increase renewable energy to at least 60% by 31 December 2035.**

Progress indicator

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

Maximise the use of electricity as a low emissions fuel

Aotearoa has one of the lowest emission electricity systems in the world. This low emissions electricity can be used to reduce emissions elsewhere through electrifying transport, process and space heating. To reduce the emissions of the electricity system itself, fossil-fuelled generation will need to be phased out and more renewable generation, like wind and solar, will need to be built.

We anticipate a steep increase in demand for electricity as the number of EVs on the country's roads grows. The industry will need to build more low emissions generation capacity rapidly to meet this. Big changes in demand or supply, like the Tiwai Point Aluminium Smelter closing, create uncertainty in the market that can result in generators delaying investment in new renewable generation. Barriers to rapid electrification will need to be systematically addressed. For consumers and industry to invest and convert to electrification, they need to have confidence that electricity will be available, affordable and reliable.

The NZ Battery project will deliver advice on potential solutions to the challenge of dry year energy security. While a solution to this challenge could enable Aotearoa to reach 100% renewable electricity, it could cost taxpayers billions of dollars. As noted above, electricity is part of a broader energy transition. Alternative options for reducing emissions should be considered, as other actions may have a larger impact for the same cost. Arriving at 100% renewable electricity is the desired end point, but the timing and sequencing of the transition is important.

Technology has the potential to change the way New Zealanders generate, store and consume electricity. It will affect how the market could work, and create greater potential for independent and distributed generation, micro-grids and demand response. Innovations like peer-to-peer trading are emerging, and these disruptions create opportunities for Māori-collectives, remote and rural communities and others.

Innovations that enable consumers to participate in the market can help to reduce the amount of fossil-fuelled generation required to meet peak electricity demand and replace the need for diesel as back-up generation.

The regulatory regime must continue to adapt and respond to innovations, to ensure it can deliver access to abundant, affordable, and reliable low emissions electricity. It must be able to deliver the services needed to underpin electrifying the vehicle fleet and industry. The capacity and capability of electricity distribution businesses will be an important consideration. The Electricity Price Review and others have called for more innovation to be led by these businesses.

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

We recommend that, in the first budget period the Government take steps to ensure a low emissions, reliable and affordable electricity system to support electrifying transport and industry through progress on the following:

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

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

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

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

e. **Enable more independent generation and distributed generation, especially for remote rural and Māori communities, and ensure access to capital for this purpose.**

f. **Monitor and review to ensure electricity remains affordable and accessible, and measures are in place to keep system costs down, such as demand response management.**

Scale up provision of low emissions energy sources

Producing low emission fuels is important in meeting the 2050 target. Government support will be needed to increase the amount of clean energy Aotearoa can produce during the first emissions budget. This will ensure the emissions reductions required in later emissions budgets can be met.

Some activities, such as industrial processes that use high temperature heat, will be hard to electrify. Aotearoa will need a range of energy sources to support decarbonisation. Diverse energy sources will also be needed to maintain energy security.

Bioenergy and hydrogen both hold promise, but Aotearoa needs to understand how best to make use of their potential. Our analysis indicates that these fuels have significant potential for reducing emissions in transport, process heat and industrial processes. However, more work is needed to support establishing supply chains and infrastructure and making them more cost competitive.

To establish a bioeconomy, greater government coherence and coordination is needed. The Government needs to provide direction on the priority uses of bioenergy, to signal the optimal scale of a system, help overcome barriers, and to provide investment and procurement support.

Necessary action 6

Scale up provision of low emissions energy sources

We recommend that, in the first budget period the Government make progress in scaling up the provision of new low emissions fuels by:

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

b. **Assessing the place that hydrogen has in the new national energy strategy.**

Reduce emissions from process heat

Reducing emissions from process heat will be critical for meeting the 2050 target. Improving energy efficiency, optimising processes and switching to cleaner energy sources like electricity and biomass are key opportunities.

The rate at which emissions can be reduced will be limited by several factors. This includes the time required to convert plants and establish or expand fuel supply chains, as well as how long it takes to upgrade grid infrastructure and build new renewable electricity generation. Our emissions budgets require reduction in the use of coal in boilers of around 1.4 PJ per year. This is a substantial amount, roughly equivalent to the energy used by one very large dairy processing factory.

Low and medium temperature process heat is generated predominantly from boilers and is used for food processing and pulp and paper production. The emissions associated with these activities were around 4 Mt CO_2e in 2018. Boilers are enduring assets with life cycles of up to 40 years. To get on a low emissions pathway Aotearoa needs to take urgent action to avoid locking in new fossil fuel process heat assets, and focus on converting boilers to low emissions sources of energy.

Necessary action 7
Reduce emissions from process heat

We recommend that, in the first budget period the Government take steps to reduce carbon emissions from fossil fuelled boilers by:

a. **Urgently introducing regulation to ensure no new coal boilers are installed.**

b. **Introducing measures to help reduce process heat emissions from boilers by 1.4 Mt CO_2e over 2018 levels by 2030 and by 2 Mt CO_2e by 2035.**

c. **Increasing support for identifying and reporting on emissions reduction opportunities in industry, including energy efficiency, process optimisation, and fuel switching.**

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

Support innovation to eliminate emissions from industrial processes

Aotearoa has several single company industries with industrial processes that are unique to this country. These industrial processes create emissions that can be challenging to abate. For example, making structural grade steel requires coal as part of the chemical process.

Hard-to-abate industries are likely to still create significant emissions in 2050, but they provide products that are fundamental to the economy, like cement, steel and iron. Aotearoa has a choice as to whether it is critical to keep these industries and manufacturing plants based here. If Aotearoa keeps old, emitting plants it would be possible to use forestry to offset the associated emissions. It may be beneficial to investigate the potential of other options to remove emissions from hard to abate industries, such as carbon capture and storage (CCS) or bioenergy combined with CCS (BECCS). However, considerable research would be required as these technologies are still largely in a research and concept phase in Aotearoa.

There is also the potential to transform industrial processes from the hard-to-abate sectors to achieve gross emissions reductions in line with climate change targets. The country's heavy industrial manufacturing plants are relatively old and built to accommodate specific industrial processes. Entirely new industrial processes and technologies could potentially be adopted, or plants could be modernised between now and 2050, or retrofitted to make use of alternative fuels. Other choices are also available; for example, Aotearoa could import products from low emissions manufacturing plants overseas.

Retrofitting industrial plants with new technologies or building new low emissions processes for the hard-to-abate sectors is expensive based on current cost estimates. Significant research, development and innovation is required. Technologies developed overseas may need to be adapted to work in the unique Aotearoa industry processes.

A long-term strategy for hard-to-abate industries should be developed and closely linked to the country's Economic Plans, national infrastructure developments and equitable transitions planning. If the Government decides these hard-to-abate industries are critical national infrastructure, it must

work collaboratively and inclusively to ensure that people working in these industries are upskilled appropriately.

Necessary action 8
Support innovation to reduce emissions from industrial processes

We recommend that, in the first budget period the Government take steps to support innovation in hard-to-abate industrial processes, including by:

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

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

Efficiently use energy in buildings

The most cost-effective way to reduce energy emissions is to reduce the amount of energy consumed. Energy efficiency generally improves at the rate of 1% per year, but this needs to increase. In particular, energy efficiency measures to lower peak electricity demand can have a large impact and reduce costs.

Our analysis shows that the biggest opportunity to reduce emissions associated with operating buildings is by reducing fossil fuel use, especially gas. Continued improvements in the energy efficiency of existing buildings is also essential, particularly in large commercial buildings and public buildings.

Some of the technology required to make homes or businesses more efficient can be costly, and this is often a barrier to adoption. For example, measures like installing insulation can significantly improve energy efficiency, but come with upfront purchase and installation costs. The complexity of the retail electricity market can also disincentivise consumers from making changes that could save them money and reduce emissions.

Electricity is a more efficient and lower emissions source of energy for heating homes and businesses than gas. To get on a low emissions pathway Aotearoa needs to avoid locking in new gas assets. Portable LPG heaters are a relatively expensive and unhealthy way of heating homes. We recognise that people may not have an alternative or better choice, and to ensure an inclusive transition it is important that everyone can equally access affordable electricity to adequately heat their homes. The Government and industry should consider how they can ensure that everyone is able to participate in the move to a low emissions future.

Necessary action 9
Increase energy efficiency in buildings

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

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

b. **Introducing mandatory measures to improve the operational energy performance of commercial and public buildings.**

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

Transport, buildings and urban form

Urban form influences emissions from waste, transport and energy. While there have been numerous studies on the impact urban form, density, mobility, land use and planning have on emissions, robust quantitative evidence and information remains limited. Further investigation is needed to develop an understanding of the connections between urban planning, design, infrastructure, and climate change mitigation and adaptation. This is important to inform the design of policy interventions to reduce emissions from cities and towns, transport networks and buildings.

Achieving emissions reductions through changes to urban form takes a long time. Emissions from urban form are also influenced by many pieces of legislation, some of which are in the process of being amended – such as the Resource Management Act. The Government should ensure that the review of resource management legislation enables low emissions transport and building systems.

The range of different emissions sources affected by urban form can make it difficult to ensure accountability and coordinated planning and investments, and to ensure decision making is focused on clear outcomes.

Necessary action 10
Reduce emissions from urban form

We recommend that, in the first budget period the Government promote the evolution of urban form to enable low emissions transport and buildings through ongoing legislative reform:

a. **Develop a consistent approach to estimate the long-term emissions impacts of urban development decisions and continually improve the way emissions consequences are integrated into decision making on land use, transport and infrastructure investments.**

b. **Ensure a coordinated approach to decision making is used across Government agencies and local councils to embed a strong relationship between urban planning, design, and transport so that communities are well designed, supported by integrated, accessible transport options, including safe cycleways between home, work and education.**

Consultation question 15
Heat, industry and power sectors

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

6.1.3 Agriculture

Reduce biogenic agricultural emissions through on-farm efficiency and technologies

Changing on-farm management practices can reduce biological agricultural emissions, and will be enough to achieve the 2030 biogenic methane target. Changes include adjusting stocking rates, supplementary feed and nitrogen inputs for emissions efficiency, as well as breeding low emissions sheep into the national flock and using low nitrogen feeds. Many of these changes will be driven by freshwater policy, so farmers may already be taking actions to reduce their emissions. Policies need to be cohesive across environmental issues to ensure they achieve multiple outcomes.

Achieving emissions reductions of the scale required will rely on highly skilled farm management and high-quality data to support decision making. The Biological Emissions Reference Group found these emissions reductions could be achieved without reducing profitability. Increasing technology use on farms will help to support efficiencies and reduce environmental impacts. Improved rural connectivity via broadband will make it easier to access the information and data farmers need to measure and monitor emissions and will support precision agriculture approaches.

In addition to improving efficiency on farms now, the successful development of new technologies and practices would provide greater flexibility and allow Aotearoa to meet the more ambitious end of the 2050 biogenic methane target range without reducing agricultural production. Promising options currently being researched and developed include a methane inhibitor that would be compatible with the pastoral farming system and a methane vaccine. Government investment into research and development to reduce biological emission from agriculture is secured out to 2025, but there is no long-term plan beyond then.

The country's food safety system serves an important purpose and ensures products are safe and trusted internationally. However, it can take some time to get new mitigation technologies through the system, or even identify whether they need to go through the system. Streamlining the system would ensure that any effective new technologies and practices to reduce agricultural emissions can be implemented in a timely manner.

As noted by the ICCC, pricing biological emissions from agriculture would help to incentivise on-farm efficiency improvements and technology uptake. Government is working with industry through the He Waka Eke Noa Partnership to develop a farm level pricing system. The partnership is also developing the information and support needed to manage farms in a low emissions way, including training, extension, and farm and forestry advisory services. It will be important that these tools can deliver emissions reductions consistent with emission budgets and targets, and that they endure beyond 2025. The Commission will review He Waka Eke Noa's progress in 2022.

Many other potential ways of reducing emissions from the food and fibre system have also been proposed. For example, there has been discussion about the use of genetic engineering, and practices to increase carbon sequestration and resilience (often under the banner of regenerative agriculture). Evidence of effectiveness within an Aotearoa context, and discussions about the acceptability of different approaches, is needed.

Time-critical necessary action 4

Reduce biogenic agricultural emissions through on-farm efficiency and technologies

Currently available changes to management practices have the potential to meet the 2030 biogenic methane target. New technologies would provide greater flexibility and the ability to meet the more ambitious end of the 2050 biogenic methane target range without reducing output. We recommend that in the first budget period that the Government:

a. **Ensure that effective mechanisms are in place so that the plans, advisory and guidance tools developed by He Waka Eke Noa will endure beyond 2025 and can support achievement of the emissions budgets and targets.**

b. **Drawing on the work of He Waka Eke Noa, decide in 2022 on a pricing mechanism for agricultural emissions as is required by legislation that is suited to the characteristics of the sector and capable of supporting achievement of the emissions budgets and targets.**

c. **Ensure the Rural Broadband Initiative is resourced and prioritised to achieve its 2023 target, so that farmers have access to data and information to support decision making and the ability to practice precision agriculture.**

d. **Review current arrangements and develop a long-term plan for targeted research and development of technologies (including evaluating the role of emerging technologies such as genetic engineering) and practices to reduce biogenic emissions from agriculture.**

e. **Review and update processes and regulatory regimes to ensure that new emissions reducing technologies and practices can be rapidly deployed as and when they are developed.**

Progress indicators

a. **Government to have, by 31 December 2022, developed a long-term plan for funding research and development to support reductions in biological emissions from agriculture.**

b. **Government to have, by 31 December 2022, reviewed and amended processes and regulatory regimes for new emissions reducing technologies and practices.**

Create options for alternative farming systems and practices

Diversifying land uses and switching some land that is currently in livestock agriculture to uses like horticulture or arable cropping could reduce emissions. Transforming to alternative farming systems is unlikely to play a large role in the first few emissions budgets as the land area converted is likely to be a small percentage of that currently in pastoral farming. However, work done in the next few years can unlock future options that could play a key role in future emissions budgets.

There are currently some significant barriers to changing land use – such as market access, supply chains, and lack of experience, skills, support and infrastructure. Investment in new farming systems is higher risk if infrastructure like packhouses, transport and water storage do not already exist – and vice versa.

Different land uses have opportunities, risks and implications that have not yet been fully explored and understood in the context of the low emissions transition. Land is an important resource with the potential to support many important outcomes across environmental, social, cultural and economic domains. Better data, information and tools would help decision makers at all levels – including landowners, local and central government – to make decisions across a range of outcomes.

Water storage implications of different farming systems need to be considered in the context of broader water quantity and quality issues within Aotearoa. Implications for adaptation to climate change, and the implications for iwi/Māori (relating to use, ownership, access and cultural impacts) and broader Māori rights and interests as a Treaty Partner are also critical. Reform of resource management legislation, for example via a Strategic Planning Act, provides an opportunity to take a more holistic approach.

Verification of the emissions footprint and broader sustainability of products can help to support market access. Focusing the Government's international market access work on the country's sustainable, low emissions food and fibre products could help overcome market access barriers and encourage landowners to move to lower emissions land uses.

Necessary action 11
Create options for alternative farming systems and practices

We recommend that, in the first budget period the Government support alternative farming systems to reduce emissions by:

a. **Accelerating investment in high resolution, consistent, publicly available nationwide land and climate information, and decision-making tools and processes, to better inform local and national land use decisions.**

b. **Supporting deployment of the systems and infrastructure needed for alternative farming systems and products.**

c. **Prioritising initiatives to reduce barriers and enable international market access for proven low emissions food and fibre products.**

Consultation question 16
Agriculture

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

6.1.4 Forestry

Manage forests to provide a long-term carbon sink

Forests will play an important role in meeting the country's emissions budgets and targets. Our path for gross emissions requires at least 16,000 hectares of new native forests per year by 2025, and 25,000 hectares per year by 2030 until at least 2050. It also requires 25,000 hectares per year of exotic afforestation out to 2030, reducing down to no new exotic afforestation for carbon removals by 2050. This exotic afforestation would provide sufficient biomass feedstock for the bioeconomy.

Further reliance on forestry as a carbon sink could divert action away from reducing gross emissions in other sectors, and make maintaining net zero emissions after 2050 challenging. However, new permanent native forests could provide an enduring carbon sink to help offset residual long-lived emissions over the long term.

Native forests remove carbon at slower rates than exotic planted forests, but permanent native forests continue to remove carbon for hundreds of years. Native forests also offer other benefits, such as long-term erosion control, improved biodiversity and recreational benefits. There is an estimated 1.15 to 1.4 million hectares of erosion prone land, much of which would not be suitable for production forestry but could be suitable for converting to permanent forest. Manaaki Whenua estimate around 740,000 hectares of marginal land not suitable for commercial forests could naturally regenerate (i.e. without planting) if pests are managed. Some of this land is government owned.

However, there are currently limited incentives for landowners to change less-productive farmland to permanent native forests – either through planting or by letting it revert. Establishing permanent native forests comes at a cost for landowners, including building and maintaining fences, planting, weed and pest control, and some land would be lost to grazing. Ongoing pest control is required to maintain the integrity of forests and the carbon stored in them.

Production forests could play multiple roles in the transition to low emissions. This includes as a carbon sink in the short to medium term, by providing low emissions wood products to replace higher emissions alternatives (for example, in construction), and by substituting bioenergy for fossil fuel use. However, production forests only contribute towards meeting the country's emissions budgets and targets up until they reach their long-term average stock – which is around 20 years for Pinus radiata. Production forests planted over the next decade will continue to contribute towards emissions budgets until about 2050, while forests planted beyond 2030 will contribute to removals in the longer term.

Current NZ ETS settings may incentivise more large-scale pine plantations than is desired to meet 2050 targets and could lead to forestry displacing gross emissions reductions. Any option to limit planting exotic forests for carbon removals, including amendments to the NZ ETS, would need to be carefully explored and analysed, including working with people who may be affected by the changes, to

understand the implications and avoid unintended consequences. Concerns over the impact of whole farm or large-scale conversions to forests would likely need to be addressed by approaches outside of the NZ ETS, such as through land use rules under planning legislation.

The additional carbon removed by small areas of permanent vegetation on farms is not currently recognised in target accounting, although it is in the national greenhouse gas inventory. Ongoing technology developments, however, may make it more possible to robustly estimate emissions from these areas in future.

It is also important to enhance and maintain carbon stocks in existing forests, even though there are challenges with robustly estimating the impact on carbon stocks of forest management activities for this purpose.

There are many other worthwhile reasons beyond climate change to plant forests. Decisions about incentives for forestry should be considered alongside other strategic outcomes for the country's land including water, biodiversity, cultural, social and economic outcomes. This could be done through proposed changes to the country's resource management legislation. Some iwi/Māori-collectives own large areas of land, and face challenges transitioning land use. The Crown needs to work in partnership with iwi/Māori-collectives to understand their aspirations for land use – particularly forestry.

Unharvested pine forests or permanent exotic forests can sequester carbon rapidly but can create problems through the spread of wilding pines or when old trees die and fall over. Such forests may transition over the course of several centuries into permanent native forest if managed for that outcome. Forest management plans can lay out how this transition will be managed. Requiring forest managers to develop and implement such plans would help ensure successful transitions. These would need to include activities such as pest control, seed sources and thinning.

More broadly, delivering this level of native afforestation will require the supporting industries and infrastructure. This includes native seedling nurseries, and the labour force for planting and pest control.

Time-critical necessary action 5
Manage forests to provide a long-term carbon sink

Production forests will play an important role in meeting the first three emissions budgets, and new permanent native forests will also balance emissions from hard-to-abate sectors in the long term. The Government should enable afforestation to provide a carbon sink over the long-term by:

a. **Implementing measures to incentivise establishing and maintaining at least 16,000 hectares of new permanent native forests per year by 2025, increasing to at least 25,000 hectares per year by 2030 and continued until at least 2050.**

b. **Requiring an appropriate forest management plan for all forests over 50 hectares defined as permanent to monitor the forest's permanence and limit exposure to risks such as climate change impacts, governance failure, and community impacts.**

c. **Designing a package of policies that must include amendments to the NZ ETS and land use planning rules, to deliver the amount and type of afforestation needed over time to align with our advice on the proportion of emissions reductions and removals and addressing intergenerational equity.**

Progress indicators

a. **Government to have put in place incentives, by 31 December 2022, to deliver the afforestation of new permanent native forests to help meet the emissions budgets.**

b. **Government to have published, by 31 December 2022, a plan for the broader package of forestry policies, and to have implemented the policies by 31 December 2024 at the latest.**

Necessary action 12
Manage forests to provide a long-term carbon sink

We recommend that, in the first budget period the Government make progress in maintaining and increasing the amount carbon stored in forests by:

a. **Improving and enforcing measures to reduce deforestation of pre-1990 native forests.**

b. **Encouraging storage of additional carbon and maintaining carbon stocks in pre-1990 forests through activities such as pest control, noting that these removals may be outside of current emissions accounting approaches.**

c. **Evaluating approaches for storage of new and additional carbon through small blocks of trees and vegetation, noting that these removals may be outside of current emissions accounting approaches.**

Consultation question 17
Forestry

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

6.1.5 Waste

Reduce emissions from waste

Preventing waste at source is the most effective way to reduce emissions, followed by recovering, reusing and recycling waste before it gets to landfills. Most emissions from waste come from the decay of organic material, and organic waste that cannot be avoided or recovered should be disposed of in landfills that capture the emissions, and potentially generate electricity. These approaches lead to a more 'circular' economy with lower emissions beyond just the waste sector.

The New Zealand Waste Strategy 2010 is due to be replaced, providing an opportunity to set ambitious waste reduction targets and supporting policy.

A lack of collection and processing infrastructure means that opportunities to divert and recover waste are currently inconsistent and limited. The increase in the landfill levy in 2021 will help to reduce waste and lead to a substantial increase in the Waste Minimisation Fund, providing resources to support these activities.

Product stewardship schemes are a mechanism to make producers and importers responsible for the environmental footprint of their products, including end of life disposal. These schemes ensure that manufacturers, importers and retailers provide options for consumer and communities to reuse, recycle or appropriately dispose of products when they are no longer needed. Six 'priority products' are covered under the New Zealand stewardship scheme, and this should be extended.

There is currently a lack of quality data across the waste sector in Aotearoa. Better data collection will help identify mitigation opportunities and move Aotearoa to a more circular economy. Public education could also help reduce overall consumption, which would reduce both waste and manufacturing emissions.

Necessary action 13
Reduce emissions from waste

We recommend that, in the first budget period the Government take steps to support the reduction of waste at source, increase the circularity of resources in Aotearoa and reduce waste emissions by:

a. **Setting ambitious targets in the New Zealand Waste Strategy for waste reduction, resource recovery and landfill gas capture to reduce waste emissions in Aotearoa by at least 15% by 2035.**

b. **Investing the waste levy revenue in reducing waste emissions through resource recovery, promotion of reuse and recycling, and research and development on waste reduction.**

c. **Measuring and increasing the circularity of the economy by 2025.**

d. **Extending product stewardship schemes to a wider range of products, prioritising products with high emissions potential.**

e. **Legislating for and funding coordinated data collection across the waste industry before 31 December 2022.**

Manage the transition from hydrofluorocarbons

Refrigerants are essential chemicals that enable perishable food to be transported and stored, and the heating and cooling of interior spaces. Hydrofluorocarbons (HFCs) are the most common type of refrigerant used in Aotearoa.

HFCs are potent synthetic greenhouse gases, which present in low atmospheric concentrations. HFCs are regulated under the Kigali Amendment to the Montreal Protocol with all the signatories (including Aotearoa) agreeing to reduce the use of HFCs by more than 80% over the next 30 years.

In 2020, the Government declared refrigerants one of six priority products under the Waste Minimisation Act, which means a product stewardship scheme is required for imports of HFCs. The Government is reducing HFC imports in line with the Montreal Protocol, but there is currently no limit on the import of finished products that contain HFCs, such as air conditioning in vehicles.

A lot of existing equipment in Aotearoa contains HFCs, so there will be a lag between taking action to phase down HFCs and achieving emissions reductions. Low emissions refrigerant alternatives exist, but a lot of existing equipment is not compatible with them. Many HFC emissions are due to leakage as a result of poor maintenance and improper disposal of equipment.

Necessary action 14
Manage the transition from hydrofluorocarbons

Consistent with the Kigali Amendment to the Montreal protocol, we recommend that, in the first budget period the Government supports reducing emissions of hydrofluorocarbons (HFCs) used as refrigerants by:

a. **Extending HFC import restrictions, where feasible, to include finished products and recycled bulk HFCs by 2025.**

b. **Reducing leakage and improper disposal of HFCs through mandating good practice from business and technicians.**

Consultation question 18
Waste

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

6.2 Multisector strategy

6.2.1 Integrate government policy making across climate change and other domains

Coherent policy is important to ensure that government sends clear and consistent signals to households, business and communities about the transition to low emissions, and the nature and speed of change required.

The current siloed nature of Aotearoa government machinery presents a challenge. While the Ministry for the Environment holds the lead in terms of the overall architecture of climate policy, the policy levers for the different sectors sit with a range of other agencies. For these other agencies, climate change is not their core business and climate considerations are often crowded out by other priorities.

Another challenge is the lack of 'mainstreaming' of climate change considerations across government policies and procedures. Measures such as tax levers and structures, procurement procedures, and cost benefit and regulatory impact analysis are all instruments that can be used to support climate outcomes, but this is not done systematically, which can undermine climate change goals. Consistent signalling across investments, policy statements, direction to officials and internal policies and directives is important to ensure that all regulatory and policy frameworks are aligned with low emissions objectives.

Different agencies also give different weighting to various concerns in their decision making. To ensure that climate change goals are not undermined, it is important that climate change is considered in the development of all new policies, regulations and fiscal proposals.

Some activities that take place across sectors, such as tourism, have a large impact on emissions, but opportunities for reducing emissions are often not well understood due to their cross-cutting nature. The responsible government agencies do not have climate change as part of their core business, and do not focus on low emissions objectives.

Necessary action 15
Integrate Government policy making across climate change and other domains

We recommend that, in the first budget period the Government make progress on integrating policy making across climate change and other domains by:

a. **Providing consistent signaling across investments, policy statements, direction to officials, internal policies and directives to ensure that all regulatory and policy frameworks are aligned with low emissions and climate resilience objectives.**

b. **Investigating emissions reduction potentials and interdependencies amongst multi-sector activities, such as food production and distribution, tourism, construction and international education.**

c. **Ensuring that central and local government considers climate change alongside other environmental, social, economic and cultural aspects by including requirements in new resource management legislation, such as the proposed Natural and Built Environments Act, the Strategic Planning Act and the Managed Retreat and Adaptation Act.**

d. **Requiring government procurement policies to include climate change considerations, in order to leverage purchasing power to support low emissions products and practices, particularly with regard to third party funding and financing transactions.**

e. **Facilitating opportunities for iwi/Māori to participate in ownership of infrastructure or involvement in projects that align with iwi/Māori aspirations and climate positive outcomes.**

6.2.2 Support behaviour change

Transitioning to a low emissions economy will require New Zealanders to change some aspects of their lives. People will need to change the type of car they choose to drive, the way they choose to travel, and the way they heat their homes. Many businesses will need to switch to new processes and ways of doing things. Many farmers will need to change how they manage their land.

Technology is only part of the climate solution; the other part is creating the enabling environment for New Zealanders to make choices that support low emissions outcomes. Understanding how to encourage long-term and sustainable behaviour change will require an evaluation of current and past programmes in Aotearoa and internationally to determine what tools to use and why.

Although there have been some effective behaviour change initiatives involving multiple agencies in other areas, such as for road safety, there has been no systematic effort in Aotearoa that focuses on changing behaviour for climate change outcomes. A specific focus on how behaviour change can support climate action, with the input from different communities and stakeholders, would ensure that policies are targeted and fit for purpose.

Necessary action 16
Support behaviour change

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

6.2.3 Require entities with large investments to disclose climate related risks

Climate change exposes the financial system to risk and instability. Without clear and transparent information about exposure to climate risk, firms, lenders, investors, insurers and other stakeholders may be left with unforeseen liabilities, or risky investments.

Internationally, firms are increasingly being required to provide information on the extent of their climate risk exposure and to identify how those risks are being managed – known as climate related risk disclosure. Such disclosures generally include information about a firm's exposure to transition risks such as ownership of emissions intensive assets, physical risks from climate impacts, as well as information about how the risks will be managed.

The mandatory financial disclosures regime proposed by the Government is an important step in helping to ensure investors, insurers, consumers and others have the necessary information to make informed choices and avoid exposure to climate risks. The ongoing review of this regime will be important to ensure that it remains fit for purpose in the future, and as knowledge about the nature of climate risks evolves.

Necessary action 17
Require entities with large investments to disclose climate related risks

We recommend that, in the first budget period the Government:

a. **Implement the proposed mandatory financial disclosures regime and explore the creation of a similar regime that covers public entities at the national and local level.**

b. **Evaluate the potential benefits of mandatory disclosure by financial institutions of the emissions enabled by loans over a specified threshold.**

6.2.4 Factor target-consistent long-term abatement cost values into policy and investment analysis

The Government's policy decisions and investments must not lock Aotearoa into a high emissions development pathway or increase exposure to the impacts of climate change. At the moment, there are insufficient safeguards in place to prevent this.

Incorporating long-term abatement cost values consistent with climate change goals into the Government's cost-benefit or cost-effectiveness analysis would have a powerful effect in helping to make sure policy and investment decisions are net zero compatible. This is sometimes termed a "shadow price" on emissions and is common practice internationally. The use of long-term abatement

cost values by local government and the private sector would also help to make sure other infrastructure and investments are future proof.

Work has progressed on developing a consistent approach to incorporating long-term abatement cost values consistent with climate change goals into government decision making, but it is still not widely embedded within government processes.

The Commission's modelling has enabled a better understanding of the marginal abatement costs likely to be required in Aotearoa to meet the emissions budgets and 2050 target. Our analysis suggests that marginal abatement costs of around $140 per tonne of CO_2e abated in 2030 and $250 in 2050 in real prices are likely to be needed, as outlined in chapter 3. This information should inform the values used for policy and investment appraisal in Aotearoa.

Time-critical necessary action 6
Align investments for climate outcomes

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

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

b. **Encourage local government and the private sector to also use these values in policy and investment analysis.**

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

d. **Investigate and develop a plan for potential incentives for businesses to retire emissions intensive assets early.**

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

f. **Investigate and develop plans to mobilise private sector finance for low emissions and climate-resilient investments.**

Progress indicators

a. **Government to start, as soon as possible and by no later than 31 March 2022, factoring target-consistent long-term abatement cost values into policy and investment analysis.**

b. **Government to publish, as soon as possible and by no later than 31 March 2022, how the COVID-19 economic stimulus is helping to accelerate the climate transition.**

6.2.5 Building a Māori emissions profile

Our advice has relied heavily on the economic, social, cultural and environmental evidence and data available. Some sectors have a wealth of evidence and data, for example transport. In others the evidence and data available is old and inconsistent, for example land-use classification data.

Our advice is the first of its kind for Aotearoa, and we have discovered some gaps in the evidence and data needed to properly analyse the impacts and co-benefits of climate change policy that need to be addressed. A key gap relates to the Māori economy, which is an important aspect of Māori development and intergenerational sustainability and prosperity.

The Māori asset base is estimated at $50 billion. Without a clear understanding of the current state of emissions from Māori-collectives or a Māori emissions profile, it will be hard to make sure that emissions budgets and efforts to reduce emissions are equitable. A Māori emissions profile would enable Māori-collectives to have oversight of and manage emissions collaboratively across their takiwā, which would better enable the balancing of traditional concepts and practices of rangatiratanga/mana motuhake, alongside contemporary cultural, social, and economic aspirations for iwi, hapū and whānau.

An attempt at estimating a Māori emissions profile by iwi takiwā could be achieved by Crown agencies working collaboratively to build on existing data, such as Te Puni Kōkiri's Toku Whenua platform, to include additional data such as forestry site coverage, stocking rates and iwi/tikawā boundaries.

The Government could then support iwi/Māori to stand up their own platform to effectively measure and monitor emissions within their takiwā, and incorporate this information into planning and decision making. This would support iwi/Māori-collectives to control their own emissions, and to demonstrate leadership and impact in achieving climate positive goals. Any platform would need to ensure iwi/Māori-collectives maintain mana motuhake (control and autonomy) over their data and information.

Necessary action 18
Building a Māori emissions profile

We recommend that, in the first budget period the Government facilitate a programme and direct funding to support Māori-collectives (particularly at an iwi level) to capture and record their own emissions profile within their respective takiwā. This will give effect to rangatiratanga by enabling iwi/Māori-collectives to effectively manage and monitor their emissions and enhance intergenerational planning.

6.2.6 Strengthen market incentives to drive low emissions choices

Emissions pricing is a powerful tool, and an essential component of an effective policy package for reducing emissions. In Aotearoa, the main emissions pricing instrument is the New Zealand Emissions Trading Scheme (NZ ETS).

The NZ ETS will need adjusting on an ongoing basis to keep it fit for purpose. Since 2016, a series of reforms have been undertaken. The NZ ETS now has much of the architecture it needs to be effective, but further improvements are needed, detailed below.

Adjust ETS unit volumes and price control settings to align with budgets

The Commission's recommended emissions budgets differ from the provisional emissions budget that was used to inform NZ ETS unit supply and price control settings for 2021-2025. In 2021, these settings must be updated to cover the 2022-2026 period. They include the volume of units to be auctioned in the NZ ETS as well as the auction reserve and cost containment reserve trigger prices, which start at $20 and $50 respectively in 2021.

The Commission's modelling indicates that meeting the 2050 target will involve marginal abatement costs higher than these NZ ETS auction price control settings, at around $140 in 2030. In addition to this indicative upper value, our evidence suggests that in process heat, a sector where an emissions price can be expected to play an important role in driving decarbonisation, significant opportunities exist at costs from around $50 upwards.

These costs should not be interpreted as a forecast of the NZ ETS market prices. The prices observed in the NZ ETS will depend on the mix of policies implemented to meet emissions budgets. The more that the Government chooses to complement the NZ ETS with other policies, the more likely it is that the NZU price in the NZ ETS can be lower while still achieving the same overall emissions reductions.

Regardless of the policy combination chosen, the auction reserve and cost containment reserve price triggers in the NZ ETS need to be higher. The price corridor they signal should be sufficiently wide to allow price discovery by the market to occur and factor in inflation to prevent the price levels from eroding in real terms.

The NZ ETS cost containment reserve trigger price should be set well above expected market prices. An initial step up in value, to mitigate risks that it will be triggered and add to the NZU stockpile, should be followed by annual increases to give a trajectory that allows for prices of at least $140 in 2030.

The auction reserve price trigger should also step up, to a higher value closer to recent market prices, to ensure price continuity and to safeguard existing investments (we note the afforestation levels in our modelling are based on an assumed emissions price of $35). The annual increases after this can be more moderate than those to the cost containment reserve trigger price, to manage risks of creating unintended speculative opportunities.

The unit volumes making up the NZ ETS cap, including the amount of units to be auctioned, will also need to be updated to reflect the first and second emissions budgets. Both unit volume and price control settings should continue to factor in the need to reduce the NZU stockpile.

The current framework for incentivising forests through the NZ ETS also does not align with our recommended focus on driving gross emissions reductions and a change in the balance of exotic versus native afforestation.

Improve ETS market governance

Good governance of the NZ ETS is important for the integrity and efficiency of market trading and to reduce the risks of misconduct.

The Government has recognised that the regulatory framework governing conduct in the NZ ETS market is patchy and incomplete. It has established a work programme to address the lack of good governance and associated risks, which include insider trading, market manipulation, false or misleading advice to participants, potential lack of transparency and oversight of trades in the secondary market, money laundering, credit and counter-party risks and conflicts of interest.

Other ETS-related issues

There are a range of other NZ ETS-related issues that also need progressing, though these are not as critical as the two noted above. These include:

- Considering options for recycling some or all of the cash generated from NZ ETS unit auctions. For example, these proceeds could be invested in emissions reductions, assisting communities or local authorities with adapting to the impacts of climate change, equitable transitions or helping Aotearoa to meet its NDC.
- Undertaking a first principles review of industrial allocation policy, considering the fundamental design of the current policy as well as overallocation risks, eligibility rules, updates to the Electricity Allocation Factor and allocative baselines.
- Continuing to phase out industrial allocation.
- Exploring alternative policy instruments that could address the risk of emissions leakage, such as product standards, consumption taxes and border carbon adjustments.
- Providing more information to reduce uncertainty about adjustments to NZ ETS settings, to build confidence in the market and support informed decision making by market participants. In particular, it would be useful for the Government to clarify how it intends to manage NZ ETS unit volumes in light of the split-gas 2050 target and the planned inclusion of biogenic agricultural emissions in a separate pricing mechanism. One option the Government could consider would be to outline its approach to making adjustments over time in a published document or policy. This would help to reduce uncertainty about future unit supply and expectations of prices.
- Clarifying the role and avenues for voluntary mitigation in Aotearoa. Some individuals and businesses wish to undertake voluntary action to contribute towards or beyond meeting the country's emission reduction targets. Failure to leverage this desire for voluntary action in addition to government policy would be a missed opportunity to deliver further for climate benefits. This also needs to take into account the accounting issues connected with voluntary offsetting and carbon neutral claims, which are discussed further in chapter 7 on the rules for measuring progress.

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

The Emissions Trading Scheme (NZ ETS) needs to drive low emissions choices consistent with emissions reduction targets in Aotearoa, including a focus on gross emissions reductions. In the first budget period the Government should:

a. In the next annual update to NZ ETS settings:

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

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

iii. To maintain continuity with recent prices, immediately increase the auction reserve trigger price to $30 as soon as practical, followed by annual increases of 5% plus inflation per year.

These changes are needed because maintaining current settings will lead to failure to meet emissions budgets.

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

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

Progress indicators

a. Government ensure that, in the next annual update to the NZ ETS settings, unit volumes are aligned with emissions budgets and price control settings are increased.

b. Government to develop proposals as soon as possible to establish a sound market governance regime for the NZ ETS, and to have legislated to address the most significant risks by no later than 30 June 2023.

Necessary action 19
Continued ETS improvements

We recommend that, in the first budget period the Government make progress on:

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

b. **Undertaking a first principles review of industrial allocation policy.**

c. **Continuing to phase out industrial allocation.**

d. **Exploring alternative policy instruments that could address the risk of emissions leakage.**

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

f. **Clarifying the role and avenues for voluntary mitigation in Aotearoa.**

Consultation question 19
Multisector strategy

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

Chapter 7: Rules for measuring progress

'Rules for measuring progress' refers to the system of accounting for greenhouse gas emissions that will be used to track the progress Aotearoa makes towards emissions budgets and the 2050 target.

In Aotearoa, various emissions accounting methods are already in use, for example to prepare the national Inventory, to track the Nationally Determined Contribution (NDC) and other targets, and to produce emissions accounts that align with economic statistics. Our task is to determine which of these existing methods are best suited for setting emissions budgets and delivering the 2050 target.

In this chapter, we first outline our role and approach to thinking about accounting for emissions budgets and the 2050 target. We then discuss accounting choices related to:

- production- and consumption-based emissions estimates
- accounting for land emissions. By 'land emissions', we mean emissions and removals from land sources and sinks such as forests, vegetation, soils, and wetlands. This does not include any direct agricultural emissions such as those from livestock or fertiliser
- voluntary offsetting and carbon neutral claims.

7.1 Greenhouse gas accounting for emissions reduction targets

The methods used to calculate and attribute the amount of greenhouse gases emitted or removed from the atmosphere over time are a critical component of effective climate policy. Robust and accurate emissions accounting is essential for:

- setting emissions reduction targets
- monitoring and evaluating progress towards meeting targets
- judging compliance at the end of a target period.

A key purpose of the emission reduction targets that countries set themselves is to drive actions to reduce human impacts on the climate. The accounting methods for these targets need to deliver useful data to inform emissions reduction efforts, and influence which reduction activities are prioritised. This link to policy and to driving behaviour change is why emissions accounting for targets may differ from the methods used for national greenhouse gas inventories.

7.2 Our role

We must advise on the rules that should apply to measuring progress towards meeting emissions budgets and the 2050 target. Our recommended accounting rules have been used to develop the recommended emissions budgets. We will also use them to report on the Government's progress towards emissions budgets, starting in 2024.

This advice relates to the first three emission budgets, covering 2022-2035. In 2024, we will advise on the fourth emissions budget covering 2036-2040. At that time, we will have the opportunity to revise our recommendations on accounting for the second and third emissions budgets, if this is warranted by developments in knowledge or accounting methods.

7.3 Objective and principles to guide accounting choices

We have examined the accounting rules for emissions budgets from a first principles basis. To do this, we have set a high-level objective for emissions budget and 2050 target accounting:

A robust, transparent accounting system that tracks genuine environmental gains while balancing completeness with practicality.

We have also defined a set of principles underneath the high-level objective, to provide guidance on how to reach this goal. The principles help ensure we take a coherent approach to the range of issues covered by target accounting.

Accounting for emissions budgets and the 2050 target should:

i. *seek to cover all material human caused emissions sources and sinks;*
ii. *be grounded in robust science and evidence;*
iii. *send a clear signal for climate action;*
iv. *be accurate and reduce uncertainty as far as practicable;*
v. *be transparent, practical and acceptable; and*
vi. *be consistent and maintain the integrity of the target.*

Together, the objective and principles provide a framework to allow options and trade-offs to be understood and to inform decisions about accounting rules. For more information on the reasoning for and meaning of each principle, see the chapter 3 in the Evidence Report.

7.4 Production- or consumption-based greenhouse gas accounting

One of the most fundamental choices in greenhouse gas accounting is whether to calculate emissions on a production or a consumption basis.

Until now, production-based accounting has been the only option for tracking the country's emissions. In 2020 consumption-based emissions estimates were produced by StatsNZ for the first time. We have assessed these two approaches using the objective and principles for accounting set out above.

Our proposed advice is that production-based estimates are more suitable for accounting for emissions budgets and the 2050 target.

The production approach records emissions at the point where human activity causes their release to the atmosphere. It attributes the emissions to the original producer of the emission, for example a manufacturing plant burning coal in a boiler. Production-based accounting is the standard method used by countries for setting and tracking emissions reduction targets, and it is used to compile our national Inventory.

The consumption approach accounts for emissions 'embodied' in a good or service that result from the entire supply chain required to produce that good or service for final use. For example, in the case of vehicle transport, this approach would record all the emissions produced from making the

materials, such as the metals, and from the assembly of a car, as well as the emissions from fossil fuel combustion generated when the car is driven. Under the consumption approach, Aotearoa would not be responsible for the emissions embodied in the goods it exports but would be responsible for those embodied in imports.

The consumption emissions estimates for Aotearoa are at an early stage of development and have significant downsides. These include:

- Lower coverage of material sources and sinks. The consumption estimates exclude land emissions, due to the technical difficulty and lack of methods for attributing land emissions to industry sectors and final use.
- Accuracy and uncertainty are negatively affected by assumptions made about emissions embedded in imports from other countries. For example, StatsNZ calculates the consumption estimates assuming imports have the same emissions content as outputs of the same industry in Aotearoa.
- Lack of an internationally agreed standard for calculating and reporting consumption emissions. This would make it difficult to compare the country's targets and progress in reducing emissions against those of other countries.
- Using consumption-based emissions estimates for accounting would differ from the analysis used to set the 2050 target. This could undermine the integrity of the target.

Consumption-based emissions are, however, a useful complement to the national Inventory. We look forward to StatsNZ's efforts to continually improve and provide annual reports on consumption emissions. We intend to monitor them for insights into the wider impact Aotearoa has on global emissions, carbon-intensive supply chains and trade flows.

7.5 Accounting for land emissions

We need to decide on a framework for land emissions accounting, given the significance of these emissions for Aotearoa. Given the role forests can play meeting our net zero target in 2050 and beyond, a fit-for-purpose accounting framework is key.

There are two frameworks for land emissions accounting currently used in Aotearoa:

1. a 'land-based' approach that uses 'stock change' accounting for both pre-1990 and post-1989 forests. This is used in the country's national Greenhouse Gas Inventory for UNFCCC reporting; or
2. a modified 'activity-based' approach that uses 'averaging' accounting for post-1989 forests. This is used in the country's NDC.

For the definition of a forest in greenhouse gas accounting in Aotearoa see chapter 3 of the Evidence Report. Smaller areas of trees not meeting the forest definition are mostly accounted for as biomass on grasslands or croplands.

7.5.1 A land-based approach, as used in the national Inventory

'Land-based' accounting aims to cover all emissions and removals from soil, trees, plants, biomass, and wood products. Emissions and removals by forests are reported in a way that corresponds to tree growth, harvest and deforestation – known as stock change accounting. By trying to record emissions and removals when they occur, it gives a truer representation of 'what the atmosphere sees'.

7.5.2 A modified activity-based approach, as used in the NDC

This accounting approach uses a smaller subset of activities and land types than the land-based approach. It focuses on significant sources and sinks whose emissions can be most affected by changes to peoples' behaviour now. It does this by filtering out the effects of past actions, such as regrowth of previously harvested native forests.

This approach will be used for the country's first NDC. The NDC will account for land areas and uses corresponding to the *afforestation*, *reforestation*, *deforestation* and *forest management* activities accounted for in the country's 2020 target covering the second commitment period of the Kyoto Protocol, 2013-2020. It is not yet known if the NDC will include the land areas or uses related to the activities of *cropland management, grazing land management, revegetation* or *wetland drainage and rewetting*.

The NDC will use 'averaging' to account for afforestation and reforestation of post-1989 forests. This approach smooths out the cyclical peaks and troughs in emissions due to harvesting of post-1989 exotic production forests. It does this by accounting for removals only up until the forests reach their long-term average carbon stock. This occurs around 21 years after planting for a production pine forest on a 28-year rotation. Averaging focuses on the long-term effect of these forests on carbon stocks.

Box 7.1: Pre-1990 and Post-1989 forests

The country's activity-based target accounting has given rise to two broad classifications for forests:

- **Post-1989 forests** are those established after 31 December 1989.
- **Pre-1990 forests** are those established before 1 January 1990.

These classifications are due to the 1990 base year Aotearoa agreed to in the Kyoto Protocol. Activities occurring from 1990 onwards are 'additional' rather than business-as-usual.

In this approach, only emissions and removals due to additional human activities are counted. This means that emissions from *deforestation* are counted for all forests, but removals from *afforestation* and *reforestation* are only counted for post-1989 forests. *Forest management* aims to track the impact on emissions from changed management of pre-1990 forests.

The 1990 base year has been devolved into policy through the NZ ETS. It contributes to a sense of unfairness among pre-1990 forest owners, including iwi/Māori. This is because there is a deforestation liability constraining land use change, but no reward for forest growth. This outcome results from the approach's focus on behaviour change now, rather than penalising or rewarding past actions.

With this approach, there is still some potential for flexibility and recognition of pre-1990 forests:

- *Forest management* in theory enables counting of increased carbon stocks due to improved management. However, this is difficult to do robustly and has not yet been devolved from target accounting into the country's policies.
- Both target accounting and NZ ETS rules allow avoidance of deforestation liabilities if an equivalent forest is planted elsewhere.
- Emission reduction policies for forests should broadly match target accounting, so costs sit with emitters rather than taxpayers. However, there is scope for policies to differ from target accounting. These differences can be justified for reasons of practicality or by other policy goals, if the benefits of doing so outweigh the cost to the taxpayer. In this context, consideration could be given to:
    - encouraging improved management of pre-1990 forests, even if enhanced carbon storage is not counted for targets, or
    - providing more flexibility for Māori-owned land to avoid locking in historical disadvantages.

Finally, averaging reduces the differences between the two forest types. Under averaging, post-1989 forests that reach the long-term average carbon stock are treated similarly to pre-1990 forests, as further business-as-usual growth and harvesting are not accounted for.

7.5.3 Assessment of the land emissions accounting frameworks

Overall, we consider that the NDC's modified activity-based framework for land emissions accounting, with a 1990 base year and 'averaging' for post-1989 forests, is a more suitable accounting approach for measuring progress towards emissions budgets and the 2050 target.

We assessed the two options outlined previously against our accounting principles, with key differences discussed below. A full analysis is provided in the chapter 3 of the Evidence Report.

Coverage of material emissions sources and sinks: The land-based approach's main advantage is that it covers more sources and sinks than the modified activity-based NDC approach. The NDC currently only includes forest-related activities, although its scope could be expanded.

Sending a clear signal for climate action: The land-based approach performs worse against this principle than the modified activity-based approach, primarily due to its use of stock-change accounting for forests. This results in significant fluctuations in net emissions due to harvest cycles. These are temporary and obscure underlying, more enduring trends, confusing policy and price signals about the action needed. These fluctuations also make it easier to reach net zero but difficult to maintain it after 2050. As shown in Figure 7.1, government projections indicate that after a peak in removals around 2050, harvesting would cause forestry emissions to increase. In the NDC's modified activity-based accounting, averaging smooths out the fluctuations. This makes it clear that Aotearoa needs to plant new forests and reduce deforestation to contribute to longer-term emissions reductions.

Consistent and maintains integrity of the target: Activity-based accounting is consistent with the analysis that informed the 2050 target. Using land-based accounting would reduce the effort to achieve the target, undermining the commitment made when it was set.

Accuracy and reducing uncertainty: The land-based approach results in emissions estimates with higher overall uncertainty. Reasons for this include: having to combine carbon stock gains and losses, each with their own uncertainty, to determine net change; estimating uncertain factors related to the management of production forests such as harvest age and area; and including some land areas with highly uncertain emission factors such as wetlands. As an example, pre-1990 production forests introduced uncertainty of ±34.9% into the Inventory land emissions estimates in 2018. Netting off significant amounts of land emissions with high uncertainties against gross emissions with much lower uncertainties is problematic.

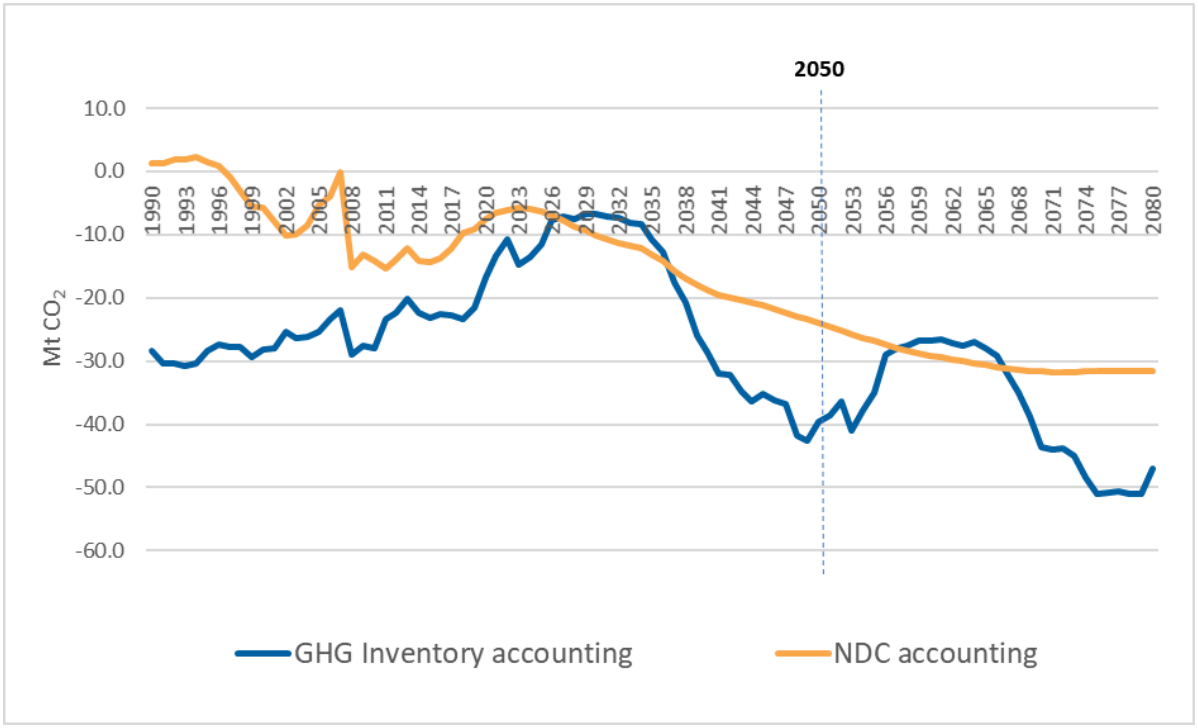


Figure 7.1: Comparison of national forest net emissions using Greenhouse Gas Inventory (stock change) and NDC (averaging) accounting.

Source: MPI October 2020 updated 'with existing measures' projection, $35 emissions price

7.6 Detailed choices within the modified activity-based accounting framework

The Commission has assessed detailed elements of the NDC accounting approach to identify if it is fit-for-purpose for emissions budget accounting. This assessment is summarised below.

The NDC accounting is not yet fully defined. It may not be confirmed until late 2024 when Aotearoa is due to submit its first Biennial Transparency Report under the Paris Agreement. This incomplete definition limits what we can consider for this first package of advice. It is not feasible to use some elements of the NDC accounting approach in accounting for emissions budgets as we do not currently have enough information on how they work, or they do not yet exist.

7.6.1 Forest management

Forest management is the part of the NDC accounting system where the impact on carbon stocks of management practices affecting pre-1990 forests is counted. It is accounted for by estimating additional emissions and removals in pre-1990 forests above or below business-as-usual due to changes in forest management. It involves setting a reference level, based on a future projection of what would have happened with no change in management. Using counterfactual projections such as this has inherent accuracy and uncertainty challenges, with risks of both over- and under-estimation.

The Government has not yet defined the reference level that will be used for the NDC. We have been unable to assess how risks will be managed and how the reference level lines up against our accounting principles. This means we cannot include *forest management* in emissions budget

accounting now. We will revisit this in 2024 to consider its inclusion in updated advice for the second and third emissions budgets.

Despite this limitation, we value the management of pre-1990 forests to enhance carbon stocks and deliver other benefits such as biodiversity. We urge the Government to encourage better management of these forests (see chapter 6), even if the carbon impacts are not accounted for in emissions budgets.

7.6.2 Harvested wood products (HWPs)

When a forest is harvested, much of the carbon is stored for a time in wood products, not released into the atmosphere immediately. HWPs is the part of the accounting system that captures this effect and the benefit of using timber in the built environment.

HWPs for post-1989 forests are likely to be incorporated into averaging through adjusting the long-term average carbon stock. HWPs for pre-1990 forests are likely to be accounted for in the *forest management* reference level. As *forest management* cannot be included in emissions budget accounting now, there is no practical way to account for HWPs for pre-1990 forests in emissions budgets either.

7.6.3 Carbon equivalent forests

This provision allows pre-1990 forests that meet specified conditions to be converted to another land use without being classified as deforestation, if a new forest that would reach an equivalent carbon stock is planted elsewhere. We have not identified material integrity risks with this provision.

7.6.4 Natural disturbances

The country's first NDC will include a 'natural disturbances' provision to manage risks of natural events radically affecting land emissions. The provision can be invoked after a natural disturbance, e.g. a volcanic eruption, to allow the emissions from the disturbance to be excluded from accounting.

The provision is expected to follow the IPCC's 2013 *Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol*, but the details of how it will work are not yet clear. The risks of adopting the provision for emissions budgets before knowing the rules can be managed, as we can control whether it is invoked through our annual monitoring reports.

7.6.5 Other sources of land emissions and removals

The most significant sources of land emissions and removals not yet part of NDC accounting are emissions from organic soils, mostly drained wetlands, and removals from biomass on grasslands, mostly small lots of trees. In line with our principle that accounting should aim to cover all material human caused emissions sources and sinks, the Government should investigate the feasibility of including these land areas and uses in target accounting in future.

7.7 Voluntary offsetting and carbon neutrality

Voluntary offsetting refers to the purchase and cancellation of emissions units such as NZUs for the purpose of making 'carbon neutral' or 'net zero' claims. It aims to compensate for the emissions footprint associated with an organisation, product or service such as air travel.

There are several requirements that are widely recognised as necessary to enable a credible carbon neutral claim. One is that voluntary offsetting should contribute to *additional* emission reductions or removals it. This requirement means that voluntary offsetting should deliver something extra on top of what would occur anyway due to business-as-usual activities, including those due to government policies like the NZ ETS. Another is the avoidance of double claiming, a type of double counting where more than one entity counts an emission reduction against an emissions reduction target.

In Aotearoa the issues of additionality and double claiming are linked. It is not possible to guarantee that an emissions reduction or removal is additional, unless it is not double claimed against the country's emissions reduction targets. In practice, this means that to deliver additional mitigation in any sector whose emissions are in scope for target accounting, both an NZU must be cancelled and an adjustment made to the accounting for targets, emissions budgets and the NDC.

This requirement is due to the NZ ETS, which is managed in way that takes account of emissions from the whole economy, including from agriculture and forests that are not covered by the NZ ETS. If over time the country's total net emissions recorded in the Inventory are lower than what is needed to meet our emissions reduction targets, more units will be added to the NZ ETS cap via the annual cap updates. This adjustment is to keep Aotearoa on track to achieve its targets, rather than to overachieve them, to avoid imposing more cost than necessary on the economy and New Zealanders.

If NZUs were cancelled for voluntary offsetting without removing the same volume from the target, it would simply make it appear that the NZ ETS is driving more reductions than necessary to meet the target. The NZ ETS cap would then be adjusted upwards, permitting more emissions elsewhere in the economy, negating the impact of the voluntary mitigation.

The Government is considering what guidance to provide about voluntary offsetting from 2021 as Aotearoa moves to Paris Agreement accounting practices. It has not yet made any decisions about whether to allow adjustments against targets when NZUs are cancelled for the purpose of voluntary offsetting. Nor has it decided whether carbon neutral claims can be made when an NZU is cancelled.

The Government should explore options for enabling voluntary mitigation and clarify the types of claims that can be made about it in Aotearoa. This should aim to encourage the private sector's desire for voluntary action for the benefit of the climate.

We consider that, given the way the NZ ETS currently operates, if there is no adjustment against targets when an NZU is cancelled, it is not legitimate to claim that any additional emission reduction or removal has occurred. This is in line with our objective and principles for accounting that relate to transparency, consistency and tracking genuine environmental gains.

7.8 Legislative requirements

The Climate Change Response Act sets out the framework for the system of emissions budgets to set the path to the 2050 target, including some of the parameters for accounting. These include the scope

of emissions budgets, which excludes emissions from international aviation and international shipping and from Tokelau, and that emissions budgets be expressed as a net quantity of carbon dioxide equivalent, calculated in accordance with international climate change obligations.

We have examined these accounting issues on their merits, in keeping with our independent role. We do not consider that any changes to legislation are warranted at this stage, given the high bar for recommending legislative change. A more detailed explanation of these issues is provided in chapter 3 in the Evidence Report.

Budget recommendation 5
The rules for measuring progress towards emissions budgets and the 2050 target

We recommend the following package of rules for measuring progress:

a. **To use the production-based approach from the national Greenhouse Gas Inventory as the basis for accounting for emissions budgets and the 2050 target.**

b. **To use a modified activity-based framework for land emissions accounting, with a 1990 base year and 'averaging' for post-1989 forests, substantially aligning emissions budget accounting with the approach used for accounting for the first NDC.**

c. **Within the modified activity-based land emissions accounting framework, to:**

   i. **Include the land areas and uses corresponding to afforestation, reforestation, and deforestation, as confirmed for the first NDC.**

   ii. **Exclude forest management, the activity relating to the impact of management practices on pre-1990 forest carbon stocks, despite its inclusion in NDC accounting because the forest management reference level has not yet been set for the period through to 2030 and we have been unable to assess how it manages accuracy and uncertainty risks. Improved management of pre-1990 forests nevertheless remains important and should be encouraged through policy.**

   iii. **Include harvested wood products (HWPs) from post-1989 forests, but not HWPs from pre-1990 forests because they are accounted for as part of forest management which is excluded from emissions budget accounting.**

   iv. **Include a natural disturbances provision, aligned with the first NDC and the 2013 IPCC Kyoto Protocol Supplement. The Commission will judge whether to invoke the provision in its reports that monitor progress each year and at the end of an emissions budget period.**

   v. **Encourage the Government to develop methods for tracking emissions and removals by sources and sinks not yet included in the country's domestic or international target accounting, such as organic soils and biomass (including small lots of trees and regenerating vegetation), with a view to allowing them to be included in future target accounting.**

d. **From 2021, if the Government allows voluntary offsetting for carbon neutral claims to take place in Aotearoa through cancelling NZUs, adjustments corresponding to the amount of NZUs cancelled must be made to the relevant emissions budget, or to the inventory, to avoid the emissions reductions claimed from being negated by increases to the NZ ETS cap.**

Consultation question 20
Rules for measuring progress

Do you agree with Budget recommendation 5? Is there anything we should change, any why?

Part B: The Nationally Determined Contribution for Aotearoa, and potential further biogenic methane reductions

Chapter 8: The global 1.5°C goal and Nationally Determined Contribution for Aotearoa

8.1 Introduction

Under the Paris Agreement, Nationally Determined Contributions (NDCs) are countries' contributions to the global effort to reduce emissions to limit the impacts of climate change. In its first NDC, Aotearoa committed to reduce net greenhouse gas emissions to 30% below 2005 levels by 2030. This means Aotearoa can emit no more than 585 Mt CO_2e from 2021-2030.

Under section 5K of the Climate Change Response Act 2002 (the Act), the Minister of Climate Change asked the Commission to provide a report on the country's first NDC under the Paris Agreement, that includes:

1. advice on whether the NDC is compatible with contributing to the global effort under the Paris Agreement to limit the global average temperature increase to 1.5°C above pre-industrial levels
2. recommendations on any changes to the NDC required to ensure it is compatible with global efforts under the Paris Agreement to limit the global average temperature increase to 1.5°C above pre-industrial levels.

The full text of the request and the terms of reference can be found on our website at: https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/reviewing-new-zealands-nationally-determined-contribution-and-biogenic-methane/

This chapter responds to that request. In this chapter, we cover the global emissions reductions modelled for the world to keep warming below 1.5°C, describe what those emissions reductions would mean for the country's contribution and reconsider the NDC as a result.

In addition, this chapter also discusses potential changes to the form of the NDC and some issues around how the Government should plan to meet it.

8.2 Global pathways to 1.5°C

The world has already warmed 1.0°C above pre-industrial levels and, without action to reduce emissions, average warming is expected to exceed 1.5°C around 2040.

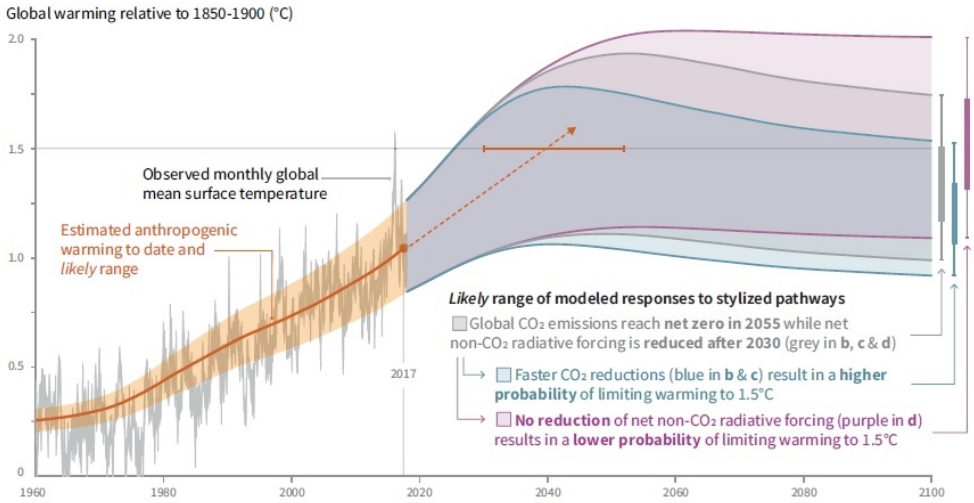


Figure 8.1: Observed and modelled global temperature change 1960-2100

Source: IPCC Special Report on 1.5°C Summary for Policymakers, Figure SPM.1

The Intergovernmental Panel on Climate Change (IPCC) has outlined different global pathways of greenhouse emissions that would limit warming to within 1.5°C of pre-industrial levels. These pathways all have differing rates of reduction for each greenhouse gas.

The IPCC pathways share some common underlying features. However, they differ in whether they always stay within the 1.5°C goal. Some allow the temperature to exceed 1.5°C before cooling down again later in the century. This is termed 'overshoot' by climate scientists.

The pathways with little or no overshoot are the most likely to deliver the best overall social, economic and environmental outcomes. Higher levels of overshoot are associated with more significant climate impacts and adaptation needs. Pathways with higher overshoot also rely on high levels of emissions removal technologies such as carbon capture and storage that may not be feasible. We have therefore chosen to only consider pathways with no or limited overshoot.

Following these pathways is not a guarantee of limiting warming to 1.5°C. The IPCC selected these pathways as the ones that have a 50-66% chance to limit warming to 1.5°C. This point is explained further in the following section.

For all these pathways, limiting warming to 1.5°C requires rapid emission reductions of all greenhouse gases between now and 2030. They then need somewhat slower reductions out to the end of the century. All these pathways have several other features in common:

- Emissions of carbon dioxide and other greenhouse gases are modelled to peak in the 2020s and then rapidly reduce through the 2030s and 2040s.
- Nitrous oxide emissions are modelled to have relatively smaller reductions. This reflects fewer options to reduce this gas, as the majority of nitrous oxide emissions come from food production and ongoing emissions are unavoidable as part of feeding the world's population.
- Emissions of methane are modelled to reduce significantly through the next 20 years, but do not reach zero by 2050 or 2100, reflecting the short-lived nature of the gas.

- Gross emissions of long-lived greenhouse gases reduce to be near zero by 2050. Most pathways have some remaining gross emissions in 2050 from hard to abate sectors, for example carbon dioxide from cement manufacturing. As a result, carbon dioxide removals are required to ensure net emissions reach and remain at net zero.

Most 1.5°C global scenarios also require ongoing levels of carbon dioxide removals beyond keeping emissions to net zero to bring temperatures back to 1.5°C after a temporary overshoot.

Table 81 below shows the modelled global reductions for carbon dioxide emissions, as well as agricultural methane and nitrous oxide emissions in 2030, 2050 and 2100. These modelled reductions are averages of the reductions needed by the whole world to keep global warming within the 1.5°C target with no or limited overshoot. We have used the interquartile range as it excludes more extreme model results that are less likely to be feasible. Note that 'biogenic methane' used to specify 2030 and 2050 methane targets for Aotearoa differs from 'agricultural methane' as modelled by the IPCC. Biogenic methane also includes emissions from the waste sector.

Table 8.1: Reductions in greenhouse gas emissions in IPCC model pathways with no or limited overshoot (interquartile range)

	Percentage change relative to 2010		
	2030	2050	2100
Net carbon dioxide emissions	-40 to -58%	-94 to -107%	-121 to -136%
Agricultural methane emissions	-11 to -30%	-24 to -47%	-37 to -60%
Agricultural nitrous oxide emissions	+3% to -21%	+1% to -26%	-6 to -39%

Source: IPCC, Special Report on 1.5°C, Summary for Policymakers, Table SPM.3b. IPCC model results.

There are questions about whether the globe can still limit warming to 1.5°C. The longer countries wait to act, the harder it gets and the more the world depends on possibly infeasible levels of carbon dioxide removed from the atmosphere. Next year, the IPCC will release its sixth assessment report that will provide the most up-to-date science on this.

8.3 What would on-track to 1.5°C look like in Aotearoa?

The IPCC modelled emission trajectories for the world for different gases that would be consistent with limiting warming to 1.5°C. Here we apply the modelled global emissions reductions by gas to Aotearoa to envisage potential NDCs that would be compatible with a 1.5°C pathway.

The first NDC is to cut emissions by 30% by 2030 compared to 2005 levels. This uses an approach where Aotearoa takes responsibility for emissions over the whole period 2021-2030.

There is an internationally agreed approach to convert from targets in a future year to contributions over a period of years. This is calculated by plotting a straight line from the previous target to the future target and then adding up all the emissions under the line. The actual emissions direction does not have to be a straight line so long as the country's total emissions over the entire period are less than the allowed level as illustrated in Figure 8.2 below.

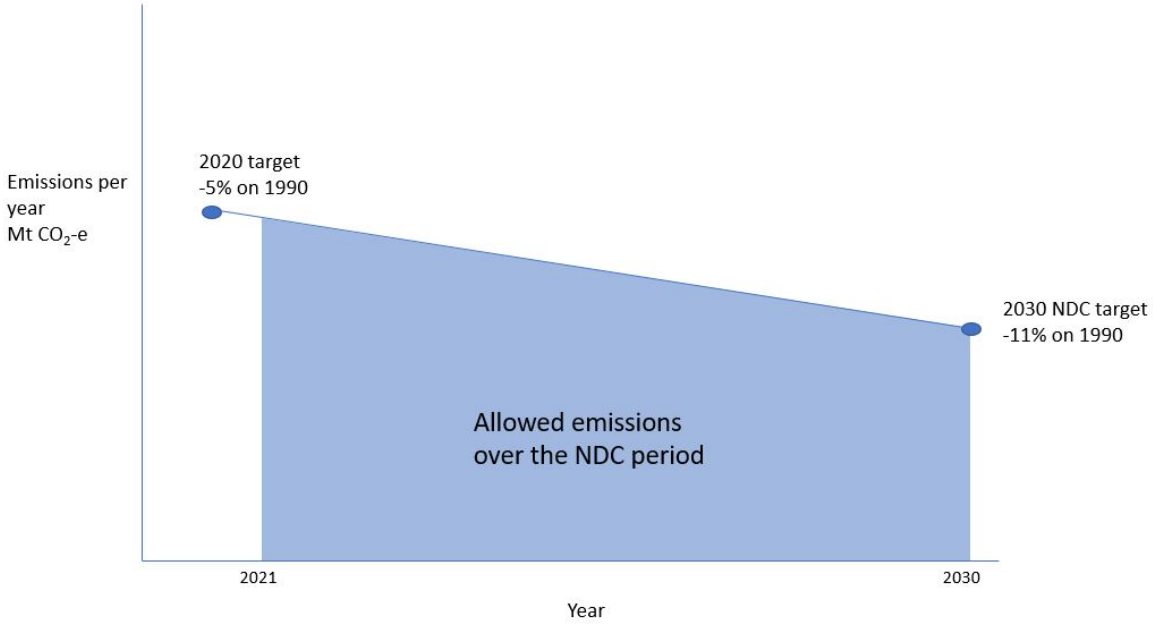


Figure 8.2: Illustration of conversion of the country's existing 2030 target to an NDC amount

Note: Our 2030 target is to reduce emissions to 30% below 2005 levels. Here it is presented as a reduction against 1990 levels for easier comparison to the 2020 target that preceded it.

The IPCC's modelling showed that different reductions of different gases are compatible with optimal paths to 1.5°C. In model pathways on track to limit warming to the 1.5°C, carbon dioxide emissions reduced by around 40-58% below 2010 levels by 2030. Emissions of methane and nitrous oxide reduced by less – around 20% for agricultural methane, and 10% for agricultural nitrous oxide. This reflects both the different warming effects of different gases, and differences in the costs to mitigate them.

The emissions profile of Aotearoa is different to that of most of other developed countries, as a much higher proportion of the emissions come from agriculture, particularly biogenic methane. In part this also reflects that the electricity sector is mostly decarbonised already. This means that a high ambition emission reduction trajectory will look different for Aotearoa than for other developed countries.

To acknowledge the differences in the country's emissions profile, and the different warming effect of different gases, we have assessed 1.5°C compatible trajectories using a split-gas approach. To do this we have developed separate emission trajectories for Aotearoa for carbon dioxide, methane and nitrous oxide, based on the IPCC modelled reductions. We have then aggregated these into a total amount of allowed emissions over the NDC period to compare with the first NDC.

We have applied this approach using both the IPCC's upper quartile of modelled reductions, and lower quartile of modelled reductions.

Applying the modelled reductions in Table 8.1 to the country's emissions profile using this approach, emissions over 2021-2030 would be 524-604 Mt CO_2e if it followed the IPCC range. This would comprise:

- 190-224 Mt carbon dioxide
- 10.8-12.2 Mt methane
- 171-201 kt nitrous oxide.

Table 8.2: Equivalent NDCs for Aotearoa applying the upper and lower quartile of reductions modelled by the IPCC

	Allowed emissions in NDC period (Mt CO_2e)	**Equivalent 2030 target level (% reduction on 2005)**
Lower quartile IPCC reductions (higher emissions)	604	25%
Midpoint reductions	564	35%
Upper quartile IPCC reductions (lower emissions)	524	44%

There is a detailed explanation of this approach and the calculations made in *Chapter 10: Requests under s5K relating to the NDC and biogenic methane - supporting evidence* of the Evidence Report.

The range in the IPCC scenarios represents the uncertainty in how fast emission of different greenhouse gases need to be reduced to limit warming. This uncertainty arises because it is not possible to predict exactly how things like global population or wealth might change and how much different mitigations might cost.

There is also uncertainty in exactly how the global climate will respond to future emissions – for example, how aerosol emissions affect temperature outcomes, and how sensitive temperature responses are to increases in carbon dioxide. As a result, the warming outcomes of the different scenarios are expressed as probabilities that they would limit warming to 1.5°C. In its special report, the IPCC only considered emission reduction scenarios that had a 50-66% chance of limiting warming to 1.5°C by the end of the century. Expressed the other way, if the emissions reductions in the scenarios were achieved, there is still a 34-50% chance that warming will exceed 1.5°C.

We can exclude some of the more extreme or unlikely scenario assumptions by looking at the inter-quartile range, that is, the middle 50% of values. This approach gives a more conservative but more likely estimate of the emission reductions that are needed.

Smaller allowed budgets (closer to the upper quartile range of the IPCC modelled emissions reductions) are associated with scenarios that have greater gross emission reductions and are less likely to overshoot the 1.5°C goal. Conversely, larger allowed budgets (closer to the lower quartile range of the IPCC modelled emissions reductions) have smaller gross emission reductions and are more likely to overshoot the 1.5°C goal and rely on greater levels of carbon dioxide removals in the latter part of the century to bring temperatures back down.

When expressed in terms of NDC allowed emissions, the lower quartile is 524 Mt CO_2e, and the upper quartile is 604 Mt CO_2e. The first NDC works out as an emissions budget of 585 Mt CO_2e. This budget is equivalent to the 63rd percentile, putting it towards the higher end of allowed emissions that are compatible with limiting warming to 1.5°C.

While all the scenarios in the interquartile range have been assessed as having a 50-66% chance of limiting warming to 1.5°C, the scenarios that focus on earlier gross emission reductions have less reliance on large scale carbon dioxide removals. The scale of carbon dioxide removals required by some of the scenarios that focus on smaller or later gross emissions reductions may not be achievable and can have a range of negative impacts on people, communities and economies. The IPCC has noted that relying on large scale carbon dioxide removals represents a major risk that the world will not be able to limit warming to 1.5°C.

These levels of allowed emissions of the different greenhouse gases represent the range of emission reductions modelled for the world as a whole to keep warming to 1.5°C, applied directly to the specific emissions profile for Aotearoa. However, they do not account for any considerations of how effort is shared between countries. This is considered in the following section.

Box 8.1: Gross-net accounting

The NDC uses a gross-net accounting approach. This is where the target is expressed relative to gross emissions (excluding forestry) in a base year but emissions and removals by forests planted or deforested since the base year are counted in meeting the target.

This is a legitimate internationally agreed approach that accounts for differences in timing of emissions and removals from forestry compared to other sectors. For most emitting sectors, the underlying activity and the emissions occur in the same year. However, for forestry, emissions and removals occur decades after the initial decision to plant. Aotearoa has 1.2 Mha of land that was in plantation forest in the base year (1990). The repeated growth and harvesting of this forest means that the country's net emissions will cyclically go up and down over decades, even if there was no change in the country's other emissions or activities.

If the target for Aotearoa was measured against net emissions in the base year, and accounted for the emissions and removals from all forests (net/net accounting) the long-term ebb and flow of growth and harvesting would make the country's climate action look unjustifiably good or bad depending on the point in the harvest cycle used for comparison. We provide more detail on this accounting approach in *Chapter 3: How to measure progress* in the Evidence Report.

8.4 Developed countries have agreed to lead the way

Climate change is a global problem and no country is immune from its effects. Greenhouse emissions from every country affects all countries. All countries will need to act and, through the Framework Convention on Climate Change and the Paris agreement, nearly all countries have agreed they will do so.

In terms of Gross National Income per capita, Aotearoa ranks as a wealthy, highly developed country (Figure 8.3).

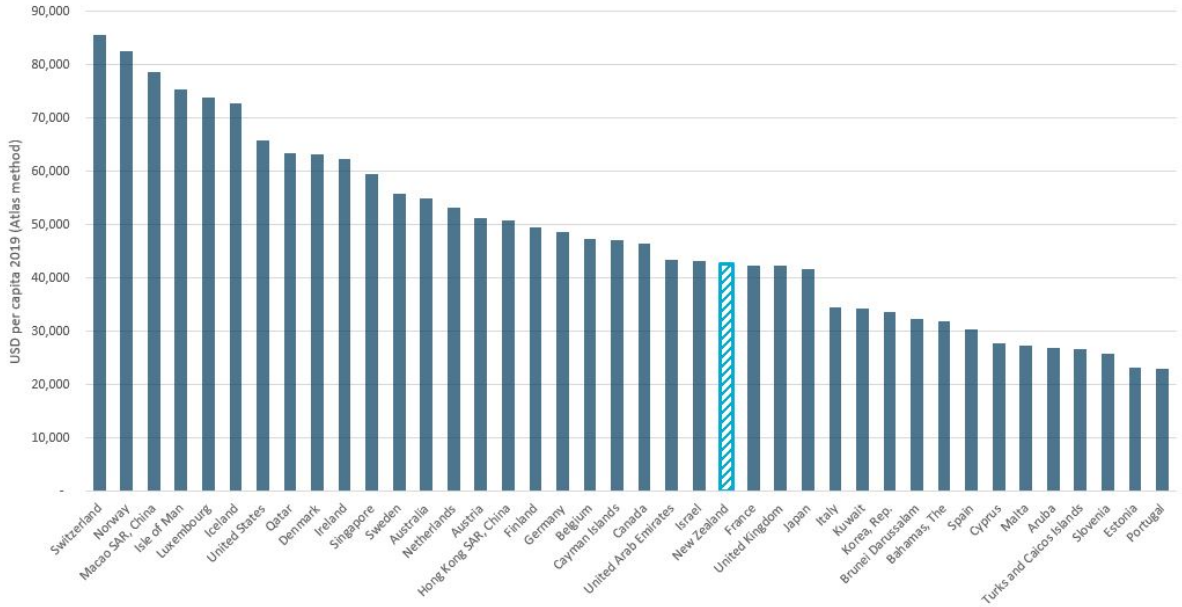


Figure 8.3: Richest 40 countries in 2019 by real Gross National Income per capita

Source: World Bank Data

Developed countries have emitted more cumulative emissions than developing countries, for longer and have benefited as a result. Consequently, developed countries have agreed to lead the way in reducing emissions and to support developing countries to reduce their own. This principle was enshrined in the United Nations Framework Convention on Climate Change in 1992 and reiterated in the Paris Agreement. Both agreements acknowledge that countries have common but differentiated responsibilities and respective capabilities to mitigate emissions.

This principle implies that in reaching any given temperature target, developed countries – such as Aotearoa – will need to reduce emissions proportionally faster and further than the average pace required of all countries.

If we are to contribute to a global effort towards limiting warming to 1.5°C, it is not sufficient for the emissions reductions to be compatible with an approach that expects the same proportional reductions from all countries. Along with other developed nations, Aotearoa has a responsibility to take the lead in reducing emissions and to support developing countries to transition and has already agreed it will do so.

8.5 The first NDC for Aotearoa

In its first NDC under the Paris Agreement, Aotearoa committed to reducing all greenhouse gas emissions to 30% below 2005 levels by 2030. Aotearoa has taken an emission budget approach to its NDC. This means that the target is converted into an emissions trajectory and the total emissions this equates to is calculated. The country then commits to limiting net emissions to no more than that amount over the whole period. Applying this approach Aotearoa can emit no more than 585 Mt of CO_2e from 2021-2030. This is based on the latest greenhouse gas inventory estimates of emissions. Previous estimates of the allowed emissions were higher – 601 Mt CO_2e reflecting the Government's best estimate of past emissions when it was made in 2017.

As better information becomes available, the government updates past estimates of emissions every year. This means the allowed emissions over the NDC period changes over time as emissions estimates improve. The level of allowed emissions under the NDC will be finalised in 2023/24 once the emissions estimate for the 2020 year has been reviewed.

The target in the NDC itself is to keep the country's net emissions to 30% below what total emissions were in 2005, using an emissions budget approach. In assessing the compatibility of the NDC with the 1.5°C goal therefore, we have used our assessment of the emissions budget associated with this target which is 585 Mt. *Chapter 10: Requests under s5K relating to the NDC and biogenic methane - supporting evidence* of the Evidence Report describes how this calculation was made.

8.6 Is the NDC compatible with Aotearoa contributing as a developed nation?

The global emission reductions necessary to limit warming to 1.5°C likely lie within the interquartile range modelled by the IPCC. The first NDC for Aotearoa is just inside the range of possible NDCs compatible with limiting warming – but sits at the lower end of modelled emissions reductions. As stated earlier, these lower levels of reductions are more likely to overshoot the 1.5°C goal and rely on uncertain carbon dioxide removals in the latter part of the century to bring temperatures back down.

This means it is likely that the current contribution is aligned with an approach – that if adopted by all nations – carries major risks in the ability to limit global warming to 1.5°C.

To be compatible with a developed country's contribution, the NDC would need to reflect deeper emission reductions than what is required of the world as a whole. Our advice is that it should reflect emissions much less than that equivalent to the middle of the IPCC interquartile range, which would mean allowed emissions of less than 564 Mt CO_2e, or reductions of much more than 35% below 2005 levels by 2030. How much stronger than that level the NDC should be set at is a question for elected decision-makers.

NDC recommendation 1

Compatibility of the NDC with contributing to a global effort towards keeping warming to 1.5°C

We advise that the first NDC is not compatible with Aotearoa making a contribution to global efforts under the Paris Agreement to limit warming to 1.5°C above pre-industrial levels.

NDC recommendation 2

Changes to the NDC to make it compatible with contributing to a global effort towards keeping warming to 1.5°C

a. **We recommend that to make the NDC more likely to be compatible with contributing to global efforts under the Paris Agreement to limit warming to 1.5°C above pre-industrial levels, the contribution Aotearoa makes over the NDC period should reflect a reduction to net emissions of much more than 35% below 2005 gross levels by 2030, with the likelihood of compatibility increasing as the NDC is strengthened further.**

b. **How much the NDC is strengthened beyond 35% should reflect the tolerance for climate and reputational risk and economic impact, and principles for effort sharing, which require political decisions.**

Consultation question 21

Nationally Determined Contribution (NDC)

Do you support our assessment of the country's NDC?

Do you support our NDC recommendation?

Box 8.2: Why the NDC is different

Our recommendation is that the NDC would need to be strengthened to reflect a reduction of much more than 35% below 2005 levels by 2030 to be compatible with contributing to the 1.5°C goal. This could still be less than some other developed countries' NDCs. This is because the emissions profile in Aotearoa is different to that of other developed countries. For most developed countries, carbon dioxide comprises the large majority of their emissions, and the IPCC modelling shows that large reductions in carbon dioxide would need to be made by 2030 to be on track to limit warming to 1.5°C.

In comparison, a larger part of emissions in Aotearoa are not from carbon dioxide, with nearly half of total emissions comprised of biological emissions from the agriculture sector. The IPCC modelled that these gases also need to be reduced but not as deeply or as quickly as carbon dioxide. Because these gases are a larger proportion of total emissions, the reductions in greenhouse gases in line with the IPCC modelling is smaller overall than an equivalent target for other countries.

By taking a split gas approach in applying the IPCC's modelling, we have accounted for the differences in the emissions profile in Aotearoa.

8.7 How might Aotearoa meet an NDC compatible with 1.5°C?

The reductions in net emissions to meet the NDC will come from a combination of domestic action within Aotearoa and offshore mitigation to support other countries to reduce emissions. Here we describe the balance between domestic and offshore mitigation in meeting the NDC and its implications for increasing the level of the NDC.

8.7.1 Domestic contribution

The Act states emissions budgets must be ambitious but achievable and that the Minister must meet emissions budgets as far as possible through domestic actions. The Act limits offshore mitigation being used in budgets to situations where there has been a major change in circumstances, not accounted for when the budgets were set, that makes it impossible to meet the budgets domestically. As a consequence, offshore mitigation cannot be used to replace domestic mitigation – Aotearoa must do as much as possible within its own borders first.

The emission budgets under the Act that we recommend, described in *Chapter 2: Our proposed emissions budgets and emissions reduction plan advice*, would limit net emissions in Aotearoa to 557 Mt CO_2e over the periods 2022-2025 and 2026-2030 together. When forecast emissions for 2021 are included, emissions over the NDC period would be 628 Mt CO_2e if our proposed emissions budgets are adopted.

The evidence and analysis we have collated is that these budget levels represent ambitious but achievable levels of emission reductions on current levels that will put Aotearoa on track to meeting the 2050 targets – while balancing the requirements under the Act. More detail on how these budgets have been arrived at is provided in *Chapter 2*: *Our proposed emissions budgets advice*. However, the 628 Mt CO_2e allowed emissions over 2021-2030 under our domestic emissions budget is higher than the level of the first NDC. This means that some offshore mitigation will be needed to bridge the gap to ensure the NDC is met.

The emission budgets are set at a higher level than the NDC because they must be able to be met entirely domestically. If too stringent budgets are set early on, Aotearoa risks losing production in areas where a technological solution could be applied if more time was available to implement it. For example, in food processing, before a coal boiler can be replaced with a biomass boiler, a supplier must be found and design work to integrate it into the existing process must be done. If time is not allowed for these solutions to be implemented, some businesses will simply have to shut down. This could lead to potentially more severe social and economic impacts on communities, people and businesses than would be necessary to achieve the same amount of emission reductions given more time.

Another consideration is around the likelihood of achieving the emission budgets. Our modelling shows that it is possible that emissions could potentially be reduced by a greater amount than the budgets we propose. However, this requires technological developments that are not yet proven – particularly technologies to reduce biogenic methane. Whether these technologies will be proven and able to be deployed is highly uncertain. Consequently, setting emissions budgets at a more stringent level relying on these technologies introduces significant risks that the budget will not be able to be met domestically. If they are developed and proven in time, Aotearoa can meet a greater proportion of its NDC domestically and will be in a better position to set a more stringent second NDC.

In advising on emission budgets we have looked further than 2030, out to 2050 and beyond. The first two emission budgets represent our estimate of what is achievable within Aotearoa up to 2030. It will be possible to reduce emissions much further after 2030, but only if the government takes decisive policy action early in the first and second budget periods. Greater levels of emissions reductions become possible as government, businesses and communities build momentum in the move away from fossil-fuels.

8.7.2 Offshore mitigation

Offshore mitigation is where one country pays for emission reductions in another country and counts those reductions towards its own emissions reduction target. Offshore mitigation representing real, verifiable and additional emission reductions is a valid contribution to addressing climate change. The benefit to the atmosphere of an emission reduction is the same, regardless where it happens. Unlike emissions budgets under the Act, our NDC deliberately includes a contribution from international mitigation.

Contributing this way means that in addition to doing as much as possible domestically, Aotearoa would help other countries to avoid locking in high emissions and to develop more sustainably. The Paris Agreement recognises that international cooperation through market mechanisms can serve the goals of increasing ambition and of promoting sustainable development and environmental integrity. This is consistent with the value of whanaungatanga – the interconnectedness of the climate and global system, and tikanga – doing the right thing in the right way. This is why the NDC is set at a more stringent level than emissions budgets set under the Act. The NDC represents the total mitigation contribution to the world beyond just what we can do at home as illustrated in Figure 8.4.

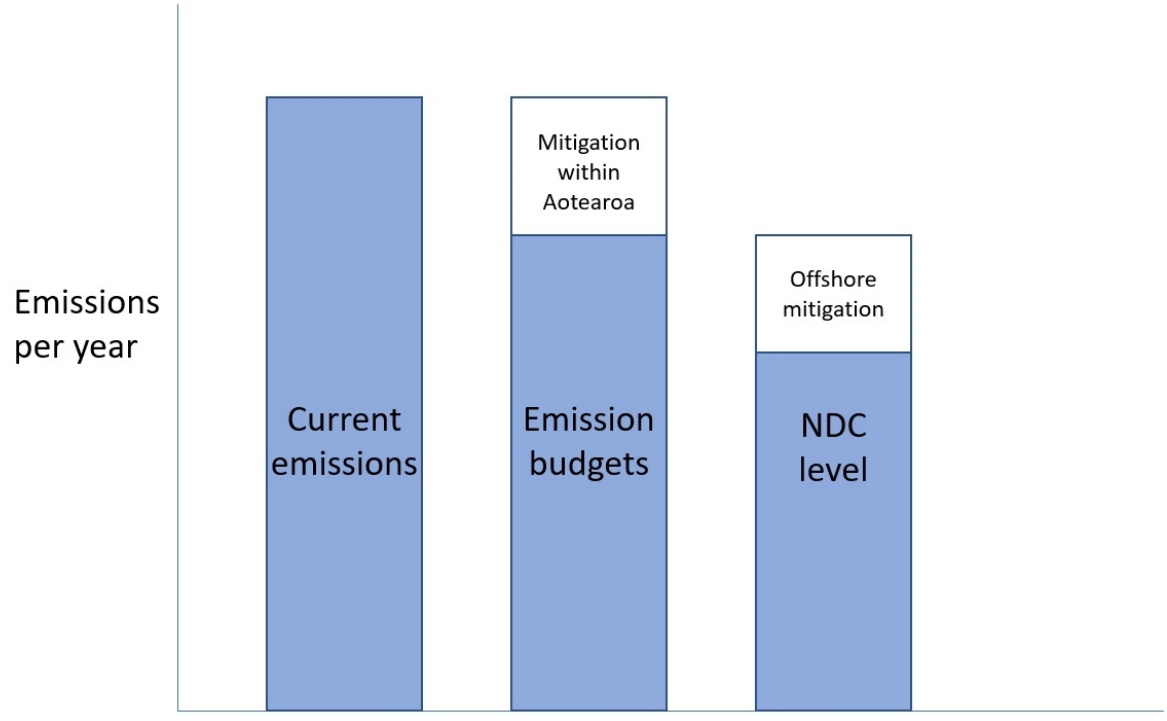


Figure 8.43: Illustration of the role of international mitigation in NDC compared to emissions budgets

8.7.3 How much international mitigation will be needed?

The gap between the first NDC and our recommended emissions budgets for domestic action is 43 Mt CO_2e. This will need to be met by purchasing mitigation from overseas. Our modelling suggests that if a methane inhibitor or vaccine can be developed and deployed by the mid-2020s, this gap could be significantly reduced.

This means that if the government was to increase the NDC to make it compatible with the 1.5°C goal, this would primarily increase the quantity of mitigation that needs to be purchased from overseas.

Table 8.3 shows the level of the NDC and the likely quantity of offshore mitigation needed for the first NDC and an NDC based on the middle or upper end of the IPCC 1.5°C pathways. If Aotearoa were to take responsibility for past emissions or set the NDC based on the relative wealth of the country, the resulting NDC would show much deeper cuts to emissions.

Table 8.3: The amount of offshore mitigation that would need to be purchased under different NDC levels

NDC approach	Level (Mt CO_2e)	Implied offshore mitigation (Mt CO_2e)
2017 estimate of the first NDC	601	27
Latest estimate of the first NDC	585	43
Middle of the IPCC interquartile range	564	64
Upper end of the IPCC interquartile range	524	104

The total cost of offshore mitigation used to meet an NDC will depend on the level of the NDC, how much of the NDC is met with domestic emission reductions and removals, and the price of offshore mitigation.

It is currently uncertain how much offshore mitigation will cost. Its cost will depend on which country or countries the government partners with, the types of mitigation available there. Once the Government has formalised a partnership for offshore mitigation with another country it will have to decide how the mitigation will be paid for. Offshore mitigation could be paid for by the Government, by emitters or a combination of the two.

The overall economic impact of expenditure on offshore mitigation will be greater than the purchase price, due to multiplier effects. Were an equivalent amount to be spent within Aotearoa, it would have a knock-on effect stimulating spending in downstream industries. With offshore mitigation these knock-on effects occur overseas, and so we do not get these benefits. However, we gain the benefit of cheaper emission reductions, and greater availability of mitigation options while the country builds momentum in decarbonising at home.

It is uncertain both how much mitigation will cost and what multiplier would be appropriate to account for the terms of trade effects. This means there is a wide range of possible economic costs to offshore mitigation. If Aotearoa was to change the NDC to reflect the middle of the IPCC range, then the range of economic costs of this component are described in Table 8.4 below.

Table 8.4: Possible economic costs of offshore mitigation used to meet an enhanced NDC

	Price ($/tonne)		
Multiplier for terms of trade	*$30*	*$50*	*$100*
No multiplier	$1.9b	$3.2b	$6.4b
1.8 multiplier	$3.5b	$5.8b	$11.5b

Note: Estimates of the possible multiplier to account for terms of trade effects vary. Here we have used 1.8 based on work done by Infometrics to assess the impact of possible NDCs in 2015 – *A general equilibrium analysis of options for New Zealand's post-2020 climate change contribution.*

8.8 How might Government decide the level of the NDC?

The middle of the IPCC range, representing the average reductions required of the world to keep warming to 1.5°C, would be an NDC of no more than 564 Mt CO_2e, equivalent to a reduction of 35% on 2005 levels by 2030.

How much deeper than this level the NDC should be set depends on a range of factors that are outside the Commission's remit and capability. This is because the first NDC will reflect a deeper level of emission reductions than we believe is practical to achieve domestically. The decision on the level of the NDC therefore does not reflect trade-offs about how we transition the economy, but decisions about the level of economic effort the country is willing to make over and above the domestic transition, in service of a global effort to mitigate climate change.

Decisions on the level of offshore mitigation purchased will need to balance a wider range of factors including judgements about

- the expectations of other countries and their governments
- the economic impacts of extending the NDC
- tolerance for climate risks
- the relative importance of funding greater levels of climate change action against other domestic or international priorities
- the Government's approach to equity between countries.

We consider that these judgements, and the decision on the level of international commitment, should be made by the elected government of the day. However, it is also important that future governments uphold the NDC, and so cross-party support for any changes to the NDC should be sought.

We can however describe some principles the government can use to guide its analysis of deciding the level of the first NDC and some limitations in their application.

8.9 Non-mitigation contributions

NDCs represent countries' mitigation commitments – how much each will contribute to the collective effort to peak global emissions and rapidly reduce them thereafter.

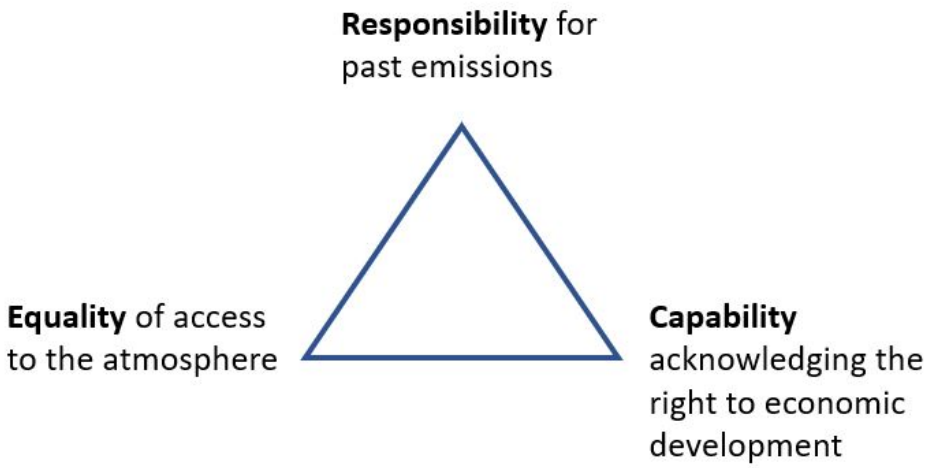
Other measures that can also support climate change efforts include wider elements such as climate finance to support developing countries to adapt to the effects of climate change and to mitigate their own emissions. Non-mitigation measures cannot replace mitigation, but can be included as supplementary commitments inside or outside NDCs to demonstrate a commitment to equity.

As the terms of reference for the review of the NDC were in reference to limiting warming to 1.5°C, we have not included non-mitigation commitments in our analysis. However, including an additional non-mitigation contribution in the country's first NDC is one option the government could consider.

8.10 Principles for setting an NDC

Aotearoa cannot ensure that warming is kept to 1.5°C on its own. It will take a global effort to do so. In seeking to make its NDC compatible with such a global effort, the government must either implicitly or explicitly make assumptions about how its NDC relates to the effort of other countries. There are different approaches to sharing the global effort between countries and they each imply different levels of NDC for Aotearoa. This section discusses some of the key principles and approaches used to estimate suitable contributions from different countries.

The IPCC described the main set of effort sharing approaches in the Fifth Assessment Report. There are three main principles and different approaches to effort sharing balance these principles differently.



- **Equality:** This principle focuses on equal access to the atmosphere. What emissions budget remains is shared between all people equally. There are a range of approaches:
    - Equal proportional emissions cuts – all countries reduce emissions at the same rate.
    - Equal per capita emissions – emissions per capita converge to, or immediately reach, the same level for all countries.
- **Responsibility:** This principle focuses on countries taking responsibility for their historic emissions. Countries that have emitted more historically have to take deeper and faster cuts.

- **Capability/need:** This principle focuses on a country's level of economic development. Higher levels of economic development imply a higher capability to reduce emissions. Lower levels of economic development imply a greater need for further development and a greater use of the world emissions budget. Consequently, richer countries are tasked with reducing deeper and faster, while less developed countries take more time before needing to cut emissions in order to develop economically.

In addition to the main principles, there are approaches that combine the different elements. The two most relevant are:

- **Equal cumulative per capita emissions:** emissions need to be reduced so that cumulative emissions per capita reach the same level. This allows countries with a high population and low historic emissions further time to develop. This approach combines elements of equality and historical responsibility.
- **Responsibility/capability/need:** a range of studies have explicitly used responsibility and capability as the basis for distributing emissions reductions. The approach taken will depend on the relative weighting given to responsibility vs capability.

Each of these approaches relies on assessing a global emissions budget that is compatible with the temperature goal and dividing it between countries, in ways that reflect equity considerations. However, careful judgements need to be made about how different gases are treated in these approaches. In particular, care must be taken to consider how short-lived gases are treated in approaches that are based on calculating cumulative emissions.

Various organisations and researchers have analysed targets and NDCs specific to Aotearoa under different effort sharing approaches including Climate Analytics and the New Climate Institute (Climate Action Tracker) and du Pont et al (Paris Equity Check). These analyses generally exclude forestry emissions/sequestration and so are not directly comparable with an NDC that includes forest sequestration but are illustrative of the depth of reductions required if these equity approaches are applied.

Oxfam New Zealand (*A Fair Target for 2030 for Aotearoa*, 2020) provides a useful overview of the different equity approaches that can be applied and what they would mean for the NDC specifically and have noted the methodological issues that need to be managed in each case.

In general, applying these equity approaches implies that Aotearoa should make significantly deeper reductions than the global average. For approaches under the equality principle, the scale of reductions needed depends heavily on what is being held equal – the allowed budget per person, or the proportionate level of reductions. Holding the proportionate reductions equal across countries is not an equitable approach and is not compatible with the international commitments Aotearoa has, as it ignores differences in national circumstances and instead requires the same proportionate reductions of developed and developing countries alike.

Emissions trajectories based on the country's relative economic capacity generally lead to deeper reductions by 2030 than the IPCC range before reaching net zero all-gases between 2040 and 2050. Emissions trajectories that account for historic responsibility follow a similar path towards net zero in the 2040s but continue to reduce emissions after net zero to address past contributions to climate change.

If the government applies any of these approaches to determine its contribution, it should be clear about the methods it uses to do so.

8.11 The form of the NDC

8.11.1 All-gas or split-gas format

The Act sets Aotearoa a split-gas domestic target for 2050. This raises a question about whether the NDC should also be expressed in a split-gas format or continue to be expressed as an all-gases target. In considering this question, it is important to keep in mind that the NDC serves a different purpose to the domestic 2050 target and that, in addition to domestic emission reductions, the NDC also includes an international contribution through funding offshore mitigation.

There are a range of options for the form of the NDC, between a fully all-gas or fully split-gas format:

1. **Fully all-gas:** maintain an all-gas headline target, with no specific reference to the domestic split gas contribution either in the headline target or elsewhere in the NDC
2. **All-gas with acknowledgement of the split-gas domestic target:** maintain an all-gas headline target but mention the domestic split gas contribution elsewhere in the NDC. This could involve either a general reference in the NDC's supporting information or specifying in detail the 2030 methane sub-target and gas-by-gas breakdown of emissions budgets one and two.
3. **All-gas with the split-gas domestic target incorporated into the headline target:** the split-gas domestic target would be brought up into the headline target statement, with the NDC also expressed in all-gas terms overall. The international contribution would remain all-gas. This could be worded in a similar way to the following: *"Aotearoa commits to reduce domestic biogenic methane emissions to 10% below 2017 levels by 2030, reduce domestic emissions of other gases by 42% on 2005 levels by 2030 and cooperate on international mitigation outcomes to reduce emissions overall to 30% below 2005 levels by 2030".*
4. **Fully split-gas:** An overall split-gas headline target, applying to both the domestic and international contributions by Aotearoa e.g. *"Aotearoa commits to reduce biogenic emissions biogenic methane to 10% below 2017 levels by 2030 and all other gases to 42% below 2005 levels by 2030".*

8.11.2 Effect of moving to a split-gas NDC

To answer the question about the appropriate form for the NDC, we need to think about what Aotearoa might want to achieve with the way the NDC is presented. Unlike the domestic 2050 target, the NDC is adopted under an international agreement, so it plays an important role in communicating Aotearoa's level of effort to the rest of the world.

Possible objectives in choosing between an all gases or a split-gas form of NDC could include:

a) Ensuring the NDC is delivered in line with 1.5°C pathways, in terms of both international and domestic contributions, including the contribution of biogenic methane emission reductions
b) Influencing the international community's expectations in order to gain more legitimacy for split-gas targets that recognise the different warming impacts of biogenic methane
c) Meeting current international expectations about the nature of developed country NDCs.

Possible objective (a) most directly relates to the Commission's task, advising on the NDC's compatibility with the 1.5°C goal. Any form of the NDC can be made compatible with a 1.5°C trajectory – it is the level and timing of emission reductions that is most relevant to compatibility rather than the form of the target. It is not necessary for the NDC to be expressed in a split-gas format to be compatible with limiting global warming to 1.5°C. Moreover, the contribution of domestic emission reductions to meeting the NDC, including the amount of domestic biogenic methane reductions, is not set by the form of the NDC. Rather, it is determined by the domestic 2030 and 2050 emission reduction targets and emissions budgets set under domestic legislation.

The other two possible objectives bring in wider issues related to foreign policy and the effectiveness of the Paris Agreement.

Expressing the NDC in a split-gas format could have the benefit of highlighting to other countries the possibility of splitting biogenic methane from other gases, in recognition of its different warming impacts. The flipside of this is that a split-gas NDC would be unlikely to meet current international expectations that a developed country's NDC should be an all-sector, all-gas absolute emission reduction target. Anything other than this is likely to be perceived as stepping back from responsibility and ambition. It could prompt a high degree of criticism from other countries and civil society groups.

It is also important to be aware that under the Paris Agreement, NDCs can only be revised to enhance ambition and each successive NDC must show progression on the previous contribution. This process of ratcheting up is informed by 5-yearly global stocktakes of collective progress towards achieving the purpose of the Agreement and its long-term goal. The first global stocktake is scheduled for 2023.

In this way, once an element is included in an NDC it becomes part of an international process where collective pressure is brought to bear to push countries for more action. This is part of the Paris Agreement's strength and why participation as a relatively small emitter is worthwhile – we play a role in building the momentum to encourage other larger countries to act.

An important implication of expressing the NDC in a split-gas format would be that it would bring domestic emission reduction targets, including the 2030 target for biogenic methane, into this collective ratcheting up process. In general, the implications of the nature and content of the NDC Aotearoa puts forward need to be very carefully considered given how this could limit flexibility in future.

Which of these objectives should be pursued and how is a matter for the country's strategy for pursuing its national interests in international climate change negotiations. For example, if Aotearoa wants to influence the international community to recognise the different warming impacts of biogenic methane, there may be a range of ways to do that and submitting a split-gas NDC may not be the best approach.

8.11.3 Metrics used to express the NDC

Metrics are used when different greenhouse gases need to be compared or aggregated together. The country's submission to the UNFCCC on its first NDC outlines that it "*applies 100-year Global Warming Potentials (GWPs) from the IPCC 4th assessment report*".

In describing the alternate NDCs based on IPCC modelling, the Commission has also used GWPs from the Fourth Assessment Report for consistency of comparison. If the Government revises the NDC,

there is a strong rationale as part of that update to move to applying the 100-year GWPs (GWP_{100}) from the IPCC's Fifth Assessment Report. This is because for emissions in years from 2021 onwards, Aotearoa's GHG Inventory reports must be prepared using that the GWP_{100} values from the IPCC's Fifth Assessment Report, in accordance with guidance adopted under the Paris Agreement (Decision 18/CMA.1).

Progress towards meeting the NDC will be tracked using the GHG Inventory. If the NDC and the GHG Inventory are calculated using different GWP_{100} values, two sets of emissions estimates will need to be calculated and reported in the Inventory. This is likely to create confusion about which set of estimates are relevant for which purpose, as well as an unnecessary administrative burden.

Moving to use of GWP_{100} values from the Fifth Assessment Report is also consistent with the Paris Agreement Decision about presenting and accounting for NDCs (Decision 4/CMA.1). This stipulates that the methods and metrics agreed for Inventory reporting are also to be used for NDCs. This guidance only compulsorily applies for second NDCs onwards, although Parties can elect to also apply it in respect of their first NDC.

Moving to the use of GWP_{100} values from the Fifth Assessment Report will have some impact on the overall ambition of the NDC, as it is calculated on an all-gas basis against emissions in a base year. The updates to GWP_{100} values in the Fifth Assessment Report will change the relative contribution of each greenhouse gas to the CO_2e amount of allowed emissions determined by a given percentage reduction against the base year. This effect should be factored into the Government's consideration of any changes it might make to the NDC.

Enabling NDC recommendation 1
Form of the NDC

a. **We recommend that the government in making its decisions should continue to define the NDC on the basis of all greenhouse gases using the most recent IPCC global warming potentials adopted by the Parties to the UNFCCC. If the government updates the NDC, it should adjust it to use the GWP_{100} values from the IPCC's Fifth Assessment Report.**

b. **We recommend that the government in making its decisions should continue to contribute to further global mitigation beyond the NDC through the provision of climate finance to developing countries and active participation in mitigation mechanisms for international aviation and shipping.**

Consultation question 22
Form of the NDC

Do you support our recommendations on the form of the NDC?

8.11.4 Alternative metrics

Different metrics are good at addressing different questions – there is no one 'correct' metric that is useful for all purposes. This is because each metric makes assumptions and judgements about what is important in order to simplify the physical differences between gases down to a quantitative relationship. Three of the most prominent metrics discussed are Global Warming Potential (GWP), Global Temperature Potential (GTP) and Global Warming Potential Star (GWP*).

GWP requires that a timeframe be set and will compare the relative total effect on radiative forcing between gases over that period – commonly 100 years is used. However, GWP excludes any considerations of the relative effects after that period. GWP values with shorter time horizons therefore put a greater emphasis on warming from short-lived gases as they exclude the effects of long-lived greenhouse gases that continue to have a warming effect beyond its time horizon. GWP also only includes the aggregate effect over the period and does not consider the temperature trajectory. This makes it less useful in analysis of pathways to a specified temperature goal.

GTP looks at the temperature effect of a pulse of gases at a defined point in the future. It ignores any effects of warming before its stated time horizon. It puts a strong emphasis on long-lived gases for a long time horizon, shifting over time to a strong emphasis on short-lived gases as the date of the temperature goal approaches. Consequently, it is not consistent through time.

GWP* compares the warming effect of a sustained rate of emitting a short-lived greenhouse gas emissions such as methane against a cumulative total of carbon dioxide emissions. It is useful for setting and comparing long-term national emission targets where cumulative emissions of long-lived gases and emission rates of short-lived gases can be traded-off between one another. However, it is less useful in national policy or in making trade-offs with short-term targets. This is because the metric compares against a rate of emissions sustained in perpetuity. Landowners making decisions about increasing or decreasing their production, and consequently their methane emissions, do not make their decisions in perpetuity, but will adjust their activity according to the economic circumstances at the time. This will make the comparison in emissions inaccurate as soon as behaviour changes.

We discuss different metrics further in the Evidence Report *Chapter 1: The Science of Climate Change.*

8.12 Planning for meeting the NDC

8.12.1 Access to offshore mitigation under the Paris Agreement

To deliver on either the existing or a strengthened NDC, the Government will need to actively pursue the development of international emissions markets with strong environmental integrity so that it can access offshore mitigation.

The landscape for international emissions markets has substantially changed from when Aotearoa last participated in these markets prior to 2015. Currently there is no centralised UN-overseen market that Aotearoa can easily access, although negotiations are continuing in this area. In the meantime, it is incumbent on individual countries to negotiate market arrangements with each other. Some countries are already making progress – Switzerland, in particular, has already signed agreements to cooperate on reducing emissions with two partner countries.

The Government has signalled it will hold itself to high standards of environmental integrity in the offshore mitigation it applies to the NDC. It is of critical importance that the Government follows through on this intent.

The need for offshore mitigation to meet the NDC also raises the question of how the purchasing will be paid for and managed. The purchasing could be undertaken by the government or by emitters and will depend in part on how Aotearoa secures access to international emissions markets.

Either way, it should be managed so that does not undermine the NZ ETS price signal which needs to remain at a level that helps drive the domestic action needed for low emissions transition.

8.12.2 Accountability and reporting on the NDC

The credibility of the NDC relies on the Government showing its intent to achieve both the domestic and international emissions reductions to meet it. Emissions budgets and the emissions reduction plan will fulfil the former, but it is not yet clear how the Government will deliver on the latter.

This raises concerns that the Government may fail to adequately plan for obtaining offshore mitigation, adding to regulatory uncertainty and increasing the risk that a potentially large amount of offshore mitigation will need to be purchased towards the end rather than spread across the entire target period. This in turn increases the chance that the NDC may not be achieved.

The Government should develop a plan for how it will access and purchase offshore mitigation and take steps to implement it. This will demonstrate a credible commitment to meeting the NDC both domestically and to the international community. It would not be responsible to wait for others to develop the markets for us, or to leave this until the late 2020s – this work needs to start now.

Internationally, Aotearoa will be held to account for the NDC through its reporting under the Paris Agreement. Governments must communicate progress towards meeting NDCs every two years, including actual and projected emissions and policies together with their effects. Aotearoa's first biennial transparency report for this purpose must be submitted by 31 December 2024 and will provide increased transparency over plans for meeting the NDC.

Biennial transparency reports are unlikely, however, to cover some information that is of interest domestically as they are prepared for an international audience. For example, they are unlikely to include how meeting the NDC, including through purchasing of offshore mitigation, may impact on public finances. The NDC is also not within scope of the Commission's annual monitoring reports, as these are about the 2050 target and emissions budgets.

There appears to be a domestic reporting gap. Given that the Government intends to require a range of businesses to disclose climate change risks in their financial reports, it is not unreasonable to expect the Government to do the same. We therefore consider that the Government should hold itself accountable for meeting the NDC through regular transparent reporting, including the disclosure of any fiscal risks that may arise from the purchasing offshore mitigation and its strategy for managing those risks.

Enabling NDC recommendation 2
Reporting on and meeting the NDC

a. **The government in making its decisions should continue to enable the NDC to be met through a combination of domestic emission reductions, domestic removals, and use of international carbon markets.**

b. **The government should report annually on how it plans to meet the NDC, including the balance of planned domestic emission reductions, removals and offshore purchasing.**

c. **The government should clearly communicate its strategy for purchasing offshore mitigation to meet the NDC and how it will manage any fiscal risks in doing so.**

Consultation question 23
Reporting on and meeting the NDC

Do you support our recommendations on reporting on and meeting the NDC? Is there anything we should change, and why?

Chapter 9: Eventual reductions in biogenic methane

9.1 What have we been asked to do?

Under section 5K of the Climate Change Response Act 2002 (the Act), the Minister of Climate Change asked the Commission to provide a report assessing biogenic methane emissions in Aotearoa. Specifically, the Minister has asked the Commission to provide:

> *"advice on the potential reductions in biogenic methane emissions which might eventually be required by New Zealand as part of a global effort under the Paris Agreement to limit the global average temperature increase to 1.5° Celsius above preindustrial levels.*
>
> *In providing this advice the Commission must:*
>
> *a. leave aside considerations on the current target range for biogenic methane specified in section 5(Q)(1)(b) of the CCRA;*
> *b. consider the available scientific evidence on the global biogenic methane emissions reductions likely to be required to limit global average temperature increase to 1.5° Celsius above pre-industrial levels;*
> *c. consider New Zealand's potential contribution to global efforts to limit biogenic methane emissions, reflecting its national circumstances; and*
> d. *consider a range of potential scenarios for economic, social and demographic changes which might occur in New Zealand and globally until 2100."*

The full text of the request and the terms of reference can be found on our website at https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/reviewing-new-zealands-nationally-determined-contribution-and-biogenic-methane/

We have interpreted part (a) to mean the Commission should not provide advice on the target range for biogenic methane emissions set for 2050. This is consistent with section 5T of the Act that sets out the limited circumstances when the Commission can review targets. As there has not been a significant change in circumstances that would justify changing the 2050 target since it was set, the Commission would be unable to recommend a change to the 2050 target.

We have structured the analysis in this chapter around the considerations (b) to (d) above, drawing findings under each.

Understanding these elements requires a mixture of quantitative and qualitative analysis. There are no exact numbers that can come out of a formula. Judgements are required regarding trade-offs, where to prioritise efforts and how the impacts and consequences of acting on climate change are distributed within Aotearoa across people, place and time. Judgement is also needed to consider opportunities and trade-offs between Aotearoa and the rest of the world. This brings in concepts of equity and fairness.

To complement our analysis, we also provide a summary of previous analyses that have looked at potential reductions in methane for Aotearoa in Appendix 1.

In this chapter we talk about methane, biogenic methane and agricultural methane. Distinguishing between these three terms is important. Methane refers to all forms of methane emitted, including

methane from agriculture, waste and fossil fuel extraction. Biogenic methane refers to methane from agriculture and waste. Agricultural methane refers solely to methane from agriculture.

While the request from the Minister requires us to consider the eventual reductions in biogenic methane, analysis that we have drawn on, including by the Intergovernmental Panel on Climate Change (IPCC), refers to agricultural methane. Although these are slightly different, in Aotearoa agricultural methane makes up 88% of biogenic methane. So, for the purposes of our analysis we have applied analysis for agricultural methane as a proxy for biogenic methane. The IPCC does not separately identify biogenic methane from waste.

9.2 Consideration 1: What global reductions of biogenic methane emissions might be required to limit warming to 1.5°C?

Our first consideration is of the scientific evidence and analysis regarding what global reductions in biogenic methane are likely to be required to limit warming to 1.5°C. This analysis is based on the IPCC special report on 1.5°C.

The long-term reduction in global biogenic methane emissions needed to limit global warming to 1.5°C depends on a number of factors. All the greenhouse gases have different warming properties. Three key factors affect the contribution of different gases to global warming: how much is emitted, how long it stays in the atmosphere and the strength of its warming effect while its in the atmosphere. Table 9.1 summarises these for carbon dioxide, methane and nitrous oxide – the three most important greenhouse gases in terms of their contribution to global warming. For further details, see *Chapter 1: The science of climate change* in the Evidence Report.

Table 9.1: Properties of carbon dioxide, methane, and nitrous oxide

	Quantity of emissions	**Duration in the atmosphere**	**Strength of warming effect**
Carbon dioxide	Comprises the majority of global emissions (~80%) Largely from fossil fuel combustion. Also from deforestation. Increasing by more than 1% per year over the last decade.	Long-lived gas that can last for centuries or milennia in the atmosphere.	Relatively small impact on per-molecule basis, but large effect with accumulation in the atmosphere over time. Responsible for the majority of human-driven warming.
Methane	Accounts for the second largest share of global emissions (~20%). Mostly from fossil fuel extraction, distribution and combustion. Biogenic methane largely stems from ruminant agriculture, rice cultivation and organic waste decomposition.	Short-lived greenhouse gas. Breaks down in the atmosphere after around 12 years.	Powerful warming effect on a per-molecule basis. Responsbile for about one-fifth of all human-driven warming. Some longer-term indirect warming effects through climate-carbon cycle feedbacks that endure after atmospheric decay.
Nitrous oxide	Relatively small quantity of emissions (<5%). Mainly from industrial processes, agricultural soils, manure management and wastewater.	Long-lived gas with warming dynamics similar to carbon dioxide over decadal to centennial timeframes.	Powerful warming effect on a per-molecule basis. Accumulates in the atmosphere over time.

The combination of these factors - the quantity of emissions, their duration in the atmosphere and the warming effect of the gas – all interact with each other to produce any given temperature. This means the reductions in biogenic methane required to meet the 1.5 ^{o}C temperature goal are dependent on the levels of other greenhouse gas emissions and emissions removals.

The global reductions in biogenic methane required to stay below 1.5 ^{o}C will depend on the level of carbon dioxide and nitrous oxide emissions over the next century. Therefore, it is not currently possible to know for certain what reductions in biogenic methane will be required. However, it is

possible to identify the ranges of reductions of the different gases that mean it is likely warming will be limited to 1.5 ºC above pre-industrial levels.

9.2.1 Global pathways compatible with limiting warming to 1.5°C

The IPCC has produced a large number of possible emissions reduction scenarios that limit warming to 1.5 ºC. Each scenario has been designed to reach the temperature goal in the lowest-cost way possible. They use current understanding of the relative costs of reducing emissions using known technologies. They do not include any direct emissions reduction technologies applying to biogenic methane. The scenarios contain a range of assumptions about economic growth, technology developments and lifestyles.

The IPCC modelling found 1.5°C compatible scenarios under a broad range of possible futures, with different economic and demographic developments. All of the 1.5ºC compatible scenarios are assume global population and food demand will increase over the course of the century, although some of the scenarios expect both population and food demand to drop by 2100.

Despite their common underlying features, the IPCC scenarios do differ in whether they always stay within the 1.5°C goal, with some scenarios allowing the temperature to overshoot 1.5°C before cooling down again later in the century.

The scenarios with little or no overshoot have been estimated to be the most likely to deliver the best overall social, economic and environmental outcomes. Higher levels of overshoot are associated with higher cumulative emissions and greater climate impacts and adaptation needs. Scenarios with higher overshoot also rely on high levels of emissions removal technologies such as carbon capture and storage that may not be feasible. We have therefore chosen to only consider scenarios with no or limited overshoot.

Each of these different scenarios results in different rates of emissions reductions for each greenhouse gas. The interquartile range of emissions reductions ranges for carbon dioxide, agricultural methane and nitrous oxide in these scenarios are summarised below in Table 9. We have used the interquartile range as it excludes more extreme model results that are less likely to be feasible. The emission reductions here are associated with scenarios with a 50-66% probability of limiting warming to 1.5ºC.

Scenarios closer to the lower quartile range have greater methane reductions and are less likely to overshoot the 1.5°C goal. Conversely, scenarios closer to the upper quartile range have smaller methane reductions and are more likely to overshoot the 1.5°C goal and rely on carbon dioxide removals in the latter part of the century to bring temperatures back down. The IPCC has noted that relying on large scale carbon dioxide removals represents a major risk that the world will not be able to limit warming to 1.5°C.

Table 9.2: Change in greenhouse gas emissions in IPCC model scenarios with no or limited overshoot.

	Percentage change relative to 2010		
	2030	2050	2100
Net carbon dioxide emissions	-40 to -58%	-94 to -107%	-121 to -136%
Agricultural methane emissions	-11 to -30%	-24 to -47%	-37 to -60%
Agricultural nitrous oxide emissions	+3% to -21%	+1% to -26%	-6 to -39%

Note: in some of the scenarios, nitrous oxide stays the same or increases out to 2050. This reflects the lack of mitigation options that exist for this gas, and the fact that some nitrous oxide emissions are an inevitable by-product of agricultural practices.

The scenarios that had the greatest chance of limiting warming to 1.5°C, all required rapid emissions reductions of greenhouse gases between now and 2030 and then slower reductions out to the end of the century. All these scenarios have several other features in common:

- Net emissions of carbon dioxide and other greenhouse gases peak in the 2020s and then rapidly reduce through the 2030s and 2040s.
- Emissions of methane reduce significantly through the next 20 years, but do not need to reach zero by 2050 or 2100, due to the short-lived nature of the gas.
- Emissions of nitrous oxide peak in the 2020s and then reduce, but do not reduce to zero due to the difficulty of eliminating nitrous oxide emissions from agriculture.
- Emissions of long-lived greenhouse gases will be near zero by 2050. Most pathways have some remaining gross emissions in 2050 from hard-to-abate sectors. This includes things like carbon dioxide from cement manufacturing. As a result, emissions removals are required to ensure emissions reach and remain at net zero.

Overall, the IPCC scenarios show that the at least a 37% reduction in agricultural methane is required to have a 50-66% chance of limiting warming to 1.5°C by 2100. Simply maintaining the current level of warming from methane is not enough, as it would require the world to reach net zero carbon dioxde by 2030 to keep warming below 1.5°C. We consider this to be infeasible and consequentially that the global warming contribution from methane must be reduced if the 1.5°C temperture goal is to be achieved.

The reductions in methane modelled by the IPCC were against 2010 levels. The current biogenic methane targets for Aotearoa are set against 2017 emission levels. As the country's biogenic methane emissions in 2010 and 2017 differed by less than 1%, the percentage reduction is the same when presented against either year. From here we present reductions in biogenic methane against 2017 levels for ease of comparison with the existing targets.

9.3 Consideration 2: What reductions of biogenic methane could Aotearoa make to contribute to limiting warming to 1.5 degrees, recognising national circumstances?

Our second consideration is of the potential contribution Aotearoa could make to reducing biogenic methane emissions, in light of national circumstances. We analyse the sources of biogenic methane emissions, the opportunities for Aotearoa to reduce biogenic methane emissions and key aspects of national circumstances that affect these.

9.3.1 The sources of biogenic methane in Aotearoa

In 2018, gross emissions of biogenic methane were about 1.34 Mt CH_4 in Aotearoa. Agriculture is the largest source of biogenic methane at around 88%, with the remainder from waste.

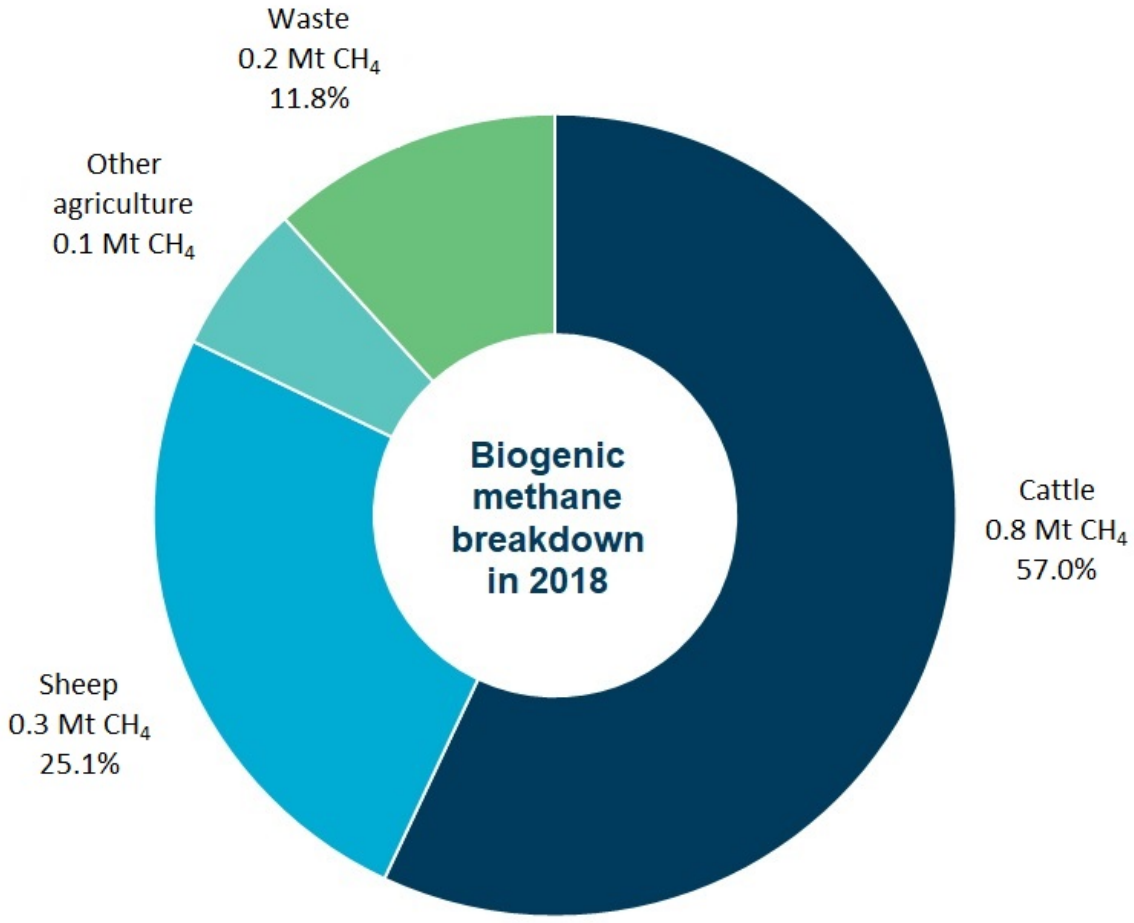


Figure 9.1: Aotearoa biogenic methane emissions by sector 2018

Agriculture

Aotearoa has a well-developed agricultural sector that makes up a much larger part of the economy than in many other developed nations. Around 9.7 million hectares of the 26.8 million hectares in total in Aotearoa are used for pastoral agriculture. The main agricultural products by volume are meat, dairy products and wool, with the vast majority being exported. Figure 9.2 shows the breakdown of historic biogenic methane emissions from agriculture and those projected under current policies

(termed the Current Policy Reference case). Dairy, sheep and beef farming account for the majority of these emissions, although the former has increased historically while the latter has decreased. For more information of these trends and the Current Policy Reference case see Chapter 7: Where are we currently heading? in the Evidence Report.

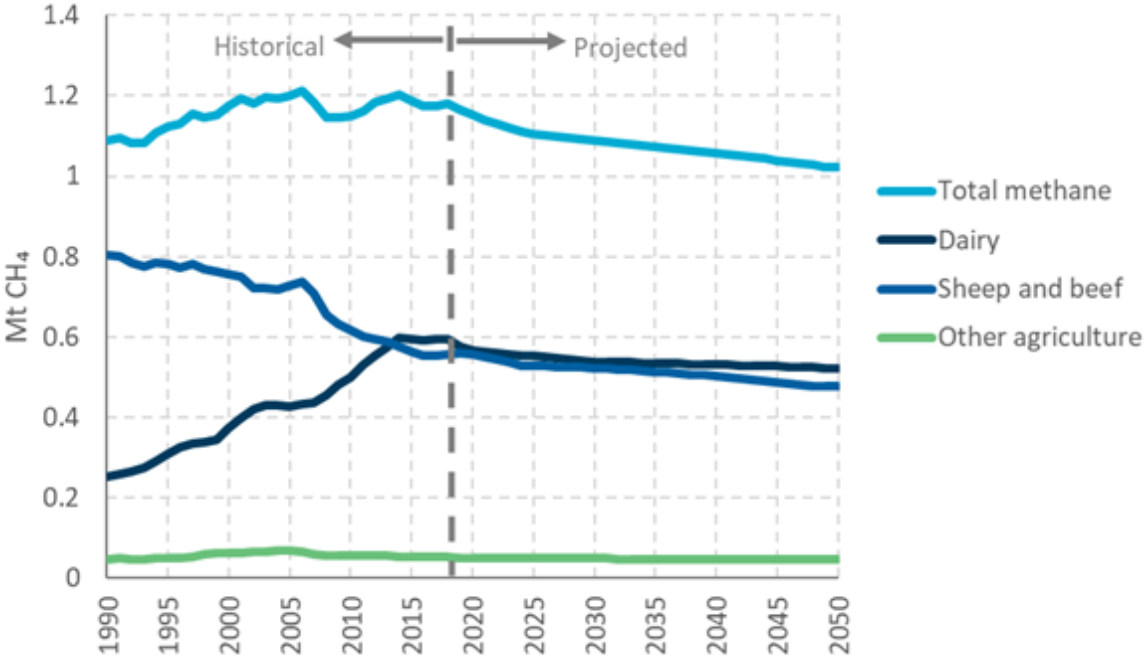


Figure 9.2: Historic and Current Policy Reference case biogenic methane emissions from agriculture

Waste

Aotearoa has a high per capita waste production and resulting methane emissions compared to many other developed countries. Figure 9.3:3 shows the historic biogenic methane emissions from waste and those projected under current policies. The main sources of these emissions are landfills, some of which use landfill gas capture (LFG) technology and farm fills. For more information on these trends and the Current Policy Reference case see *Chapter 7: Where are we currently heading*? in the Evidence Report.

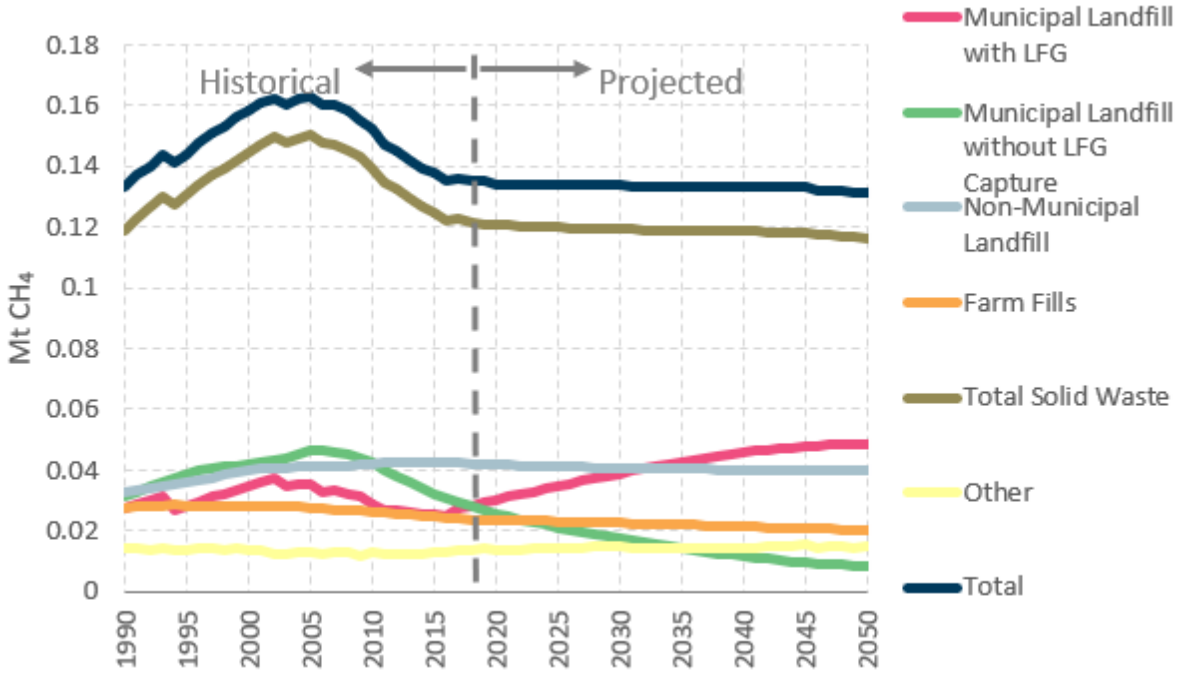


Figure 9.3: Historic and Current Policy Reference case biogenic methane emissions from waste

9.3.2 How much could biogenic methane emissions be reduced?

As part of our analysis, we have identified a number of opportunities to reduce biogenic methane emissions from agriculture and waste.

Agriculture

Biogenic methane emissions from agriculture are largely a function of the amount of feed an animal eats. Reducing methane from agriculture therefore relies largely on changes to farm management practices that reduce total feed being produced and consumed. Adjusting stocking rates, supplementary feed and other inputs can improve emissions-efficiency on-farm. Changing land use to lower emissions activities such as horticulture, could also reduce methane emissions.

New technologies also offer potential for reducing methane emissions. Selective breeding of sheep to be low emitting is already possible. This could have a significant impact over time if these traits are bred through the national flock. Research into the potential for breeding low emissions cattle is ongoing. Other promising emission reducing options currently being researched and developed include a methane inhibitor that would be compatible with the country's pastoral farming system and a methane vaccine that could supress methane production.

If Aotearoa were to pioneer the development of these methane technologies, we would also be able to make significant contributions to global emissions reductions through helping disseminate them internationally.

Waste

We have identified three broad opportunities for reducing biogenic methane emissions from waste. These are:

- reducing total waste generation by improving resource efficiency and supporting consumers to reduce household waste
- increasing the amount of waste we divert from landfills by, for example, turning what would have gone to landfill as 'food waste' into compost
- ensuring that landfills that receive organic waste have high efficiency landfill gas capture systems, that capture the majority of the methane being produced.

These opportunities are discussed in more detail in *Chapter 4d: Reducing emissions – opportunities and challenges across sectors – Waste* of the Evidence report.

9.3.3 Overall

Our analysis to inform emissions budgets indicates that it is possible to reduce total biogenic methane emissions by between 12-26% below 2017 levels by 2030 and 25-59% below 2017 levels by 2050 through reducing biogenic methane emissions from both agricultural and waste.

The lower ends of these reductions (12% by 2030 and 25% by 2050) can be achieved using currently available practices and technologies. The development of new technologies such as a methane inhibitor would provide greater flexibility and unlock the upper range of reductions. Reaching the higher range of biogenic methane reductions (26% by 2030 and 59% by 2050) without new technology would likely require reduced agricultural production from livestock and land use change. For more details on our scenarios and projected emissions reduction pathways see *Chapter 3: The path to 2035.*

After 2050, there is a high level of uncertainty around what opportunities to reduce methane may become available and how effective they will be. This makes it difficult to estimate what levels of reductions are likely to be achievable.

9.3.4 Important national circumstances that relate to potential biogenic methane emissions reductions

There are several important national circumstances that should be taken into account when considering biogenic methane emissions reductions in Aotearoa.

Firstly, there are obligations to uphold the principles of partnership, protection,and participation under the Te Triti o Waitangi. As discussed in *Chapter 5: The impacts of emissions budgets on New Zealanders*, Māori-collectives hold approximately $13 billion in assets in the primary industries with potential for further development. Any targets and supporting policies should avoid compounding historical disadvantages.

Secondly, Aotearoa has a responsibility as a developed country to take a leading role in reducing greenhouse gas emissions under the UNFCCC and principles of “common but differentiated responsibilities”. This responsibility is discussed further in *Chapter 8: The global 1.5°C goal and Nationally Determined Contribution* for Aotearoa. The responsibility means that Aotearoa must do more than the global average in terms of reducing emissions to meet fixed temperature targets. It is

based on a range of factors including historical responsibility for greenhouse gas emissions and present capacity to reduce them.

Thirdly, Aotearoa is one of the most greenhouse gas efficient producers of red meat and dairy products in the world. The climate, topography, rainfall patterns and soil types make much of the country suited to pastoral farming. Combined with access to international markets and the need to compete with subsidised international producers, this has helped drive improvements in efficiency across Aotearoa's pastoral production systems. In a low emissions future where red meat and dairy products continue to be consumed there is good reason to believe that production in Aotearoa would still be globally competitive.

Internationally, Aotearoa leverages its expertise in efficient agricultural production to support emissions reductions and sustainable development in other countries. The Government's role in founding and funding the Global Research Alliance on Agricultural Greenhouse Gases is a key example of this. Its ability to credibly lead such initiatives is enabled and underpinned by the country's innovative ecosystem of farmers, researchers and agriculture experts. The value of these international contributions should also be considered in assessing biogenic methane emissions reductions.

Fourthly, the large role played by agriculture in the economy of Aotearoa should also be considered when considering reductions in biogenic methane. Reductions in biogenic methane that come at significant cost to agricultural industries could have negative social and economic consequences as discussed in *Chapter 5: The impacts of emissions budgets on New Zealanders.* At the same time, the long-term viability of these industries may require reductions in biogenic methane to maintain access to international markets and to meet evolving domestic and international consumer preferences. This is discussed more in the next section of this chapter.

On balance, we consider that the country's national circumstances do not provide sufficient reason to reduce biogenic methane emissions by less than other developed countries in contributing to the global 1.5 °C goal.

9.4 Consideration 3: What social, economic and demographic changes may occur?

Our third consideration is of the the key social, economic and demographic factors and changes that may occur until 2100 – both within Aotearoa and globally – that could affect the contribution Aotearoa makes to biogenic methane emissions reductions. This section steps through some of the key trends that we have incorporated into our analysis.

9.4.1 Population growth and food demand

The world population is expected to continue to increase over the century, reaching more than 9 billion people by 2050. The growth in the global population is expected to slow over the century, although by how much is uncertain. Estimates used in the IPCC 1.5°C report suggest the global human population is expected to increase to between 9-11 billion by the end of the century.

This growing population will need to be fed. As the majority of meat and dairy produced in Aotearoa is exported, changes in global demand for these products could have important consequences for biogenic methane emissions.

A number of estimates exist for changes in food demand, which include both an increase in total amount and changes in the type food required. The Food and Agriculture Organization of the United

Nations (FAO), estimated the need to double global food production by 2050 to meet the expected demand of around 9.7 billion people, although this need is not evenly distributed around the world. The FAO also predicts increasing demand for animal products, fruit and vegetables and more processed foods, due to a combination of increasing wealth and greater urbanisation.

The majority of global population growth and increased food demand is expected to occur in regions that are not currently major export destinations for Aotearoa, such as sub-Saharan Africa and South Asia. Most of the dairy and meat exports are currently targeted at middle-class and premium consumers in China, Europe, and North America. In addition to global population growth, incomes in many developing countries are expected to rise and bring with it an expanded global middle-class. There is a clear relationship between increasing incomes and consumption of meat and dairy products.

In a future where meat and dairy products remain in high demand, there is good reason to expect Aotearoa can continue providing these to the world if Aotearoa can maintain and strengthen its position as one of the lowest emissions producers.

9.4.2 Demand for low emissions agricultural production

Both globally and domestically, there are growing concerns about the environmental impact of food – including for greenhouse gases. In response, a number of agricultural accreditation and sustainability schemes have been established, such as Toitū Envirocare's farm carbon certification programme. A number of producers in Aotearoa have already signed up to such schemes.

The rapid development of alternative protein industries has built on consumer preferences for environmentally sustainable products. These include plant-based protein products and synthetic meats grown in laboratories, many of which have lower emissions, water and land use footprints than conventional animal agriculture products. The rapid expansion of these industries, which often promote themselves as more sustainable alternatives to animal agriculture, could compete with agricultural exports.

Overall, the impact of growing alternative protein markets remains uncertain but appears to push in the direction of reducing methane emissions from agriculture, either through reduced demand and production or through the need reduce emissions per unit of product to help maintain a niche market.

Rising consumer expectations could favour producers in Aotearoa if consumers place a premium on lower emissions varieties of the products they already consume. Red meat and dairy products from Aotearoa are already some of the least emissions intensive in the world. But, shifts in preferences for low emissions products could negatively impact exports if preferences move away from these products entirely. A Gallup poll showed almost 1 in 4 Americans reduced their meat consumption in 2019, with environmental concerns being the second ranked reason after health. These trends are likely to be stronger in Europe and North America than in emerging markets in Asia and Africa.

9.4.3 Other environmental challenges:

Other environmental challenges are related to waste and agriculture in Aotearoa. These include freshwater quality, soil health, biodiversity loss and soil erosion. The growing pressure of these challenges combined with efforts to address them may have important consequences for efforts to reduce methane emissions.

Freshwater quality has been a particular focus of attention over the last few decades as large areas of sheep/beef and plantation forestry were converted to dairy. Although rates of nitrogen and phosphorus and pathogen loss into waterways varies with land management, rates of nutrient loss into waterways are generally higher from dairy operations than from sheep and beef farming and forestry. In some parts of the country where there have been large scale land conversions, such as Canterbury, Southland and the central North Island, indicators of water quality and ecological health have significantly declined.

Declining freshwater quality is a threat to many native species, this is also exacerbated by the clearance and conversion of native habitats – such as forests, wetlands and natural grasslands – often into pasture.

Waste management is also associated with other environmental challenges. While modern, engineered landfills mitigate some of the environmental impacts associated with their construction and management, they have wider ecological effects which may lead to landscape changes, loss of habitats and displacement of fauna. Waste leaching, particularly from older landfills, can also contaminate nearby soils and aquifers.

Changes in the way land and waste are managed could also have impacts on biogenic methane emissions. For example, limitations on land use change to dairy to protect water quality are likely to limit additional methane emissions, while initiatives that promote diversion of waste from landfills or the retirement of erosion prone land from pastural farming may result in reduced methane emissions.

9.4.4 Overall

Overall we assess that there are good reasons for Aotearoa to expect to reduce biogenic methane emissions by at least the global average as part of contributing to the global 1.5°C goal. The country's relatively efficient food production and a growing global population suggests that Aotearoa might be expected to take a smaller than average reduction in biogenic methane. However other factors, such as increasing awareness of the environmental impact of animal based products, and local environmental challenges, would suggest that Aotearoa could make a greater than average reduction in biogenic methane.

9.5 Findings

In summary, we make the following findings in relation to each of the considerations requested by the Minister.

Consider the available scientific evidence on the global biogenic methane emissions reductions likely to be required to limit global average temperature increase to 1.5 °C above pre-industrial levels

The global reductions in biogenic methane required to stay below 1.5 °C would depend on the level of carbon dioxide and nitrous oxide emissions over the next century. Therefore, it is not currently possible to know for certain what reductions in biogenic methane will be required. However, it is possible to identify the ranges of reductions of the different gases that mean it is likely warming would be limited to 1.5 °C above pre-industrial levels.

Overall, the IPCC pathways show that the at least a 37% reduction in agricultural methane is required to limit warming to 1.5°C by 2100. Simply maintainig the current level of warming from methane is not

enough, as it would require the world to reach net zero carbon dioxide by 2030 to keep warming below 1.5°C. We consider this to be infeasible and consequentally that the global warming contribution from methane must be reduced if the 1.5°C temperture goal is to be achieved.

Consider New Zealand's potential contribution to global efforts to limit biogenic methane emissions, reflecting its national circumstances

Our scenario analysis indicates that it is possible to reduce total biogenic methane emissions by between 12-26% below 2017 levels by 2030 and 25-59% below 2017 levels by 2050 through reducing biogenic methane emissions from both agricultural and waste.

The lower ends of these reductions (12% by 2030 and 25% by 2050) can be achieved using currently available practices and technologies. The development of new technologies such as a methane inhibitor would provide greater flexibility and unlock the upper of range reductions.

Reaching the higher range of biogenic methane reductions (26% by 2030 and 59% by 2050) without new technology would likely require reduced agricultural production from livestock and land use change. For more details on our scenarios and projected emissions reduction pathways see *Chapter 3: The path to 2035.*

On balance, we consider that national circumstances do not provide sufficient reason for Aotearoa to reduce its biogenic methane emissions by less than other developed countries in contributing to the global 1.5°C goal.

Consider New Zealand's potential contribution to global efforts to limit biogenic methane emissions, reflecting its national circumstances and local and global economic, social, and demographic trends

The country's relatively efficient food production and a growing global population suggests Aotearoa might be expected to take a smaller than average reduction in biogenic methane. However other factors, such as increasing awareness of the environmental impact of animal based products and local environmental challenges, would suggest that Aotearoa could make a greater than average reduction in biogenic methane. Overall we assess that there are good reasons for Aotearoa to expect to reduce biogenic methane emissions by at least the global average as part of contributing to the global 1.5°C goal.

9.5.1 Where does this get us?

Our assessment of the IPCC scenarios has identified the range of global reductions in biogenic methane that are compatible with limiting warming to 1.5°C. These are represented by the interquartile range of modelled pathways. The pathways in the top half of this range are the ones with greater reductions in methane and less reliance on unproven carbon removal methods. They have also been estimated to be the most likely to deliver the best overall social, economic and environmental outcomes.

Fundamentally, it is our judgement that there is no reason to anticipate that Aotearoa would be expected to contribute less that then middle of the IPCC range for reductions of biogenic methane.

Biogenic methane recommendation 1

Reductions in biogenic methane that might be required of Aotearoa in the future as part of a global effort to limit warming to 1.5°C

We advise that the reductions in emissions of biogenic methane that Aotearoa may eventually need to make as part of a global effort to limit temperature increase to 1.5°C could be between 49% and 60% below 2017 levels by 2100.

Our analysis suggests that the successful development of a methane vaccine or inhibitor suitable for pastoral systems would help reduce the country's methane emissions by more than 50%.

There is a role for agricultural products from Aotearoa in a low emissions future, both for the nutrition it can provide and the valuable natural products such as wool. However, to create and maintain the market for those products, Aotearoa needs to be able to demonstrate their genuine climate, environmental, social and cultural credentials.

Consultation question 24

Biogenic methane

Do you support our assessment of the possible required reductions in biogenic methane emissions?

Glossary of Te Reo Māori Terms

Te reo Māori	English translation
Hapū	Kinship group, comprised of whānau who share a common ancestry.
Haukāinga	Home people, people from the pā.
iwi	Extended kinship group, often referring to a large group of people descended from a common ancestor and associated with a distinct territory. Also means bone.
Kaitiaki (verb)	Guardian/steward. Tangata whenua, whānau, hapū, iwi exercising responsibilities of kaitiakitanga inherited through whakapapa Māori.
Kaitiakitanga (noun)	Guardianship/stewardship, tangata whenua, whānau, hapū, iwi holding this responsibility.
Kawa	Custom/protocol the foundational principle underlying tikanga (values/principles), ritenga (behaviours/enactments) and āhuatanga (attributes, traits, characteristics).
Kotahitanga	Unity, inclusive and collective action.
Manaakitanga	Care, respect, hospitality. Enhancing the mana of others.
Mana Motuhake	Prestige, power, authority. Power, influence. The spiritual power and authority to enhance and restore tapu.
Mana whenua	Territorial/occupation rights over land and associated resources.
Mātauranga Māori	Māori knowledge systems.
Papakāinga	Home, village, residence, in contemporary terms refers to housing, or housing development constructed on the concept of the kāinga/pā.
Rangatira	Chief, leader, representative/s with authority.
Rangatiratanga	Chieftainship, right to exercise authority.
Taiao/Te Ao Tūroa	Natural world.
Tangata whenua	People of the land.
Taonga	Items of value; includes resources/access to resources. In Te Ao Māori taonga incorporates a range of social, economic and cultural aspects such as te reo (Māori language), wāhi tapu (sacred sites), waterways,

Te reo Māori	English translation
	fishing grounds, mountains and place names. Children and future generations may also be regarded as taonga.
Taonga tuku iho	Heirloom/cultural property handed down.
Tiaki (verb)	Guardian/steward. To safeguard/protect.
Tiakitanga (noun)	Guardianship, caring of, protection.
Tikanga	Customary system of values.
Tino rangatiratanga	Sovereignty.
Tūrangawaewae	Place of standing, place of belonging.
Utu	Reciprocity.
Waiora	Wellbeing.
Wairua	Eternal essence of being, source energy, spirit.
Wairuatanga	Spirituality.
Wānanga	Centre for knowledge development/deep learning/Māori tertiary institution.
Whakapapa	Genealogy, to layer.
Whānau	Family/extended family unit.
Whānaungatanga	Kinship, sense of family connection- a relationship through shared experiences and working together which provides people with a sense of belonging. It develops as a result of kinship rights and obligations, which also serve to strengthen each member of the kin group.
Whenua	Land. Also means placenta.

Technical Glossary

2050 target	The target set out in the Climate Change Response Act for Aotearoa to: • reduce emissions of greenhouse gases, other than biogenic methane, to net zero by 2050 and beyond. This relates to emissions of carbon dioxide, nitrous oxide, non-biogenic methane and F-gases (hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride). • reduce biogenic methane emissions by at least 10% by 2030 and 24-47% by 2050 and beyond, compared to 2017 levels.
Adaptation	Actions that can help people or natural systems adjust to the actual or expected impacts of climate change. Actions can be incremental and temporary in their effect or transformational by changing systems and their functions, depending on the scale and pace of change and what is at stake.
Biogenic methane	Methane emissions resulting from biological processes in the agriculture and waste sectors.
Biomass	Material originating from living organisms. Some forms of biomass in the environment store significant amounts of carbon. Solid biomass such as wood chips, wood pellets and briquettes can be used as fuel in residential, commercial and industrial situations.
Climate Change Response Act 2002	The Act that provides a legal framework to enable Aotearoa to meet its international obligations under the United Nations framework Convention on Climate Change and the Kyoto Protocol. The Act also provides for the implementation of the New Zealand Emissions Trading Scheme (NZ ETS) and the synthetic greenhouse gas levy.
Climate resilience	Climate resilience is the ability to anticipate, prepare for, and respond to the impacts of changing climate, including those that we know about and can anticipate and those that occur as extreme events. This includes planning now for sea level rise and more frequent flooding. It is also about being ready to respond to extreme events like forest fires or extreme floods, and to trends in precipitation and temperature that emerge over time like droughts.
CO_2e	Carbon dioxide equivalent. This is a way to describe different greenhouse gases on a common scale that relates the warming effect of emissions of a gas to that of carbon dioxide. It is calculated by multiplying the quantity of a greenhouse gas by the relevant global warming potential.

Deforestation	The conversion of forest land to another use such as grazing. In greenhouse gas emissions accounting and policy relevant to Aotearoa, deforestation is defined as clearing forest and not replanting within four years. It does not include harvesting where a forest replanted.
Dry year	In Aotearoa, hydro lakes only hold enough water for a few weeks of winter energy demand if inflows (rain and snow melt) are very low. When inflows are low for long periods of time, hydro generation is reduced and the system relies on other forms of generation such as natural gas and coal. These periods of time are often colloquially referred to as 'dry years'.
Embodied emissions	The sum of emissions involved in making a product, sometimes termed the "carbon footprint".
Emissions	Greenhouse gases released into the atmosphere. The Climate Change Response Act 2002 covers the following greenhouse gases: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride.
Emissions budget	The cumulative amount of greenhouse gases that can be emitted over a certain period. In the Climate Change Response Act 2002, emissions budgets are the total amount of all greenhouse gases (expressed as a net amount of carbon dioxide equivalent) that can be released over a five-year period (or four years in the case of 2022-2025).
Emissions leakage	Emissions leakage would occur if efforts to reduce emissions in one location caused an increase in emissions somewhere else so that global emissions overall do not reduce. Emissions leakage risk is created by the uneven implementation of climate policies around the world.
Emissions reduction plan	A plan setting out the policies and strategies for meeting an emissions budget, as required by the Climate Change Response Act 2002.
Exotic plantation forests	Intentionally planted forests consisting of non-native species, such as pine.
F-gases	Fluorinated gases, such as hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.
Free allocation	The distribution of emissions units without cost to specific businesses by the government.
Global Warming Potential (GWP)	A factor relating the warming effect of a tonne of emissions of a particular greenhouse gas to those of a tonne of carbon dioxide emissions.

Greenhouse gases	Atmospheric gases that trap heat and contribute to climate change. The gases covered by the Climate Change Response Act 2002 are carbon dioxide (CO_2), methane (CH4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).
Gross emissions	Gross emissions include total greenhouse gas emissions from agriculture, energy, industrial processes and product use (IPPU) and waste. Greenhouse gas emissions and removals from land use, land use change and forestry (LULUCF) are excluded.
Kyoto Protocol	An international treaty under the UNFCCC that deals with emissions limitation or reduction commitments for ratifying developed (Annex 1) countries.
Long-lived gases	Greenhouse gases that have a long lifetime in the atmosphere, i.e. they persist in the atmosphere for without breaking down for multi-decadal, centennial or millennial timeframes. For ease of presentation, this report refers to all greenhouse gases other than biogenic methane collectively as long-lived gases, although this includes small amount of other short-lived gas emissions (non-biogenic methane and certain fluorinated gases).
Methane inhibitors and vaccines	Chemical compounds that reduce the production of methane in animals' rumen (stomachs). They typically do this by targeting enzymes that play a key role in the generation of methane.
Mitigation	Human actions to reduce emissions by sources or enhance removals by sinks of greenhouse gases. Examples of reducing emissions by sources include walking instead of driving or replacing a coal boiler with a renewable electric powered one. Examples of enhancing removals by sinks include growing new trees to absorb carbon, or industrial carbon capture and storage activities.
Mt	Megatonnes (million tonnes)
Nationally determined contribution (NDC)	Each country that is party to the Paris Agreement must define its contribution to achieving the long-term temperature goal set out in the Paris Agreement. The first NDC adopted by Aotearoa is a target to reduce greenhouse gas emissions by 30% below 2005 levels by 2030.
Net emissions	Net emissions differ from gross emissions in that they also include emissions from the land use, land use change and forestry (LULUCF) sector as well as removals of carbon dioxide from the atmosphere, for example due to the growth of trees.

NZ ETS	New Zealand Emissions Trading Scheme.
Organic waste	Waste containing organic matter that decays to create methane emissions.
Paris Agreement	An international treaty under the UNFCCC to address climate change after 2020.
Post-1989 forests	New forest established after 31 December 1989 on land that was not forest at that date.
Pre-1990 forests	Forest or shrub land established before 1 January 1990.
UNFCCC	United Nations Framework Convention on Climate Change. This is the major foundation global treaty focused on climate change that was signed in 1992 at the Earth Summit in Rio de Janeiro.

Appendix 1: What other studies of methane reductions for Aotearoa have been conducted?

Over recent years there have been a series of estimates of the implications of different reductions of the country's biogenic methane. Two studies have looked at what reductions and by when, may be needed to make sure Aotearoa adds no additional warming from the gas.

In 2018, the Parliamentary Commissioner for the Environment estimated the warming from methane under two different situations. The analysis showed that if emissions of methane were held constant at 2016 levels, this would lead to an additional 10-20% of warming by 2050 and another 25-40% by 2100. This was primarily the result of inertia in the climate system that continues to respond to the longer lasting warming effects from past methane emissions.

Given these persistent warming effects, the reduction of methane that would be required to achieve no additional warming given current levels of emissions was calculated to be at least 10-22% below 2016 levels by 2050 and 20-27% by 2100. The range reflected differences in global action, from action sufficient to keep temperatures well below 2 ^{o}C, to global action that would lead to between 2 and 3 ^{o}C of warming. The lower end of this estimate is based on an assumption that the world does **less** to reduce methane, while the upper end of the range is based on the assumption that the rest of the world does more to reduce methane.

As part of a submission on the Zero Carbon Bill in 2018, Allen et al. also analysed what reductions in biogenic methane could ensure Aotearoa contributed no further warming from this gas. They applied the GWP* metric in their analysis, which is designed to specifically account for the temperature effects of methane emissions over time.

Using this approach, an estimated reduction in biogenic methane of 0.4% per year would prevent any further warming, which equated to a total reduction of about 10% by 2050. This estimated level of reduction was fairly consistent whatever reductions in biogenic methane other countries made. As it was not the purpose of the submission, the authors did not offer any specific reductions in methane that would be compatible with limiting warming to 1.5 degrees.

In 2019, a third study looked to answer that question by asking what warming would Aotearoa contribute if the targets in the Climate Change Response Act were met? The study modelled the warming caused by reaching net-zero long-lived gases by 2050, along with the effect of reaching either the 24% and 47% reduction in methane. The study concluded:

> *"Reducing fossil carbon dioxide and nitrous oxide emissions to net zero by 2050 would result in additional warming from those gases combined above current levels until that time. After 2050, their contribution to warming would stabilise and decline very slowly if emissions remain constant after 2050 levels. However, if biogenic methane emissions remain at current levels, New Zealand's overall contribution to climate change would still continue to increase well beyond 2050."*

Figure A.1 from Reisinger and Leahy (2019) shows that if biogenic methane emissions were reduced by 10% below 2017 levels by 2030 and by 24% by 2050, this would result in some additional warming from all emissions until approximately 2050. If emissions of all gases then continue at the same level after 2050, Aotearoa's contribution to global warming would remain at approximately the same level for the second half of the 21st century.

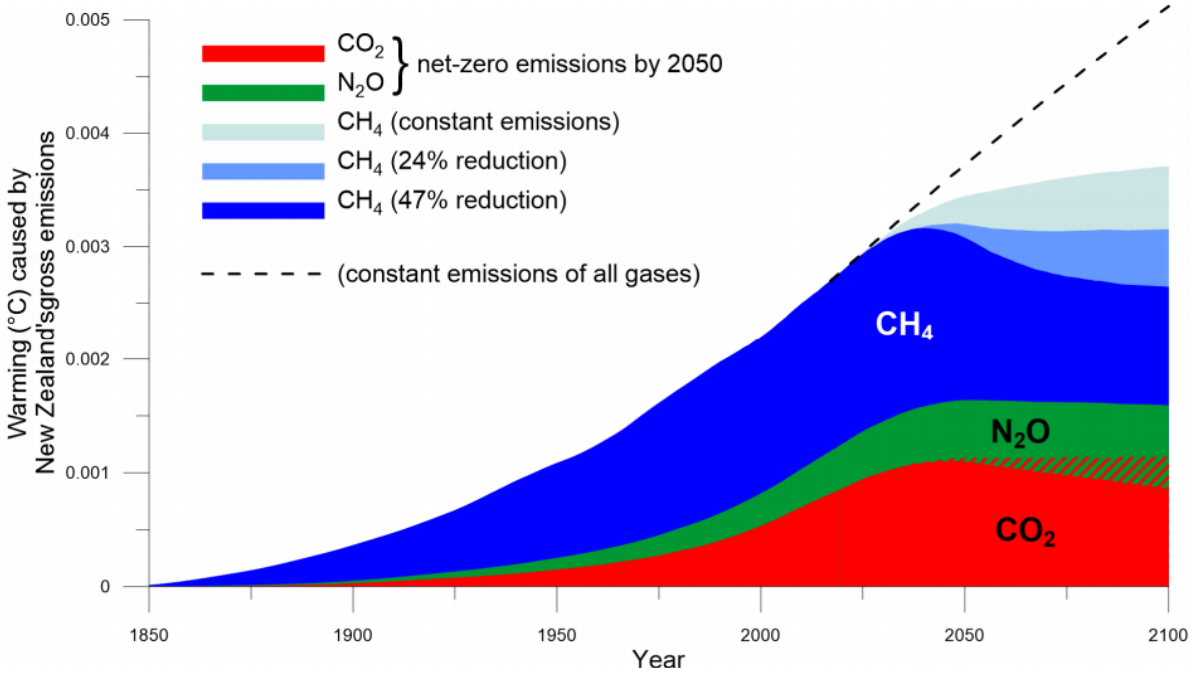


Figure A.1: Combined contribution to global average temperature change from Aotearoa's gross emissions of carbon dioxide, nitrous oxide, and biogenic methane. (Source: Reisinger and Leahy, NZAGRC 2019)

If biogenic methane were reduced by 47% below 2017 levels by 2050, this would see the total warming caused by Aotearoa peak around 2040 and decline thereafter. If emissions of all gases then continue unchanged, Aotearoa's contribution to global warming by the end of the 21st century would be slightly below the warming caused today.