Chapter 4:
Reducing emissions - **opportunities and challenges across sectors**

Transitioning to a thriving, climate-resilient and low emissions Aotearoa will create a number of opportunities and challenges across all sectors and communities. This means our analysis has considered a wide range of factors, including existing technology and anticipated technological developments, the costs and benefits of adopting new technology and the impacts on households, employment and regions.

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4.1 Introduction

The transition to a thriving climate-resilient and low emissions Aotearoa would mean adopting new practices and technologies across the country: in transport and buildings, in industry and manufacturing, in the land sector and in the waste sector. New behaviours and thinking are also required to speed up this transition.

Globally, technologies and practices to reduce emissions exist for every sector - although these are in differing states of development and deployment. New technologies and opportunities to reduce emissions would also emerge in the coming years.

Many of these current and emerging emission reduction opportunities offer multiple co-benefits such as improved health outcomes, new job opportunities and reduced local environmental impacts. However, these opportunities to reduce emissions also have the potential to have negative impacts, which must be considered. They may be too expensive for people to afford, or may consistently fall on some groups in society, including iwi/Māori and Pacific Peoples, meaning the transition is not an equitable one.

There are also uncertainties around the emissions reduction potential, reliability and costs of a number of emerging technologies, making it hard to determine which technologies present the greatest opportunities and the fewest challenges. This means any emissions reduction practice or technology needs to be carefully assessed before it is included in emissions reduction plans and budgets.

4.2 What does this chapter cover?

When analysing the potential emissions reductions opportunities, the Climate Change Response Act 2002 (the Act) requires consideration of a wide range of factors. This includes existing technology and anticipated technological developments and the costs and benefits of early adoption of these in Aotearoa. It requires the consideration of a range of impacts, including on households, employment and different regions. The Act also requires the Commission to specifically consider the impacts of emissions reduction on future generations and for iwi and Māori.

The Commission's overarching analytical framework (see *Introduction* chapter) sets out our approach to weaving these different components together. We specifically consider the impacts of mitigation options and how these may be managed in later chapters.

This chapter summarises evidence on the technologies and practices that could be deployed across the different sectors and outlines what the options and limitations might be in Aotearoa. It first sets

out the factors the Commission is required to consider under the Act and then outlines the framework/approach we used to assess the opportunities. We have grouped our analysis into:

a. heat, industry and power
b. transport, buildings and urban form
c. agriculture
d. waste.

Chapter 5: Removing carbon from our atmosphere discusses removal of carbon and *Chapter 6: Perspectives from Tangata Whenua: Considering impacts of emissions reductions and removals for iwi/Māori* discusses Te Ao Māori perspectives and potential impacts of reducing emissions for iwi and Māori in accordance with what we heard through engagement.

New behaviours required for the transition to a thriving climate-resilient and low emissions Aotearoa have not been specifically considered in this chapter, although often behaviour change may be required in order for a particular technology to take off. Enablers and policies will often be required to ensure emissions reduction opportunities described below are realised. These are discussed in *Chapter 17: The direction of policy for Aotearoa.*

4.3 How were emissions reduction opportunities and challenges assessed?

For each emissions reduction opportunity, we considered a range of different factors that affect the role it could play in helping to reduce Aotearoa's emissions. These factors are set out in the figure below.

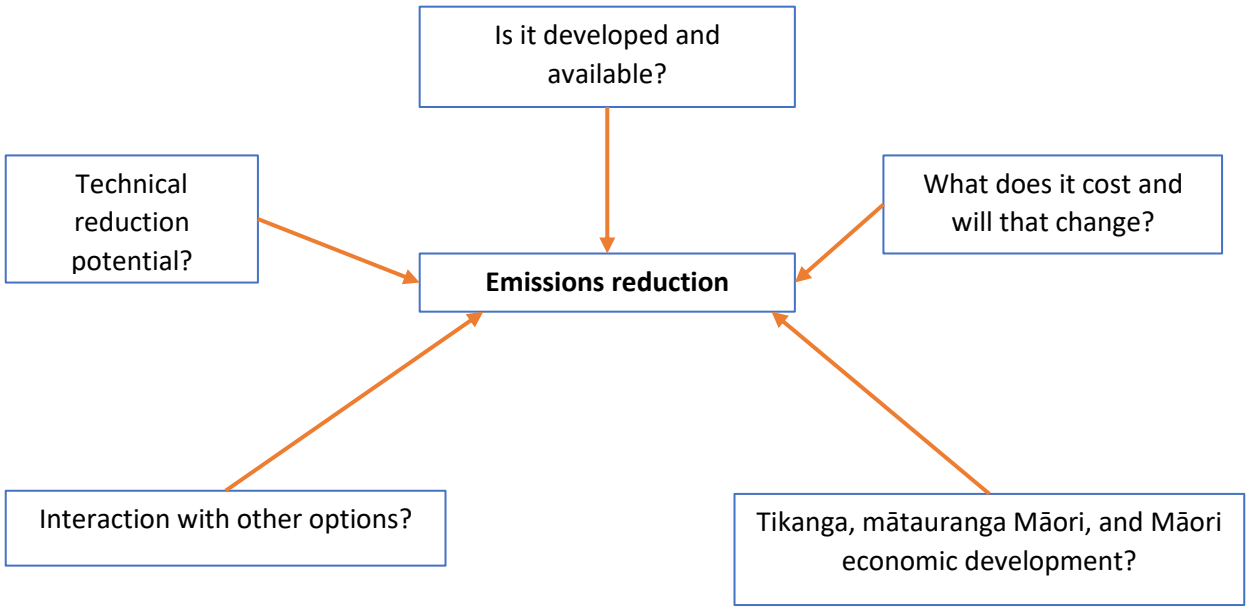

Figure 4.1: Framework for assessing emissions reduction potential

Key features of the framework include:

What is the technical reduction potential? – The starting point is knowing how much potential the reduction opportunity actually has. Can it make a significant reduction in emissions if it is used, or would the difference be minor? For example, driving an electric vehicle, taking public transport or

walking a couple of kilometres to work would produce fewer emissions than driving there in a petrol or diesel vehicle.

Is it deployed and available? – Not all opportunities are available in or relevant to Aotearoa. For example, companies in Europe are piloting the use of hydrogen to make steel, however Aotearoa has a unique steelmaking process and international technologies may not apply in their current form. For new and emerging opportunities, they may not yet be developed to the point that they are commercially available and it may be unclear how long that would take. New technologies generally go through a three-stage process from the initial concept and research phase, to development and testing, to deployment into the market (see Box 4.1).

What does it cost and would that change? – For opportunities to be taken up, they need to be affordable both at time of purchase and over the life of the investment. Often the cost of an opportunity will decrease over time, as economies of scale kick in and improvements are made to design and manufacturing. There are several examples of the costs of technologies decreasing and often faster than predicted - for example electric vehicle batteries, offshore wind and photovoltaic cells. When considering costs, it is also important to recognise individuals may think about the up-front cost, rather than the lifetime cost of owning or using the asset. EVs are an example of this, where the up-front cost is higher than a comparable petrol or diesel car, but the lifetime running costs and total carbon dioxide emissions are lower.

Interaction with other options – Practices and technologies will interact and interconnect once they are deployed in a sector. In many circumstances, options could be substitutes for each other, so not all the emissions reduction opportunities can be added up to give the overall potential for reducing emissions. For example, the emissions reductions from transitioning most of the light vehicle fleet to EVs cannot be realised if more people are using public or active transport instead. One important point to note is that this means estimates of emissions potential presented in this chapter cannot be added up to give an overall estimate for the country.

Tikanga, mātauranga Māori and Māori economic development – Practices and technologies that enable emissions reduction opportunities should consider relevant aspects of tikanga and mātauranga Māori (noting there would be variations between iwi and hapū across the motu). Establishing relationships with local iwi and hapū to build an understanding of local tikanga and mātauranga would help minimise intergenerational risks of unintended and undesirable consequences that may be associated with new technologies and practices. Consideration should also be given to the developing Māori economy and how trade-offs associated with changes in technology and practice would be assessed for Māori-collectives that have been historically disadvantaged (noting there is also huge potential for favourable outcomes).

Box 4.1: The stages of technology development

Aotearoa has a track record in ingenuity. The development and widespread use of emissions reduction technologies follows three general phases.

Concept and research phase:

An idea or concept has been identified and the basic principles have been studied. A proof-of concept model is constructed and validated.

Analysis and development:

Multiple component pieces are tested in a laboratory environment and field trials or demonstration projects have taken place in a relevant environment.

Market launch and deployment:

The technology is demonstrated in a relevant operational environment and is commercially available for development. Depending on factors such as economics or behaviour patterns, policies might be required for the technology to be applied widely and for exports.

4.4 How was uncertainty dealt with?

When considering the potential emissions reduction an opportunity might provide, it is important to factor in the uncertainty that could affect its effectiveness in Aotearoa. Uncertainty in costs, future industry trends, uptake and availability of technology and the overall acceptability of the option were considered. These affect the effectiveness of technologies in Aotearoa.

There is higher confidence in technologies and practices when:

- there is consistency in estimates of emissions reductions and costs from multiple sources
- the information is from reliable and credible sources (trusted by others, peer reviewed)
- the information is directly applicable to the situation (i.e. Aotearoa-specific source or an international source directly relevant to the Aotearoa context)
- the technology is more developed and there is more tested information about its operation.[1]

In conducting our analysis, we assessed our level of confidence in the quantitative evidence we gathered using a high/medium/low scale (see Table 4.1).

These assessments informed the conclusions we reached about each technology or practice, given uncertainties about potential emissions reductions timeframes, likelihood of successful implementation and barriers faced by companies and individuals.

Table 4.1: The criteria used to assess level of confidence in the evidence

Confidence level	Justification
High	High confidence levels because: • There is consistency in evidence from multiple sources. • The information is from reliable and credible sources (trusted by others, peer reviewed). • The information is directly applicable to the situation (i.e. Aotearoa-specific source or an international source directly relevant to the Aotearoa context). • The technology is mature and there is more information about it.
Medium	Moderate confidence levels because: • There is some variability in evidence from different sources. • Some of the information is less credible (e.g. has had limited independent review, or information supplied by stakeholders).

[1] We can have less confidence when there are few sources of the information, the traceability and reliability of information is difficult to ascertain, or the information is not applicable to the situation in Aotearoa and difficult to estimate.

Confidence level	Justification
	• The information is not directly applicable to the situation in Aotearoa but may be enough to estimate the situation. • The technology and information on it are still developing.
Low	Limited confidence levels because: • There are few sources of the information. • The traceability and reliability of information is difficult to ascertain. • The information is not applicable to the situation in Aotearoa and difficult to estimate. • The technologies are more speculative or less developed.

4.5 Where did we get information from?

We gathered information and evidence through engagement with stakeholders and Treaty partners, as well as Aotearoa research and international sources. We also received information from the public and met with sector experts. This included Call for Evidence submissions, stakeholder meetings and establishment of a number of Technical Reference Groups to help gather information and test our developing analysis.

As a result, the Commission has built a credible evidence base on the potential range of current and future actions to reduce emissions.

4.6 What comes next?

The following sections of the chapter focus on the different sectors of the economy that we have assessed. For each sector, we set out the key context – where emissions come from in the sector and how they have been changing. We then present the key opportunities to reduce emissions from the sector, as well as outlining the main challenges that could affect whether those opportunities can be realised. Detailed analysis of what impacts could arise from the different emission reduction options and how those impacts could be avoided or managed is contained in later chapters.