Introduction

This report accompanies the Commission's draft advice report. This report sets out the detailed evidence that we have drawn upon to support the development of our recommendations and advice.

By presenting this evidence, we hope to support and facilitate informed feedback and responses to our draft advice report and consultation questions, before providing our final advice to the Government and public.

Contents

Introduction 1

1. Our task **3**

2. Stages of analysis **4**

2.1 Tools that have informed our analysis 5

2.1.1 Analytical Framework 5

2.1.2 Modelling to support our advice 7

2.1.3 Emissions value and the NZ ETS 9

2.1.4 Cost-effectiveness analysis 9

3. What comes next **10**

4. References **12**

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1. Our task

Our first task as a Commission is to provide the Government with advice on the first three five-year emissions budgets that will put Aotearoa on track to meeting its domestic 2030 and 2050 emissions targets, and on the direction of policy for the Government's first emissions reduction plan.

The Climate Change Response Act outlines specific pieces of advice that the Commission must provide to the Government. As outlined in Sections 5ZA and 5ZH of the Act, these are:

- The recommended quantity of emissions that will be permitted in each emissions budget period;
- 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;
- 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;
- How the emissions budgets, and ultimately the 2050 target, may realistically be met, including by pricing and policy methods;
- The direction of the policy required in the emissions reduction plan for that emissions budget period; and
- The rules that will apply for measuring progress towards meeting emissions budgets and the 2050 target.

The Minister for Climate Change has also asked the Commission to provide advice on the eventual level of reduction needed for biogenic methane, and on the Government's Nationally Determined Contribution (NDC).

The analysis that underpins these different pieces of advice is inter-related. For example, advice on the direction of policy required in the emissions reduction plan needs to draw on analysis for emissions budgets – including barriers to technology uptake or behaviour change. Likewise, analysis on pathways that are compatible with the 1.5°C global effort, and the science and international context that informs that analysis, will also inform the Commission's advice on biogenic methane, emissions budgets and the NDC.[1]

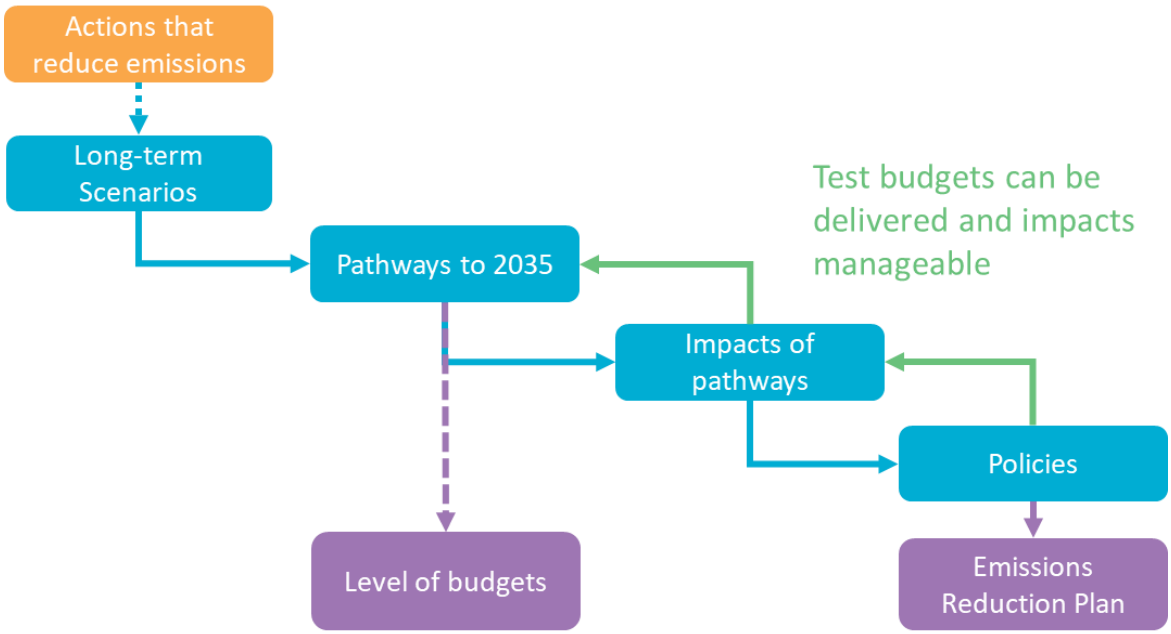
[1] Under the CCRA, emissions budgets must be set "*with a view to meeting the 2050 target and contributing to the global effort under the Paris Agreement to limit the global average temperature increase to 1.5° Celsius above pre-industrial levels*" (Climate Change Response Act 2002, Section 5W.)

2. Stages of analysis

In developing our advice, the Commission has progressed through different stages of analysis, which are summarised in **Figure 1** below.

Our approach draws on experience from within Aotearoa and the rest of the world in developing low-emissions transition pathways and advising on emissions budgets, while paying particular attention to the Aotearoa context and the broad range of elements that we are required to consider in our advice. It shares many common features with how others have approached similar analytical tasks, such as the Productivity Commission, the UK Committee on Climate advice on carbon budgets, and the European Commission's analysis of decarbonisation pathways for the EU.

Figure 1: Stages of analysis for developing the Commission's advice



Actions that reduce emissions. The first stage of our analysis was to gather evidence on current and anticipated actions to reduce emissions. Actions include adopting new technologies, as well as changes to behaviour and practices. We reviewed the available evidence on mitigation options for each sector, to understand whether these actions are suitable for Aotearoa, what their mitigation potential might be, their likely costs, risks and uncertainties, and what their co-benefits might be.

Long-term scenarios. We then used this evidence to develop a set of long-term scenarios showing how technology and behaviour could change over the next 30 years. This allowed us to understand how Aotearoa could meet the 2050 targets under a range of possible futures.

Pathways to 2035. We used the insights from the long-term scenarios to look in more detail at the possible pathways to 2035. We modelled a range of scenarios looking at possible futures, and these pathways have helped us to examine different possible levels of emissions budgets, and to test whether these are achievable and ambitious.

Impacts of pathways. Based on the pathways, we have examined the impacts of possible budgets to understand their likely costs and benefits, and to test if these are manageable. This analysis has considered economic, social, cultural and environmental impacts.

Policies. We also looked at whether policy can be implemented to deliver the actions that are assumed under the pathways. This included looking across all sectors and across the economy at the policies that would be needed to deliver emissions budgets. After testing and iteration, we refined the emissions budgets to ensure that it is feasible to implement policies to achieve them, and to mitigate any substantial negative impacts from the proposed budgets.

This analytical process has allowed us to recommend the **level of emissions budgets** and the direction of policy for the first **emissions reduction plan**.

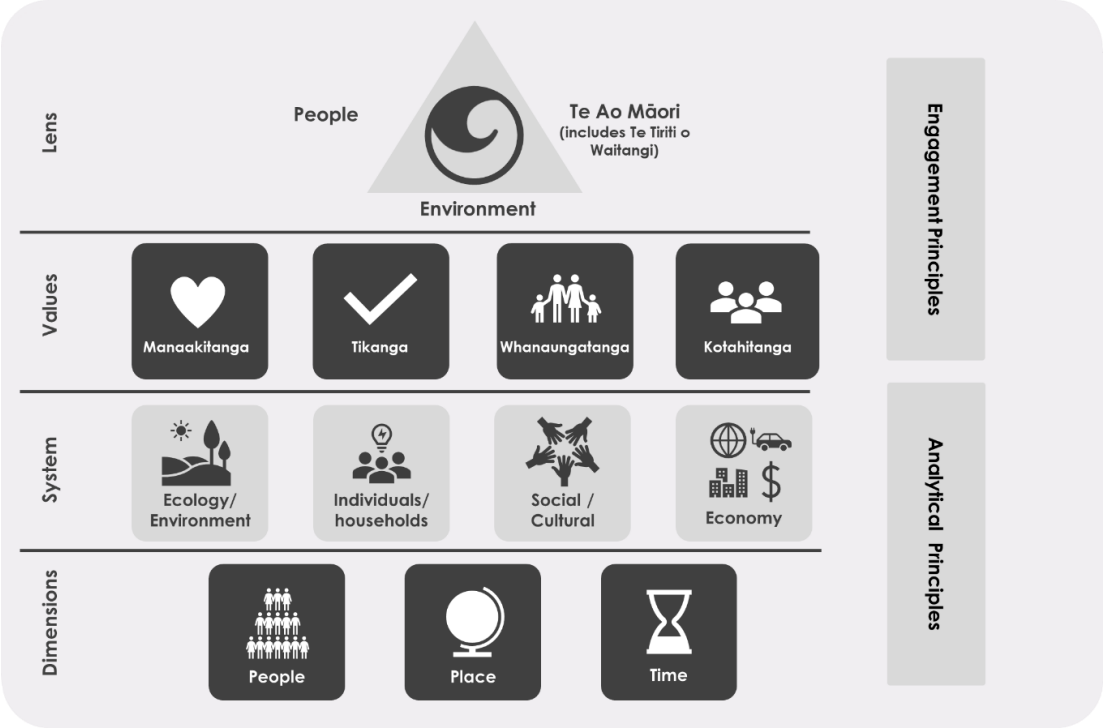
2.1 Tools that have informed our analysis

In developing our analysis and preparing our draft advice we have had to balance a number of considerations and make some judgements. As we have progressed through the stages of analysis described above, we have used a range of quantitative and qualitative tools, including economic models and analytical frameworks, to support the development of our advice.

2.1.1 Analytical Framework

To guide our work, we developed an analytical framework that captures the broad range of factors that we must consider under the Climate Change Response Act, and as a Treaty partner – see **Figure 2**. Consideration of the elements contained in this framework has guided key judgments we have had to make while developing our advice.

Figure 2: Our analytical framework



Lens. The first layer of this framework makes explicit the lens though which we are approaching our work. The Commission needs to consider the perspectives of all New Zealanders. We are a Crown entity, and as Treaty Partners we need to consider the perspectives of Māori. This requires us to understand a te ao Māori or Māori world view and incorporate this perspective into our approach.

Values. The next layer of the framework sets out how we have gone about performing our functions. The advice we provide must consider the wellbeing of the people and the systems involved in, and affected by, our recommentations. In identifying these values we have drawn from tikanga Māori values, as we think these values resonnate with all New Zealanders. Our values are:

- **Manaakitanga** – approaching our work with a deep ethic of care towards the people and systems involved.
- **Tikanga** – ensuring the right decision makers are involved, and the right decision making process is implemented.
- **Whanaungatanga** – being mindful of the relationship between all things, our connections to each other and how we connect to our whenua.
- **Kotahitanga** – taking an inclusive approach and working collaboratively with other agencies/organisations, to have access to the best information, and to do the best work we can, collectively.

System. The Climate Change Response Act requires us to think broadly about potential impacts of our advice across the whole system. This layer of the framework identifies the components of the system that our analysis needs to consider:

- **Ecology/environment**. Recognising the inherent relationality within our natural environment and ecological systems. Being attentive to the potential effects that a change to one part of the system may have on other parts of the system.
- **Individuals/households.** Recognising that individuals and households form the base unit of our social and economic constructs, and understanding the potential impacts of recommended changes on them. Giving consideration to the structures that support and enable the wellbeing of individuals and whānau, including connectivity, health, jobs, skills and income.
- **Social/cultural/business.** Recognising the importance of social and cultural constructs. Identifying and understanding the potential impacts and effects of changes for iwi and hapū, business, industry, sectors, supply-chains and others.
- **Economy**. Recognising the contribution of our economy to wellbeing, as well as understanding and identifying the potential impacts and effects of changes to the way we conduct economic activity.

Dimensions. The final layer of our framework identifies key dimensions, to ensure that our analysis considers the different impacts and effects of our work across:

- **People.** For example, how will changes impact different social demographics? How will changes impact current and future generations?
- **Place.** For example, what would this mean for regions? What would this mean in the global context?
- **Time.** For example, what will this mean now? what will it mean for future generations?

We have used this analytical framework to guide our analysis and the develoment of our advice. It provides a foundational premise to ensure we are thinking broadly from the outset.

2.1.2 Modelling to support our advice

Models are useful tools that can provide clarity about the drivers of a system, and what can affect those drivers and alter outcomes. Models also require us to make explicit our assumptions and to consider the interactions between different parts of the system.

As we have moved through the stages of analysis for developing our advice, we have used models to help us understand the potential paths for emissions under different circumstances and the implications of these potential paths.

All models are necessarily a simplification of a more complex system and are not intended to represent all aspects in detail. Therefore, it is not possible or appropriate to solely rely on models to guide our advice. Modelling is therefore an important part of our analysis, but it is only one component. We have complemented our modelling with other quantitative and qualitative analysis to help us reach our recommendations.

We have commissioned and developed two models to support our analysis: Energy and Emissions in New Zealand model, and the Climate Policy Analysis model, which has a distributional Impacts Microsimulation sub-model.

Energy and Emissions in New Zealand (ENZ) model

ENZ is a bottom-up sectoral model that covers all the main emitting sectors of the Aotearoa economy – energy, industry, transport, land use, agriculture, forestry, product use and waste. This model was built by Concept Consulting and is being further developed in conjunction with the Commission.

ENZ has been used to give us a sense of the emissions reductions that are feasible in each sector by factoring in specific technologies and mitigation options. The model also captures the major interactions between different sectors. For example, if there is an increase in forestry, this will flow through into an increase in the amount of biomass available for heat or biofuels. Other key interactions include; agricultural production and food processing energy demand, transport electrification and electricity demand.

ENZ is highly adaptable and modular, with the ability to provide relatively detailed representation of activities and technologies. As with many economic models, there are limitations as to how well ENZ can simulate private decision-making. The model is more likely to reflect real-world behaviour where decisions are made by companies using rigorous analysis informed by a project's expected costs and benefits – for example, companies deciding to build new electricity generation assets. Even in these cases, however, factors such as business priorities and capital constraints may cause observed outcomes to differ from model results.

For some decisions and sectors, there may be significant non-monetary considerations and other factors that cannot be directly represented in the model. For instance, in the land sector there is inherent uncertainty in many factors that drive outcomes, significant non-price factors driving

farmer decisions,[2] variations in farm circumstance, non-linearities in the economics of outcomes, and lack of data in many areas. In the realm of energy efficiency, it is well-established that there are significant cost-saving opportunities not taken up due to various barriers and in some cases market failures.[3]

A further issue is that real-world decisions are based on expectations about the future and may often consider a range of possible outcomes (e.g. changes in fuel prices). Within ENZ, however, decisions are optimising to a particular set of assumptions with perfect foresight. This is particularly relevant in situations where there is high sensitivity to future changes in cost factors, for example. This highlights the need for robust exploration of the effects of uncertainty, and to avoid placing too much emphasis on any single model.

Climate Policy Analysis (C-PLAN) model

The C-PLAN model has been developed by Motu Economic and Public Policy Research, and Vivid Economics. The model has two parts – the base model and a sub-model for distributional impacts analysis.

The C-PLAN base model is a global Computable General Equilibrium (CGE) model that takes data on the interactions and relationships between various economic actors (firms, workers, households, government, overseas markets),[4] and introduces a shock to understand how that shock impacts the structure of the economy. This includes the impact on GDP, different sectors, employment, gross valued added, energy prices, sectoral export and import prices and quantities, and emissions prices.

A CGE model is usually built on the assumptions that actors are economically rational, that firms are profit maximising, that consumers are utility maximising, that there is a market for all goods and services, and that these markets are in equilibrium, and that firms are earning zero pure profit.

The Distributional Impacts Microsimulation (DIM) sub-model uses the economy-wide outputs from C-PLAN base model and combines them with granular data from Stats NZ[5] to explore the effects on employment for each sector, different regions, for Māori, Pacific and other ethnic groups, and for different age groups.

C-PLAN will provide an overall estimate of the impact of different pathways and emissions budgets on GDP and consider how this flows through into the wider economy, including the sectoral composition and the balance of payments.

Unlike the ENZ model, C-PLAN does not contain detailed representations of the major emitting sectors, and can only model a limited range of the specific mitigation options and technologies available for reducing emissions in those sectors. As a result, C-PLAN cannot derive estimates of the direct resource costs on these sectors and is likely to overestimate the total costs.

[2](Cortés-Acosta et al., 2019; Journeaux et al., 2016)
[3](Ministry of Business, Innovation and Employment & Energy Efficiency and Conservation Authority, 2017)
[4] The data used is from Statistics New Zealand input-output tables and the Global Trade Analysis Project database, which represent the economy in 2014.
[5] The DIM model will draw on data from Stats NZ's Integrated Data Infrastructure (IDI) and Longitudinal Business Database (LBD). These are large micro datasets including data about people, households, businesses, workers.

C-PLAN can also provide us with analysis on the international implications of different pathways, including the implications for imports and exports, and potential changes in New Zealand's competitiveness.

We have used the C-PLAN model to understand the overall change on the economy from the proposed emissions budgets, the expansion and contraction of sectors, and (using the DIM) how this might affect employment across different sectors, regions, demographic groups and socioeconomic groups.

2.1.3 Emissions value and the NZ ETS

In our models, some choices are determined within the model through reference to the abatement cost of a particular action, while others are imposed externally through assumption.

Where abatement costs are used, the model simulates changes in some sectors by reference to the marginal abatement cost of certain actions, where actions are taken if their abatement cost is less than a chosen emissions value imposed on the model. These emissions values provide an estimate of the cost required in each year of reducing the last tonne of emissions. Many actions will have very low, or even negative, costs of abatement.

The emissions values we have modelled should not be interpreted as a forecast of 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.

2.1.4 Cost-effectiveness analysis

Cost-effectiveness analysis has been widely used in climate change policy to help determine the actions that should be taken to meet an emissions reduction target. It has often been used to find the lowest-cost way to achieve a given emissions reduction target. This type of analysis commonly involves estimating the cost per tonne (or marginal abatement costs) of different actions that could reduce emissions, and using this to prioritise those with the lowest cost.

While we acknowledge the merits of this approach and its strong theoretical basis, we have avoided relying solely on cost-effectiveness in recommending the level of emissions budgets. There are a number of principled and practical considerations for this approach:

- **Different warming impacts of different gases/removals:** There are different warming impacts from reducing long lived greenhouse gases, carbon removals by forestry, and reductions in biogenic methane emissions. The split-gas nature of the 2050 target requires that we think beyond a simple CO_2 equivalent calculation, which therefore limits the usefulness of using a cost per tonne calculation to prioritise which actions to undertake.
- **Need to reach sustained net zero emissions:** The Climate Change Response Act requires that Aotearoa achieve net zero emissions of long-lived gases by 2050, and then sustain this from then on. Under this target, a cost-effectiveness approach is less useful. Such a target implies that eventually all emissions will have to be reduced or offset through permanent removals. Therefore, while a cost effectiveness calculation can help prioritise which actions to take first, its use for guiding advice on reaching the 2050 target is limited.
- **Failure to appropriately incorporate co-benefits or external costs**: Many actions to reduce emissions create co-benefits and/or external costs. These are often ignored when

calculating the cost per tonne of emissions. In addition, co-benefits and external costs are often dependent on local circumstances, which make it difficult to accurately incorporate them into a cost-effectiveness calculation.

- **Failure to capture dynamics:** It may be appropriate to undertake some actions with higher marginal cost in the short term if there is an expectation that, in doing so, future costs could be reduced. For instance, early adoption of a technology could encourage greater innovation that reduces costs later. Also, simple application of a cost-per tonne metric could encourage actions that increase later costs by creating a path dependency. For instance, encouraging the use of natural gas in the short term to reduce emissions may create lock-in and increase costs later if it is expensive to develop an alternative to natural gas.

For these reasons, we have used the cost per tonne as a guide to help us understand where actions should be prioritised, but have complemented this with other evidence and analysis where appropriate.

3. What comes next

This report contains a large amount of information, which we have drawn upon to support the development of our recommendations and advice. The report is structured as follows:

Part One: Our place in the world. This section focuses on the context within which the Aotearoa approach to climate change is being developed. **Chapter 1** explores the science of climate change and sets out why urgent action is needed. **Chapter 2** looks at how our targets compare with those of other countries. **Chapter 3** outlines the system for monitoring greenhouse gas emissions over time, to understand whether Aotearoa is on track to achieve emissions budgets and targets.

Part Two: Our current path. This section examines the opportunities and challenges for reducing emissions across different sectors, and where Aotearoa is currently heading. **Chapter 4** looks at opportunities and challenges for reducing emissions in heat, industry and power; transport, buildings and urban form; agriculture; and waste. **Chapter 5** examines opportunities for removing carbon from the atmosphere, through forestry and carbon capture and storage. **Chapter 6** presents a basis for our analysis of opportunities and challenges for iwi/Māori. **Chapter 7** explores what future emissions in Aotearoa could look like if we keep progressing with no new policies or regulations.

Part Three: How can we reach our climate goals? This section looks at possible futures for Aotearoa, and potential paths forward. **Chapter 8** outlines four different scenarios, based on our modelling and analysis, to help us to see what the future could look like in Aotearoa. **Chapter 9** draws on the insights from those scenarios to advise on an ambitious and achievable path forward for meeting the 2050 target. **Chapter 10** presents analysis on the eventual level of reduction needed for biogenic methane, and on the Aotearoa NDC.

Part Four: What this means for New Zealanders. This section looks at how Aotearoa could transition to low emissions in a way that considers the wellbeing of people, the land, and the environment. **Chapter 11** provides an introduction, looking at where impacts of the low-emissions transition could be compounded and how they could be managed. **Chapter 12** examines potential impacts on the economy, including on businesses and workers. **Chapter 13** looks at what impacts the transition may have on households and communities, including on household bills. **Chapter 14** focuses on the environmental impacts of reducing emissions, including on biodiversity, water quality and air quality.

Chapter 15 looks at the link between mitigation and adaptation, and how some actions to reduce emissions may impact on the ability to adapt to the physical impacts of climate change.

Part Five: How to make this happen. This section focuses on the direction of policy needed to meet emissions budgets and targets, drawing on the material in the proceeding sections. **Chapter 16** outlines the approach we have taken to developing our advice on policy direction, including our policy framework. **Chapter 17** presents our analysis on policy direction needed in different sectors of the economy, policies that cut across sectors, and measures to address the impacts of mitigation policies.

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