



Ministry for the  
**Environment**  
*Manatū Mō Te Taiao*

# Ngā Kōrero Āhuarangi Me Te Ōhanga

## Climate Economic and Fiscal Assessment 2023





We have used the tukutuku designs from within Ngā Mokopuna ā Tāne in Te Tai Ōhanga, to visually reflect the way the report integrates and impacts people.



**PĀREKEREKE**

depicts intergenerational prosperity



**KAOKAO**

talks to noble behaviour and the protection of people and assets

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# CONTENTS

<b>Foreword</b>	<b>2</b>
<b>Executive summary</b>	<b>6</b>
1 Introduction	14
2 Framework for assessing climate-related economic and fiscal impacts	20
3 Sources of climate-related economic and fiscal impacts	24
4 Economic impacts from physical climate change	36
5 Economic impacts from the low-emissions transition	50
6 Fiscal impacts	64
7 New Zealand's first Nationally Determined Contribution – scenario analysis of fiscal risk from offshore mitigation	80
<b>References</b>	<b>89</b>
<b>Glossary</b>	<b>95</b>

# FOREWORD

Climate change is here. The scientific evidence is incontrovertible. Temperatures are increasing, rainfall patterns are changing and sea levels are rising.

Over the past century, New Zealand's average annual temperature has increased by 1.1°C, with 2022 being the warmest year on record. Most southern and western areas of the country are becoming wetter and most northern areas drier. The sea level around New Zealand is 20 centimetres (cm) higher on average than a century ago, and the rate of sea-level rise is accelerating.

At the time of writing, New Zealanders are dealing with the devastating impacts of the flooding in the upper North Island and the effects of Cyclone Gabrielle. While the costs of those impacts are not included in this Assessment, these recent events reinforce the breadth and scale with which climate change can impact New Zealand.

The Intergovernmental Panel on Climate Change projects that by 2040 mean temperatures in New Zealand will be 0.7°C to 1.0°C higher than they were between 1986 and 2005 and the intensity of extreme rainfall events could increase by 5% to 7%. By 2050, sea-levels are projected to rise by 23cm to 28cm.

These changes will impact the economy, as well as the physical environment. This report brings together the available information on the future economic and fiscal implications of climate change for New Zealand.

The purpose of doing so is to help decision-makers in both the public and private sectors identify and manage the risks and opportunities of physical climate change and New Zealand's transition to a low-emissions and climate-resilient future.

This report has been jointly produced by the Treasury and the Ministry for the Environment. It is informed by the Living Standards Framework and He Ara Waiora. It is also informed by international perspectives, including work by the United Kingdom Government and the Task Force on Climate-related Financial Disclosures.

The report therefore reflects what we observe in our current economic landscape and what we might see in the future given domestic and international signals on climate action.

The report is clear there will be large economic and fiscal costs. The choices governments, businesses and households make today will influence how prepared we are to manage the impact of climate change and transition to a low-emissions future.

The cost of climate change will inevitably be influenced by factors outside our control. For example, our future exposure to physical climate impacts is highly dependent on actions in other countries. The scale, nature and complexity of these costs highlight the need to be flexible and manage our public finances prudently.

New Zealand is in a strong position to face the challenges posed by climate change. In 2020, the Notre Dame Global Adaptation Initiative ranked New Zealand ninth globally in its readiness to improve its resilience. The economy and public finance system have shown remarkable resilience to previous shocks and crises. Available evidence suggests that our strong institutions and high levels of social cohesion are strengths, as noted in Treasury's recent Wellbeing Report, *Te Tai Waiora*.

Importantly, this report highlights concerns about the impacts of climate change on wellbeing in New Zealand. Physical climate change and the transition to lower emissions will put pressure on individuals and communities, institutions and governance. While we are still only beginning to understand the possible wellbeing impacts of climate change, they are likely to be large, wide-ranging and unevenly felt. We intend to update this report in the

future to reflect the latest research and evidence on climate impacts for New Zealand.

We invite readers to reflect on the evidence and analysis presented in this report, including the critical gaps, to think about New Zealand's readiness to face future climate change impacts, and to consider these in the choices we make that will influence our collective future wellbeing.



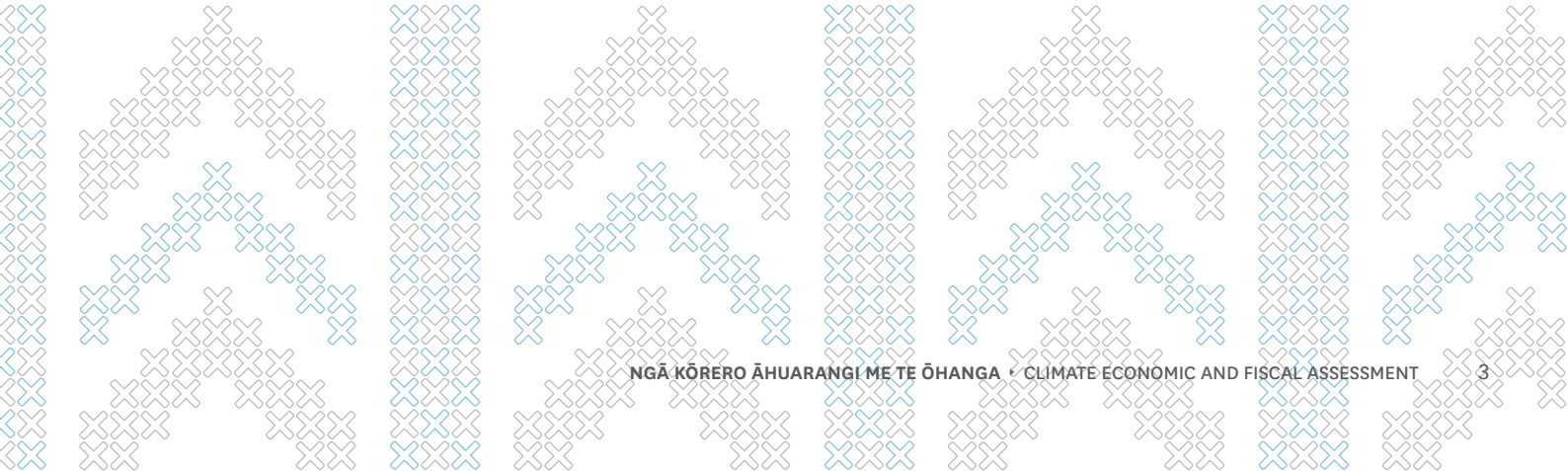
A handwritten signature in blue ink that reads "Clui".

**Caralee McLiesh**  
*Te Tumu Whakarae Mō Te Tai Ōhanga*  
*Secretary to the Treasury*



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**James Palmer**  
*Manatū Mō Te Taiao*  
*Secretary for the Environment*



# KŌRERO WHAKATAKI

Kua huri te āhuarangi. Tē taea te whakahē i te taunaki pūtaiao.  
E piki ana ngā pāmahana, e huri ana ngā tauria ua, kei te piki te pae moana.

I roto i te rau tau kua pahure, kua piki te pāmahana ā-tau toharite o Aotearoa, tōna 1.1°C, ā, ko te tau 2022 te tau mahana rawa atu kua tāngia ki ngā mauhanga. Ko te nuinga o ngā rohe kei te tonga me te uru o te whenua e haumākū haere ana, ā, ko te nuinga o ngā rohe kei te raki e pakapaka haere ana. Tōna 20 mitarau (cm) te piki toharite o te pae moana mai i te kotahi rau tau i muri, ā, kei te horo haere te pikinga o te pae moana.

I te wā o te tuhinga, e urupare ana ngā tāngata o Aotearoa ki ngā pānga whakangaro o ngā waipuke i te Tai Tokerau, me ngā pānga o te Huripari Gabrielle. Ahakoa kāore e whai wāhi atu ana ngā utu o aua pānga i roto i tēnei Aromatawai, nā ngā raru o inā tata nei i miramira te whānui me te taumaha o te pānga o te hurihanga āhuarangi ki Aotearoa.

Ki tā te Intergovernmental Panel on Climate Change matapae, i mua i te tau 2040, ka piki ake ngā pāmahana toharite o Aotearoa mā te 0.7°C ki te 1.0°C i ō ngā tau i waenga i 1986 ki 2005, ā, ka piki te karawhiu o ngā ua taikaha mā te 5% ki te 7%. Kua matapaetia, i mua i te tau 2050 ka piki te pae moana mā te 23cm ki te 28cm.

Ka pā ēnei panoni ki te ōhanga, tae ana ki te taiao ōkiko hoki. Ka kōhi tēnei pūrongo i ngā pārongo ka taea te kōhi mō ngā hiraunga ōhanga, ngā hiraunga mō te moni tūmatanui hoki o te hurihanga āhuarangi ki Aotearoa.

Ko te whāinga o tēnei mahi, ko te āwhina i ngā kaiwhakatau whakaaro kei te rāngai tūmatanui me te rāngai tūmataiti ki te tautohu, ki te whakahaere hoki i ngā tūraru me ngā mea angitu o te hurihanga āhuarangi ōkiko, o te whakawhitinga o Aotearoa ki tētahi āpōpō tukuwaro-iti, whakapūioio ki te āhuarangi hoki.

Kua whakaputaina tēnei pūrongo i te mahi tahi a Te Tai Ōhanga me te Manatū Mō Te Taiao. Kua whai mōhiotio i Te Anga Paerewa Oranga, i He Ara Waiora hoki. Kua whai mārama anō hoki i ngā tirohanga o tāwāhi,

tae ana ki ngā mahi o te Kāwanatanga o te United Kingdom me tō rātou Task Force on Climate-related Financial Disclosures.

Nā reira, ka whakaata te pūrongo i ō mātou kitenga i ngā āhuatanga ōhanga o nāiane, me ngā kitenga pea o āpōpō e ai ki ngā tohu o te kāinga, o tāwahi hoki mō ngā tū āhuarangi.

He mārama te pūrongo, ka nui ngā utu ōhanga, ngā utu moni tūmatanui hoki.

Ka whakaaweawe ngā whiringa o ngā kāwanatanga, ngā hinonga, me ngā kāinga i te kaha o tō tātou rite ki te whakahaere i ngā pānga o te hurihanga āhuarangi me te whitinga ki tētahi āpōpō tukuwaro-iti.

Kāore e kore ka whakaaweawetia te utu o te hurihanga āhuarangi e ngā āhuatanga tē taea e mātou te whakahaere. Hei tauria, ko ngā pānga mai o te āhuarangi ōkiko he ngā tau kei te heke mai he mea ka kaha whakaaweawetia e ngā mahi i whenua kē. Nā te nui, ngā tūmomo me te matatini hoki o ngā utu, ka miramira te matea kia pīngohengohe, kia āta whakahaeretia hoki e tātou ngā ahumoni tūmatanui.

Kua kaha te tū a Aotearoa ki te papare i ngā wero o te hurihanga o te āhuarangi. I te tau 2020, nā te Notre Dame Global Adaptation Initiative i whakarārangi a Aotearoa hei tuaiwa i te ao mō te rite ki te whakakaha i tōna manawaroa. Kua kitea te manawaroa whakaharahara o te taiōhanga me te pūnaha ahumoni tūmatanui i ngā mōrearea me ngā whētuki o mua. I roto i ngā taunaki ka taea, e kitea ana he pūmanawa nui ō tātou tōpūtanga me te kotahitanga i te pāpori kua kōrerohia i te Wellbeing Report nō nā tata nei, arā, *Te Tai Waiora*.

Ko te mea nui, ka miramira tēnei pūrongo i ngā māharahara mō ngā pānga o te hurihanga o te āhuarangi ki Aotearoa. Ka pēhia ngā tāngata takitahi, ngā hapori, ngā tōpūtanga me te mana whakahaere e te hurihanga āhuarangi ōkiko me te whitinga ki te tukuwaro-iti. Ahakoa e tīmata noa ana tātou ki te whai mārama ki ngā pānga toiora o te hurihanga āhuarangi, ko te āhua nei ka nunui, ka whānui hoki, ā, kā pāhikahika te pānga ki tēnā, ki tēnā.



A handwritten signature in blue ink that reads "Clui".

**Caralee McLiesh**  
*Te Tumu Whakarae Mō Te Tai Ōhanga*  
*Secretary to the Treasury*

E hiahia ana mātou ki te whakahou i tēnei pūrongo ā tōna wā, hei whakaatu i ngā rangahau me ngā taunaki hou rawa mō ngā pānga āhuarangi ki Aotearoa.

Ko tō mātou whakahau ki ngā kaipānui, kia āta whaiwhakaaro ki ngā taunaki me te tātari i roto i tēnei pūrongo, tae ana ki ngā āputa arohaehae, kia whakaaro ki te rite o Aotearoa ki te papare i ngā pānga o te hurihanga āhuarangi kei te haere mai, me te whaiwhakaaro ki ēnei i roto i ō tātou kōwhiri e whakaaweawetia ai te oranga tonutanga o tātou katoa ā muri ake nei.



A handwritten signature in blue ink that reads "James".

**James Palmer**  
*Manatū Mō Te Taiao*  
*Secretary for the Environment*



# EXECUTIVE SUMMARY

Climate change is accelerating, and its effects are being felt more and more by New Zealanders. We are experiencing more severe and frequent droughts, floods and storms, higher temperatures and rising sea levels.

Large impacts from future warming are already locked in, driven by historic global emissions. The future trajectory of global emissions will affect how much more temperatures rise beyond this level. Assuming policies are unchanged globally, studies have shown that mean temperatures in New Zealand in 2090 could be as much as 4.6°C higher than pre-2005 levels. An increase of this size could cause catastrophic damage to our economy and society. It is therefore important for New Zealand to consider how to adapt to already unavoidable global temperature rises, alongside how to contribute to efforts to constrain future temperatures within acceptable ranges.

Government, businesses, communities and households are already taking action to respond to and prepare for climate change and its impacts. New Zealand has committed to a 50% reduction of net emissions below our gross 2005 levels by 2030. This represents the country's contribution to the global effort under the Paris Agreement to limit the mean temperature rise to 1.5°C above pre-industrial levels.

## **This report brings together what we know about the economic and fiscal impacts of climate change on New Zealand**

Both climate change itself, and how New Zealand responds to the risks and opportunities it presents will have material economic and fiscal implications. Ngā Kōrero Āhuarangi me te Ōhanga – the Climate Economic and Fiscal Assessment (CEFA) – brings together available information on these implications in one document to better inform decisions by government, businesses, communities and households. It adds to a growing body of reporting on climate-related impacts, risks and opportunities.

The CEFA also identifies areas where future work would be valuable to both deepen and broaden our understanding of the fiscal and economic impacts of climate change, including to fill gaps in our current knowledge.

While there are things we know for certain, there are things that remain uncertain. This is driven by dependence on policy and strategic decisions yet to be made and factors that New Zealand has limited control over. These include future global emissions, the resilience of the natural environment, and the pace at which mitigation technologies develop.

Tables 1 and 2 summarise both the expected impacts of climate change set out in this report and key sources of variability.





## The economic and fiscal impacts of climate change are expected to be large, wide-ranging and unevenly felt

It is clear that the size and breadth of the economic and fiscal costs of climate change to New Zealand will be large. The physical impact of climate change and the choices the country makes to transition to a low-emissions future will affect every aspect of the economy and society for generations. These impacts

will have flow-on implications for the Crown's fiscal position.

Climate change represents both economic risks and opportunities for different sectors and population groups.

 <p><b>Physical climate impacts</b></p>	<ul style="list-style-type: none"> <li>› Agriculture, forestry, fisheries and tourism are particularly exposed given their direct dependence on climate-sensitive natural resources. The transport and energy sector are also exposed due to their reliance on extensive physical networks.</li> <li>› Some aspects of climate change may benefit some sectors (for example warmer temperatures and increased CO<sub>2</sub> concentration could increase primary sector productivity). Due to New Zealand's relatively high latitude, its primary agriculture may be less affected than in other countries, which could create demand for this country's products.</li> </ul>	<ul style="list-style-type: none"> <li>› Regions with high populations located in low-lying coastal areas (such as Northland and Tairāwhiti) or those dominated by vulnerable sectors (such as Waikato and the West Coast) will also be more affected.</li> <li>› Households in areas with high natural hazard risk are likely to find it harder to get affordable insurance.</li> </ul>
 <p><b>Impact of transitioning to a low-emissions economy</b></p>	<ul style="list-style-type: none"> <li>› Sectors with comparatively high abatement costs and/or limited options to make deep emissions reductions are likely to face potentially large disruption. Those that are less emissions-intensive or have more economic options to reduce emissions may grow.</li> <li>› Regions such as Southland, Tairāwhiti, Taranaki and the West Coast, whose economies are reliant on emissions-intensive industries (such as agriculture, heavy manufacturing, food manufacturing, and extraction and distribution), will be more affected.</li> </ul>	<ul style="list-style-type: none"> <li>› Impacts on consumer prices (such as fuel and food) are over time likely to disproportionately affect lower-income households.</li> <li>› Over time investments in low-emissions technologies could lead to cost savings, for example electric vehicles (EVs) having lower operating costs. Other potential co-benefits from the transition to a low-emissions future (such as improved public health, environmental outcomes and reduced household bills from resource efficiency) could be substantial.</li> </ul>

## Some sectors will be particularly exposed to both physical climate change and the transition to a low-emissions future

Agriculture, forestry, fisheries, tourism, and energy and transport networks will be particularly exposed to the physical impact of climate change. For land-based primary industries, this is true for both emissions-intensive land-use activities (such as livestock farming) and other activities with smaller emissions profiles (such as forestry).

Since emissions from agriculture currently account for almost half of New Zealand's total gross emissions, emissions reduction policies are expected to have material implications for land-use change. Historically, New Zealand has undergone significant land-use change. However, recent modelling suggests that climate change could cause the pace of future change to exceed historic trends, toward lower-emissions land uses (such as forestry).

The energy and transport sectors are also expected to be greatly impacted. On the physical side, critical energy infrastructure is exposed to increased flooding, wind damage, droughts and changes in rainfall patterns. A rise in flooding is also expected to affect low-lying airports, and coastal railways and roads. Energy is the second largest source of gross emissions in New Zealand, especially transport energy. Decarbonising the economy is likely to require more electrification, alongside greater levels of renewable electricity generation. While efforts to decarbonise will incur costs, they are also expected to present opportunities for potentially significant co-benefits (such as improved air quality).

## The economic impacts on Māori from climate change could be material

Māori are especially vulnerable to impacts from the transition to a low-emissions economy and the physical risks of climate change. Māori are over-represented among low-income households and account for around 23% of the workforce in emissions-intensive industries (compared to being 17% of the national population).

However, a number of businesses in the Māori economy are likely to be well placed to leverage economic opportunities from the transition (for example, expanding businesses that are already low-emitting, such as in forestry and low-emissions horticulture).

## At a macro level, the combined effect of climate change and the transition to a low-emissions future is expected to be negative

Treasury modelling from 2021 suggests that the New Zealand economy is relatively resilient to more frequent droughts or storms. The average of the modelled simulations showed that at the end of a 40-year projection period, higher frequency of droughts could reduce gross domestic product (GDP) by 0.5%, and a scenario with increased storms and floods could decrease GDP by about 0.7%. For context, the New Zealand Institute of Economic Research (NZIER) estimated that the drought associated with the 1997 to 1998 El Niño event resulted in a loss of GDP of 0.9%.

However, the physical impacts of climate change are expected to be greater than droughts or storms alone. In addition to other physical impacts that will occur here, New Zealand is exposed to climate impacts

abroad, affecting trade, migration and financial flows, and global economic activity.

As New Zealand takes action to meet its emissions targets, modelling indicates that the economy will continue to grow, but at a slower rate. The Climate Change Commission (CCC) has estimated that achieving New Zealand's domestic targets would result in GDP in 2050 being 1.2% lower than would otherwise be the case. This impact sits within the range of estimates from other studies that were carried out before New Zealand's domestic targets were set.

While some new sectors are likely to be created (bringing economic and wellbeing benefits), some existing sectors are anticipated to shrink and, in some cases, disappear altogether, causing disruption for affected communities.

## The overall cost of climate change will be influenced by how flexible and adaptable both the economy and decision-makers are

Effectively tackling the challenges presented by climate change and the transition to a low-emissions future, and making steady and timely progress toward New Zealand's climate-related objectives, will require actions and decisions over an extended period.

Effectively mitigating and adapting to climate change will require adaptability and flexibility on the part of both decision-makers and the economy as a whole. The greater the ability of the economy and decision-

makers to recognise and act on opportunities to reduce net emissions or adapt to the physical impacts of climate change in a timely way, the more efficient the overall climate response, with benefits for aggregate economic growth and broader wellbeing. For example, the more effectively the economy reallocates resources and adopts productivity-enhancing technologies and practices, the more resilient New Zealand's economy is likely to be, and the smaller the impact on GDP.

## The economic and fiscal costs of physical climate impacts are expected to grow over time

The costs from the increased severity and frequency of natural hazards due to climate change are likely to increase over time, expanding New Zealand's already significant natural hazard risk profile. Modelling shows that sea-level rise of 30 centimetres (cm) – expected to occur between 2045 and 2070 – could expose an additional \$6 billion worth of buildings to at least a 1% chance of flooding in a given year, beyond the \$12.5 billion exposed at the present sea level.

Other modelling shows that around 10,000 houses could become uninsurable by 2050 because of coastal flooding hazards from sea-level rise.

While such risks are anticipated to bring additional cost, government, businesses, communities and households face adaptation choices that have the potential to mitigate long-term costs.

Strengthening our understanding of these impacts and their economic and financial implications is an important area of further work.

## Meeting New Zealand's first NDC represents a large fiscal cost, and depends on domestic and international factors

New Zealand's Nationally Determined Contributions (NDCs) represent its commitments to contribute to global efforts to limit warming to within 1.5°C. To meet the first NDC (NDC1), New Zealand's domestic net emissions over 2021 to 2030 less mitigation New Zealand supports overseas must not exceed 571 megatonnes of carbon dioxide equivalent (Mt CO<sub>2</sub>e). Based on New Zealand's domestic emissions budgets over the same period, supporting offshore mitigation will be required to meet NDC1.

This report explores a number of scenarios for the cost of offshore mitigation purchases required to meet NDC1 (in addition to domestic action). These costs represent a significant fiscal risk under all scenarios considered.

The size of the cost of offshore mitigation will depend on whether New Zealand under-, exactly or over-achieves its domestic emissions budgets, but more critically on what price New Zealand pays for these international reductions. The future price of international reductions is unknown, reflecting that many markets are at early stages or yet to be developed.

## New Zealand's economy and public finances have shown resilience in the past, but climate change will test this

New Zealand has shown flexibility and resilience in response to past shocks. Its fiscal and economic resilience, and the strength of its institutions, mean that it may better absorb and respond to climate impacts than many other countries.

However, climate change is an unprecedented challenge. How future changes arising from climate change will compare with prior experience and the economy and society's capacity to adjust is difficult to predict and will depend on the choices of Government, private sector, and broader society. Early modelling suggests New Zealand may be fiscally resilient to an increase in the severity and frequency of certain extreme weather events.

The combination of physical impacts and the low-emissions transition will create cost pressures for the Crown and is likely to negatively affect its revenue bases.

- › Due to increased storms and droughts, Treasury modelling shows that net core Crown debt could be higher by 3.77% of GDP in 2061.
- › NZIER estimates that climate change could cause an increase in the annual growth of the Crown liability for natural hazards from 5.3% to 5.5%-5.7% through to 2050.
- › Calculations based on CCC modelling illustrate the fiscal cost of direct support for additional investment in a range of key mitigation technologies through to 2050 could be around \$4 to \$12 billion, assuming the Crown contributes 10% to 30% of investment costs. The degree to which the Crown directly funds or supports such investments depends a lot on how present and future governments choose to balance spending and non-spending levers.

Climate change presents a unique challenge to the Crown due to the combination of discrete, slowly developing risks, alongside other acute and fast-moving risks. The nature and scale of climate adaptation and the transition to a low-emissions future is likely to have implications for the assets and liabilities the Crown holds on its balance sheet, and how it manages these.

The balance sheet is a tool, alongside policy and regulations, to enable timely investment while smoothing the risks and costs of the transition.

Alongside climate change, New Zealand will also face other long-run fiscal pressures (such as health and superannuation) in the future. Making informed fiscal choices will be an important part of helping to mitigate long-term economic and fiscal costs.

Areas where governments may choose to increase climate spending are diverse (for example research, science and innovation, transport, infrastructure, foreign aid and investment, civil defence and conservation). Choices made by present and future governments about both spending priorities and the balance of fiscal and non-fiscal levers they use will affect future fiscal impact.

For example, current and future governments face choices between the level of investment in domestic action (potentially with broader social, cultural and economic benefits) and investment in offshore mitigation that can be counted towards our NDC1 (potentially at a lower cost).

Options to make greater use of fiscal levers include:

- › direct funding to achieve New Zealand's domestic climate transition
- › offshore mitigation that can be counted towards NDC1
- › emergency preparedness and response and recovery
- › direct funding for economy-wide adaptation measures
- › direct support and compensation for disrupted households, businesses and communities.

Within these options, current and future Governments will also face choices regarding how they balance the focus of fiscal levers between them. For example, between domestic and international investment to achieve New Zealand's international commitments under the Paris Agreement.



## The recently established Climate Emergency Response Fund leverages cash proceeds from NZ ETS auctions to fund the Government's climate response

The Climate Emergency Response Fund (CERF) was set up for Budget 2022 with initial funding equal to the forecast cash proceeds from the NZ Emissions Trading Scheme (NZ ETS) auctions. Illustrative modelling in this report indicates that, depending on future auction prices, the cash proceeds from NZ ETS auctions over the period 2023 to 2026 could range from \$2.4 billion to \$6.2 billion.

As a core lever to reduce domestic emissions, the NZ ETS is a fundamental element of New Zealand's transition. It is also a source of Crown revenue and the issuance of units yet to be surrendered represents a

liability on the Crown's balance sheet. The broader fiscal impact of the NZ ETS is explained more in Section 6. The overall impact depends on factors, such as:

- › supply and demand interactions in the market, including expectations of future prices
- › signals provided through regulated auction price control and volume settings
- › the general cost relativities of low-emissions investments and activities in the market.

## The choices made by governments, businesses and households, domestically and internationally, will have implications for how these impacts play out

Most global climate change is driven by emissions outside of New Zealand. The choices and investments of international businesses and governments will therefore greatly affect the climate change this country ultimately faces and the resulting economic and fiscal impacts.

While the broader international context will also affect New Zealand's transition-related impacts, the choices and actions of government, businesses and households in this country will have relatively more influence on the size of impacts and how they are distributed across the economy and society.

Key areas of policy choice include:

- › The mix and timing of policies to build resilience to climate change and how the responsibilities and costs of natural hazard risk management are shared across individuals, the private sector, local authorities and central government.
- › The mix and timing of policies to drive domestic emissions reductions, including the balance of effort toward net and gross emissions (in particular choices around land-use change and the role of sequestration in achieving New Zealand's targets), and the mix of spending and non-spending levers used.
- › The balance of domestic and offshore mitigation toward New Zealand's NDCs.
- › What sources of offshore mitigation New Zealand pursues and when, affecting the options available, and the cost and the achievement of NDC1.
- › The ambition of future emissions reduction targets, including domestic budgets and future NDCs.
- › To what degree and how governments choose to address the equity impacts of climate change.

## Next steps

We intend to update this report over time to present the best available information for the economic and fiscal impacts of climate change on New Zealand. Areas where future research would be valuable include.

- › Building a more robust view of the long-term macroeconomic implications of physical risks from climate change for New Zealand's economy.
- › Updated modelling on the wider macroeconomic impacts of climate change (such as on New Zealand's trade balance) and building better understanding of the potential macroeconomic implications from investment in domestic action (such as innovation and growth benefits).
- › How the impacts of physical climate and the low-emissions transition could interact and compound, particularly at a sectoral level.
- › Improving understanding of the unique implications of climate change for Māori and exploring how different impact channels could interact.
- › Building a better understanding of risks to the Crown's balance sheet from assets exposed to climate change risks.
- › Better understanding the potential non-emissions implications from investments in domestic action (including any innovation or growth benefits).

**Table 1: Physical climate risks – summary of economic and fiscal implications**

Summary of expected impacts	Key quantitative evidence (see relevant section for more detail, including limitations)	Key sources of variability
<b>Economic impacts</b>		
 <p><b>Macro-economic impacts</b></p> <ul style="list-style-type: none"> <li>› A fall in GDP growth due to expected damages to assets, lost productivity and supply chain disruptions.</li> <li>› New Zealand may be less vulnerable to physical climate risk than many other countries, in part due to its strong institutions and economic and fiscal resilience.</li> </ul>	<ul style="list-style-type: none"> <li>› The average of the modelled simulations by the Treasury indicated that the impact of increasing the frequency of droughts would cause GDP to be 0.5% lower in 2061 than the assumed counterfactual trend. A scenario with increased storms and/or floods estimates this impact would be a 0.7% decrease (Section 4.1 and Box 6.1).</li> </ul>	<ul style="list-style-type: none"> <li>› New Zealand contributes approximately 0.17% of the world's gross greenhouse gas emissions. The future climate change New Zealand faces will therefore be heavily dependent on global action.</li> </ul>
 <p><b>Sectoral impacts</b></p> <ul style="list-style-type: none"> <li>› Dependence on climate-sensitive resources means the primary sector and tourism are likely to be most affected.</li> <li>› Regions dominated by primary production or in low-lying coastal areas are expected to be particularly affected.</li> <li>› Extreme weather events and sea-level rise are likely to have a negative impact on the value and functioning of public assets and infrastructure (such as roads).</li> <li>› Households facing high natural hazard risk are likely to find it harder to get affordable insurance.</li> <li>› Māori are expected to face unique impacts from risks to sites of cultural significance, for example many marae and urupā are in coastal low-lying areas.</li> <li>› Physical assets will have increased risk of damage, with the potential for higher insurance claims and loss of financial value.</li> </ul>	<ul style="list-style-type: none"> <li>› NIWA analysis shows that sea-level rise of 30cm could expose an additional \$6 billion worth of buildings, 409km of roads and one airport to coastal flooding (Box 4.6).</li> <li>› The Treasury estimated that physical climate impacts caused at least \$120 million of private insured damages from floods, and \$720 million in economic losses from droughts between 2007 and 2017 (Box 4.1).</li> <li>› There is a trend of increasing insured damages from weather-related events over the last decade (Figure 4.1).</li> <li>› Research for the Deep South Science Challenge projects that 10,000 houses in Auckland, Wellington, Christchurch and Dunedin could become uninsurable by 2050 because of coastal flooding hazards from sea-level rise (Box 4.5).</li> <li>› About 12% of bank lending in New Zealand is directed to the agricultural sector, which faces relatively high exposure to climate change (Box 4.4).</li> </ul>	<ul style="list-style-type: none"> <li>› Adaptation choices by households, communities, businesses, and local and central government will affect long-run costs.</li> <li>› Policy choices by the Government will affect how the costs and risks associated with adaptation and building resilience are shared.</li> <li>› Impacts on the competitiveness of domestic sectors will depend on the relative impacts of physical climate change in New Zealand and abroad.</li> </ul>
<b>Fiscal impacts</b>		
 <p><b>Fiscal impacts</b></p> <ul style="list-style-type: none"> <li>› Key areas of fiscal pressures are expected to be: <ul style="list-style-type: none"> <li>– additional costs for disaster response, for example costs of supporting the repair of essential infrastructure</li> <li>– investment to reduce risk for public assets, and any potential support for risk reduction measures for private assets</li> <li>– support for households, businesses and communities to transition to lower emissions or more resilient ways of operating.</li> </ul> </li> <li>› Lower economic activity and crystallisation of climate-related fiscal risks are likely to negatively impact Crown revenue.</li> </ul>	<ul style="list-style-type: none"> <li>› Net core Crown debt could be higher by 3.77% of GDP in 2061 from increased storms and droughts that could result from climate change (Box 6.1).</li> <li>› NZIER estimate that climate change could cause an increase in the annual growth of the Crown liability for natural hazards from 5.3% to 5.5%-5.7% through to 2050, due to increased risk from storms and floods (Box 6.1).</li> </ul>	<ul style="list-style-type: none"> <li>› The choices of key actors, in particular central and local government, will have large implications for how fiscal impacts are realised. For example, choices around: <ul style="list-style-type: none"> <li>– risk management and adaptation policy settings, including how risks and costs may be shared between individuals, the private sector, local authorities and central government</li> <li>– the use of any redistributive and compensatory policies to address the broader equity impacts of climate change.</li> </ul> </li> </ul>



**Table 2:** The transition to a low-emissions economy – summary of economic and fiscal implications

Summary of expected impacts	Key quantitative evidence (see relevant section for more detail, including limitations)	Key sources of variability
<p><b>Economic impacts</b></p>  <p><b>Macro-economic impacts</b></p> <ul style="list-style-type: none"> <li>› GDP is expected to continue to grow, although at lower levels relative to baseline counterfactual scenarios.</li> <li>› Additional investment in key mitigation technologies beyond baseline counterfactual levels is expected to be required to meet New Zealand’s emissions targets.</li> </ul>  <p><b>Sectoral impacts</b></p> <ul style="list-style-type: none"> <li>› The composition of the economy is likely to significantly change, with the land and energy sectors and others reliant on fossil fuels particularly affected.</li> <li>› Adverse impacts from changing consumer prices over time are likely to disproportionately affect lower-income households.</li> <li>› Māori are especially vulnerable to transitional impacts, being over-represented in lower-income households and in high-emitting sectors.</li> <li>› The financial system faces some degree of risk from transition-related business closures.</li> <li>› The transition has the potential to provide significant co-benefits, for example through improvements in health and environmental wellbeing.</li> </ul>	<ul style="list-style-type: none"> <li>› The CCC estimated that achieving New Zealand’s domestic targets in line with its modelled demonstration pathway: <ul style="list-style-type: none"> <li>– could reduce the rate of GDP growth over the period 2020 to 2050 by 0.04% and the level of GDP in 2050 by 1.2% compared to its modelled counterfactual (Table 5.1)</li> <li>– could require an additional \$38 billion of capital investment in key sectors through to 2050 beyond the investment assumed under its counterfactual scenario (Box 5.1).</li> </ul> </li> <li>› Findings from Treasury modelling of the impacts of NZ ETS prices on household expenditure indicate that petrol, electricity and other price changes will be regressive, and Māori households will be more negatively impacted (Figure 5.2).</li> <li>› Recent modelling indicates that introducing a price on agricultural emissions is likely to result in significant land-use change and a reduction in aggregate net revenue for the agriculture sector (Box 5.2).</li> </ul>	<ul style="list-style-type: none"> <li>› The pace of technological innovation and New Zealand’s rate of uptake of low-emissions technologies will influence overall economic costs.</li> <li>› The economy’s ability to efficiently reallocate resources toward, and enhance productivity in, low-emitting activities will be a key determinant of economic costs.</li> <li>› Behavioural shifts at a household level will affect the pace of the transition and overall economic impacts.</li> <li>› The timing and impact of domestic policy choices will affect overall transition costs and how they are distributed across the economy.</li> <li>› The effect of any disruptive changes on social cohesion will have implications for how the economy functions.</li> </ul>
 <p><b>Fiscal impacts</b></p> <ul style="list-style-type: none"> <li>› Key areas of fiscal pressure are expected to include: <ul style="list-style-type: none"> <li>– publicly funded measures to support domestic emissions reduction and investment in offshore emissions reduction</li> <li>– international climate finance contributions</li> <li>– support for disrupted households, businesses, communities, and other measures to support the objective of an equitable low-emissions transition.</li> </ul> </li> <li>› Impacts on Crown revenue are likely to be negative. Adverse impacts on GDP are expected to reduce revenue bases. Changes in the transport system will have some adverse impacts on revenue over time.</li> <li>› The Crown asset base is expected to require changes in both nature and scale to support the transition.</li> <li>› Since late 2021 cash proceeds from NZ ETS auctions have been used as the basis for public spending on climate change as funded through the recently established CERF.</li> </ul>	<ul style="list-style-type: none"> <li>› Based on the illustrative scenario analysis in this report, the cost of offshore mitigation purchases required to meet NDC1 (in addition to domestic action) represents a significant fiscal risk under all scenarios considered (Section 7).</li> <li>› Illustrative modelling indicates that, depending on future auction prices, the cash proceeds from NZ ETS auctions over the period 2023 to 2026 could range from \$2.4 billion to \$6.2 billion (Table 6.4).</li> <li>› Illustrative calculations based on CCC modelling indicate that the fiscal cost of direct support for additional investment (beyond considered counterfactual levels) in a range of key mitigation technologies through to 2050 could be around \$4 to \$12 billion, assuming the Crown contributes 10% to 30% of investment costs (Table 6.2).</li> </ul>	<ul style="list-style-type: none"> <li>› Key policy choices include the mix and timing of domestic mitigation measures, how current and future governments choose to leverage available spending and non-spending levers, the balance of effort toward domestic and offshore mitigation action, the ambition of future emissions targets (for example future NDCs), and the use of balance sheets to fund the transition (for example low-emissions hospitals).</li> <li>› The volume required and purchase price of offshore mitigation to support achieving New Zealand’s NDC1 will be influenced by both domestic policy decisions and wider developments, including a shifting international context.</li> <li>› Fiscal flows from the NZ ETS depend on variables such as regulatory settings, supply and demand.</li> </ul>

# 1

## INTRODUCTION

### THIS SECTION COVERS:

the purpose and  
structure of this report

how the report relates  
to existing reporting in  
NZ and abroad, as well  
as NZ-specific wellbeing  
frameworks

limitations of the report  
due to uncertainties  
and gaps in knowledge

our intentions to  
update the report in  
future.

### Purpose of the Climate Economic and Fiscal Assessment

This report brings together information on the economic and fiscal implications of climate change and New Zealand's response to it.

In summary, the report:

- › presents a framework to assess the different ways climate change could affect New Zealand's economy and public finances
- › assembles and summarises the latest available information and evidence on the potential economic and fiscal impacts of climate change in New Zealand
- › identifies areas of value for deepening our understanding of these impacts
- › provides new analysis carried out by the Treasury and the Ministry for the Environment (MfE) on potential fiscal costs of purchasing offshore mitigation to meet New Zealand's first commitment under the Paris Agreement.

The purpose of consolidating this information in one place is to help decision-makers across the public and private sectors identify and manage the risks and opportunities of physical climate change and New Zealand's transition to a low-emissions and climate-resilient future.

## Structure of this report

This report is structured as follows:

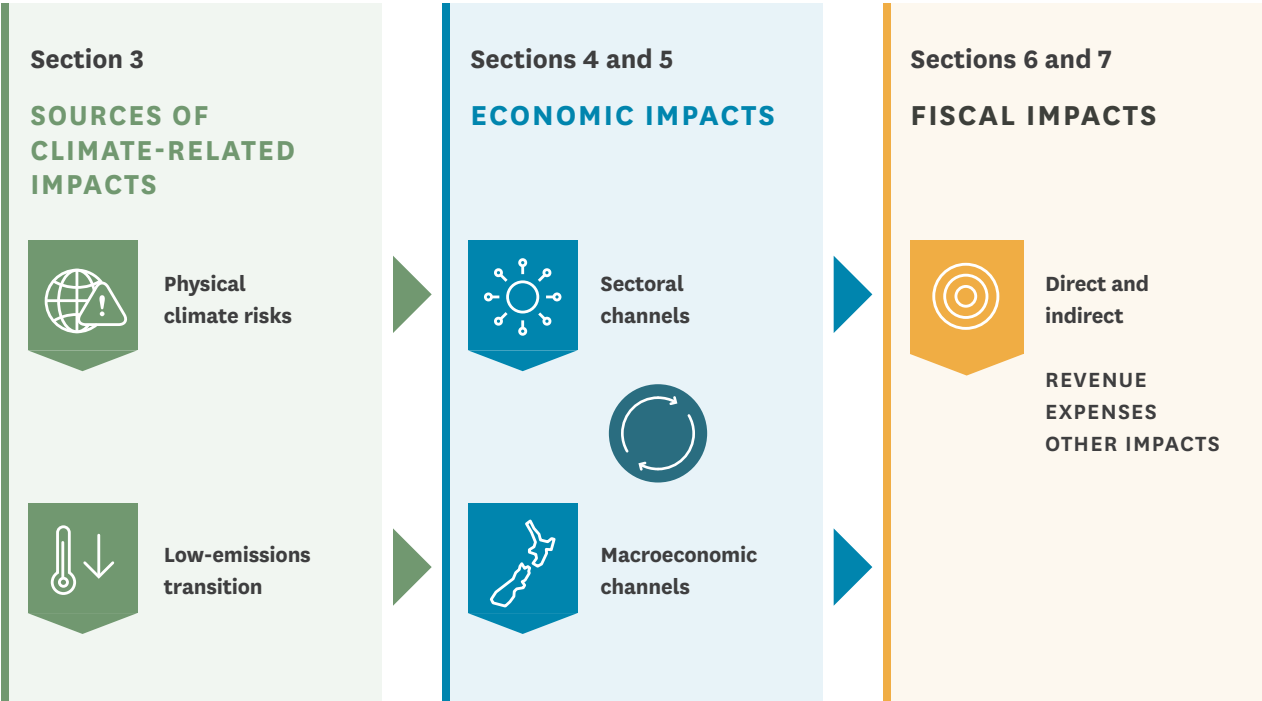
**Section 2** outlines the framework to show how climate change could affect New Zealand’s economy and public finances. It draws on both established international and domestic approaches and gives a frame for the rest of the report.

**Section 3** provides key context about the two main sources of climate-related economic and fiscal impacts for New Zealand – physical climate change and the transition to a low-emissions economy.

**Sections 4 and 5** summarise anticipated economic impacts from physical climate change and the low-emissions transition.

**Section 6** summarises anticipated fiscal impacts due to the economic (or wider) impacts of climate change.

**Section 7** presents a scenario analysis for the potential fiscal costs of purchasing offshore mitigation toward meeting New Zealand’s first Nationally Determined Contribution (NDC1).





## How this report relates to international climate reporting

Globally, more and more public and private sector entities are reporting on the climate impacts, opportunities and risks they face. In the public sector, key reports have been published by government entities on both the economic and fiscal risks that climate change poses to countries or states.

The trend of increased climate-related risk and opportunity reporting has been supported and accelerated most clearly by the recommendations of the Financial Stability Board's Task Force for Climate-related Financial Disclosures (TCFD).<sup>1</sup>

The TCFD framework creates a structure through which organisations can better identify, manage and disclose climate-related risks and opportunities. It facilitates a more forward-thinking, strategic approach and helps organisations link climate change and resulting impacts to their strategy (for example its specific recommendations on governance, strategy, risk management, and metrics and targets).

Within this broader international context, the CEFA is most aligned with publications from public sector entities such as the United Kingdom (UK) Office for Budget Responsibility, the New South Wales (NSW) Treasury and the United States' Office of Management and Budget.<sup>2</sup> However, much like the approach taken across these reports, the findings and recommendations of the TCFD are influencing how both public and private sector entities alike think about and classify climate risks and opportunities. Box 1.1 has more detail on how the CEFA has been informed by the high-level messages and recommendations of the TCFD.

Ultimately, the purpose of the CEFA is to serve as a repository of information on the anticipated economic and fiscal impacts of climate change on New Zealand. *It is not* an attempt to formally disclose the climate-related risks and opportunities faced by New Zealand. However, as decision-makers face key choices, we hope the framework, impacts and analysis presented in the CEFA can complement and support more detailed analysis, decision-making and, ultimately, reporting.

### Box 1.1

#### How the framework and insights of the TCFD have informed the CEFA

##### Framework for articulating and classifying climate-related risks

As other public entities have done in reporting on the climate-related economic and fiscal impacts and risks their countries and states face, the framework presented in the CEFA draws on the TCFD's classification of climate-related risks into two broad categories – physical and transition risk.

Rather than map these risks and opportunities through to an organisation's income or balance sheet, the CEFA framework articulates broader economic channels through which New Zealand's economy, public finances and broader wellbeing are impacted. This is because the CEFA seeks to consider all-of-economy impacts, and does not treat the economy like an organisation.

##### Highlighting areas of importance

The TCFD's recommendations are underpinned by a core focus on understanding the climate-related risks and opportunities faced by an organisation to promote more robust decision-making, governance and risk management process. This will help to integrate climate-related considerations into an organisation's core strategy.

Underpinning the CEFA is a similar intent – to provide information that both public and private decision-makers can consider as they make key choices that will shape how climate change will ultimately impact New Zealanders. Over time, greater levels of detail and understanding of the data at aggregate and distributional levels will strengthen the information set. The CEFA's intent is to overview such information and collect it in one place, identifying areas for further work, and not to provide the entire information set either a public or private decision-maker will ultimately require.

1 The UK Office for Budget Responsibility (2021) *Fiscal Risk Report – July 2021* addresses the long-term sustainability of the UK's public finances, with three specific topics covered including climate change; the NSW Treasury report by Wood, Beauman & Adams (2021) *An Indicative Assessment of Four Key Areas of Climate Risk for the 2021 NSW Intergenerational Report* sets out an approach to assessing physical climate risks for NSW from an economic and fiscal perspective; and the United States Office of Management and Budget (2022) *Climate Risk Exposure: An Assessment of the Federal Government's Financial Risks to Climate Change, April 2022* report assesses the risk in the United States from physical climate impact on six government programmes.

2 Task Force on Climate-Related Financial Disclosures, 2017.

**Table 1.1:** Summary of the existing climate reporting landscape across government in New Zealand

Publication	Owner	Frequency	Forward or backward looking	Fiscal outcomes	Economic outcomes	Environmental and climate outcomes			Broader wellbeing outcomes
						Progress against emissions targets	Progress against policy outcomes	Physical impacts of climate change	
<b>Ngā Kōrero Āhuarangi me te Ōhanga (Climate Economic and Fiscal Assessment)</b>	<b>The Treasury and MfE</b>	<b>Periodically</b>	<b>Both</b>	✓	✓				
Economic and Fiscal Updates	The Treasury	Twice annually	Forward	✓	✓				
Financial Statements of Government	The Treasury	Annual	Backward	✓					
Reporting on the Climate Emergency Response Fund	The Treasury	Six monthly	Backward	✓					
Sovereign Green Bond Programme reporting <sup>3</sup>	The Treasury	Annual	Backward	✓					
Climate Change Interdepartmental Executive Board monitoring against the Emissions Reduction Plan <sup>4</sup>	Interdepartmental Executive Board	Annual	Both			✓	✓		
CCC monitoring of progress against emissions targets <sup>5</sup>	Climate Change Commission	Annual	Both			✓	✓		
National Climate Change Risk Assessment	Climate Change Commission	Six-yearly (next in 2026)	Both					✓	
Progress update on the National Adaptation Plan	Climate Change Commission	Two yearly (from 2024)	Backward				✓		
Retrospective evaluation of progress toward domestic emissions budgets	Climate Change Commission	Roughly five-yearly	Backward			✓	✓		
National Greenhouse Gas Inventory Report	MfE	Annual	Backward						
Environmental Reporting	MfE	Six monthly	Both					✓	✓
Investment Statements	The Treasury	Four yearly	Both	✓					
Long-term Fiscal Statement	The Treasury	Four yearly	Forward	✓					
Wellbeing Report: <i>Te Tai Waiora</i>	The Treasury	Four yearly	Both		✓		✓		✓
Target Progress Update ( <i>formerly Net Position Report</i> )	MfE	Annual	Backward			✓			
Biennial Report and National Communication Report	MfE	Every two; and every five years	Both			✓	✓		

<sup>3</sup> Reports forthcoming.

<sup>4</sup> Reports forthcoming.

<sup>5</sup> For more information, see [www.climatecommission.govt.nz/our-work/monitoring/](http://www.climatecommission.govt.nz/our-work/monitoring/)

## How this report fits in the climate change reporting landscape in New Zealand

Several reports published by government agencies present information on climate change, the economy or public finances to varying degrees. Table 1.1 summarises the current reporting landscape. This report contributes to this growing landscape by looking in depth at the economic and fiscal implications of climate change on New Zealand.

## Use of New Zealand-specific wellbeing approaches to inform the report

The first National Climate Change Risk Assessment (NCCRA) and the Treasury's report, *Te Tai Waiora: Wellbeing in Aotearoa New Zealand 2022*, both identified climate change as a key risk to the future wellbeing of New Zealanders.<sup>6</sup>

Given the significance of climate change for future wellbeing, the development of the climate impacts framework in this report has been informed by two existing New Zealand-specific wellbeing frameworks – the Treasury's Living Standards Framework (LSF) and He Ara Waiora (see Box 1.2).<sup>7</sup> The climate impacts identified reflect risks and opportunities expected to affect multiple dimensions of New Zealanders' wellbeing. This report has a particular focus on

physical and financial capital given its significance for the Crown's fiscal position, although it also looks at several wellbeing impacts that are unique to Māori as seen through a te ao Māori lens.

While the report touches on a range of wellbeing impacts, it is not a comprehensive effort to assess the wellbeing impacts of climate change on New Zealanders using the LSF or He Ara Waiora. Deepening our understanding of how climate change affects wider dimensions of wellbeing – especially those important for Māori wellbeing, as reflected by the central roles of wairua (spirit) and te Taiao (the natural world) in He Ara Waiora – is an important area for further work.

## This report reflects the current state of knowledge and highlights areas of uncertainty

The assessment of climate-related impacts in this report is based on current knowledge, which is subject to limitations and uncertainties. In many cases the likelihood of an impact is highly certain, but information about its potential size and timing may be limited. Where possible, the report gives quantitative

estimates to show the potential size of a given impact. Where these estimates are not available, impacts are discussed more qualitatively. Over time, we expect the information on the scale and timing of some impacts to improve.

## We intend to continually update our reporting over time

We intend to update this report in the future to present the best available information for the economic and fiscal impacts of climate change on New Zealand. As our understanding of these impacts improves, so too will our ability to articulate them in future reports.

<sup>6</sup> Ministry for the Environment, 2020; The Treasury, 2022a.

<sup>7</sup> For more information on the LSF, see The Treasury (2021a). For more information on He Ara Waiora, see The Treasury (2021b).

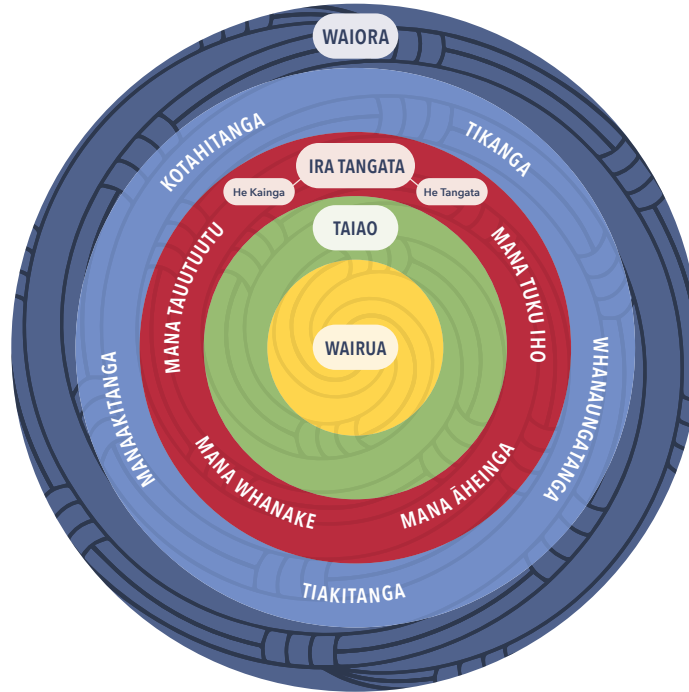


## Box 1.2

### Description of He Ara Waiora

He Ara Waiora is a framework that helps the Treasury to understand waiora, a Māori perspective on wellbeing. Developed by Māori thought leaders, Ngā Pūkenga, the framework articulates both the ends that are important for achieving waiora and the means that help to achieve these outcomes.

**Figure 1.1:** He Ara Waiora framework



Flowing outwards from the centre, these are the three fundamental concepts:

- › **Wairua** (spirit, intuition, emotion, expression) is at the centre to reflect that it is the foundation or source of wellbeing. Values, beliefs and practices related to wairua are essential to Māori concepts of waiora.
- › **Te Taiao** (the natural and living state of the world) is paramount and inextricably linked with human wellbeing. Humans have responsibilities and obligations to sustain and maintain the balance of relationships with Te Taiao to ensure abundance for current and future generations.
- › **Te Ira Tangata** encapsulates human activities and relationships. This includes four aspects of mana (power, authority, influence) in which human action towards wellbeing takes place.

Surrounding these concepts are five key values:

- › **Kotahitanga** – working in an aligned, coordinated way
- › **Tikanga** – making decisions in accordance with the right values and processes, including in partnership with the Treaty partner
- › **Whanaungatanga** – fostering strong relationships through kinship and/or shared experience that provide a shared sense of wellbeing
- › **Manaakitanga** – enhancing the mana of others through a process of showing proper care and respect
- › **Tiakitanga** – guardianship, stewardship of, for example, the environment, particular taonga or other important processes and systems.

# 2

## FRAMEWORK FOR ASSESSING CLIMATE-RELATED ECONOMIC AND FISCAL IMPACTS

### THIS SECTION:

presents a framework developed for this report to show how climate change can affect the economy and public finances.

### Summary

- › The framework in this report draws on existing domestic and international approaches to examining the economic and fiscal impacts of climate change.
- › The framework's focus is New Zealand-specific impacts and the ways they can affect the economy and the Crown's fiscal position.
- › The framework's core elements are:
  - **Sources of climate-related impacts** – including physical impacts of climate change and the implications of New Zealand's transition to a low-emissions economy.
  - **Economic impact channels** – to show how climate impacts can affect the economy. These include sectoral channels (such as households, industries, businesses, whānau, hapu and iwi, central and local government) and macroeconomic channels.
  - **Fiscal impacts** – these can be direct (such as the fiscal costs of repairing damaged public assets or directly funding mitigation policies) and indirect (such as through changes to the size and composition of the Government's tax base).
  - **Sources of variability** – factors influencing both the scale and nature of identified impacts (such as future domestic policy choices or global economic conditions).

This section presents a framework for assessing the likely impacts of climate change on New Zealand's economy and public finances.

This framework draws on existing domestic and international frameworks, including:

- › Frameworks for climate risk and opportunity identification developed by the TCFD and the Network for Greening the Financial System (NGFS)<sup>8</sup>, the UK's Office for Budget Responsibility<sup>9</sup> and the Coalition of Finance Ministers for Climate Action.<sup>10</sup>
- › The classification system used in New Zealand's first NCCRA to inform our conceptual approach to considering physical climate risk.<sup>11</sup>

8 Network for Greening the Financial System, 2019.

9 Office for Budget Responsibility, 2021 (p. 83-152).

10 Dunz & Power, 2021.

11 Ministry for the Environment, 2020.

## 2.1 Sources of impact

The framework groups the ultimate sources of climate-related impacts into **two broad categories**:



**Physical climate change**<sup>12</sup> – physical changes in the climate, including increased severity and frequency of adverse weather events (such as droughts and storms) and gradual changes (such as temperature and sea-level rise).



**Low-emissions transition** – the economic and societal changes from reducing emissions in line with achieving New Zealand’s emissions targets (could be policy, legal, technology, market or reputational in nature).

## 2.2 Economic impact channels



There are multiple channels through which these changes ultimately affect the economy (such as through employment and incomes for households, business access to finance and the balance sheets of local authorities). In reality, precise impacts are likely to vary across and within different groups (such as households and communities) and actors (such as banks and companies). Macroeconomic impact channels will also affect the wider population, for example through impacts on consumption or investment. How resilient New Zealand’s political, economic, social and cultural institutions are in responding to shocks, stressors, impacts and opportunities will have further implications for how these impacts are realised.



Climate change, and New Zealand’s response to it, will affect many aspects of Māori life. Māori are kaitiaki of their whenua, leaders in their communities, decision-makers about resources and infrastructure, landowners and business owners. Māori as tangata whenua are also vulnerable to the effects of climate change.

As noted, how the framework considers the unique impacts of climate change on Māori is informed by He Ara Waiora. For instance, the wellbeing ‘ends’ of mana āheinga (aspirations and capability) and mana whanake (sustainable prosperity), along with implications for mātauranga, cultural sites and te Ōhanga Māori (the Māori economy), are captured through the ‘whānau, hapū and iwi’ impact channel.

## 2.3 Fiscal impacts

These impact channels will have flow-on effects for the Government’s fiscal position both directly and indirectly:



**Direct impacts**, such as the costs of repairing damaged buildings and public infrastructure, funding specific mitigation and adaptation across the economy, or targeted expenditure to reduce the distributional costs of climate change, and revenue from the NZ ETS.



**Indirect impacts**, such as those from reduced economic growth (for example, from more extreme weather shocks) and changes to the Crown’s tax revenue, asset base value or cost of borrowing (including through potential changes to credit ratings).

## 2.4 Sources of variability

Multiple factors will influence the scale and timing of impacts, and who bears them. These factors tend to be complex and are referred to in the framework as **sources of variability**.

Examples include:

- › the economy and society’s capacity to adapt to a changing physical environment
- › future changes in global economic conditions
- › future domestic and international policy decisions.

The way that impacts compound upon and interact with each other is an additional source of variability as they often do not occur in isolation.

The framework further classifies sources of variability as ‘amplifiers’ or ‘moderators’.<sup>13</sup>

- › **Amplifiers** are factors that can worsen or heighten impacts. For example, families and households could face financial pressures from increased damage to their properties from flooding at the same time as pressures to decarbonise how they heat their household.
- › **Moderators** can dilute or reduce the overall impact. For example, previous adaptation actions and broader resilience factors (such as supply chain diversification and availability of insurance) that could dampen the potential impacts of climate risks on the economy and public finances.

<sup>12</sup> The CEFA uses the term ‘physical climate change’ (instead of simply ‘climate change’) in order to make a clear distinction when discussing the economic and fiscal impacts caused by physical effects of climate change and those caused by the transition to a low-emissions economy.

<sup>13</sup> This terminology and approach draw on the work of the Bank for International Settlements (2021).

Figure 2.1: Framework for assessing the economic and fiscal impacts of climate change in New Zealand

## SOURCES OF CLIMATE-RELATED IMPACTS

**Physical climate risks**

**CHRONIC**

- Temperature increase
- Sea-level rise

**ACUTE**

- Heatwaves
- Flood
- Drought
- Wildfires
- Storms

**ADAPTING AND BUILDING RESILIENCE TO PHYSICAL IMPACTS**

- Strategies, policies and proposals to help understand and respond to physical risks

**Low-emissions transition**

- Policy
- Technology
- Preferences and sentiment

## ECONOMIC IMPACTS

**Sectoral channels**  
*Impacts on individuals and sectors*

**FAMILIES AND HOUSEHOLDS**

- Income and wealth
- Health
- Access to finance
- Employment and skills

**CENTRAL AND LOCAL GOVERNMENT**

- Balance sheet
- Sources of funding
- Spending
- Revenue sources
- Regulatory activities

**FINANCIAL MARKETS**

- Credit risk
- Market risk
- Liquidity risk
- Underwriting risk
- Operation risk
- Capital allocation

**WHĀNAU, HĀPU AND IWI**

- Te Ōhanga Māori
- Mātauranga
- Cultural sites
- Manā āheinga
- Manā whanake

**FIRMS AND MARKETS**

- Balance sheet
- Supply chains
- Access to capital
- Legal liabilities

**INTERNATIONAL CONNECTIONS**

- International policies
- Carbon leakage
- Spill-over impacts

**Feedback effects**

**Macroeconomic channels**  
*Aggregate impacts*

**DEMAND FACTORS**

- Consumption
- Trade
- Investment

**SUPPLY FACTORS**

- Capital stocks
- Technology
- Innovative capabilities
- Labour, energy and other inputs

## FISCAL IMPACTS

**Direct impacts**

**REVENUE**

- Emissions Trading Scheme revenue

**EXPENSES**

- Repairs to public infrastructure and assets
- Replacing damaged infrastructure and assets
- Support for disrupted households and businesses
- Funding for mitigation and adaption policies
- Emissions trading scheme liability

**OTHER**

- Write-down and impairment of existing assets
- New adaption and mitigation assets

**Indirect impacts**

**REVENUE**

- Changing composition and size of the Crown's revenue bases

**EXPENSES**

- Borrowing costs
- Pressure on the public services (eg, health, welfare)

**OTHER**

- Valuations of assets on balance sheet
- Contingent liabilities
- Additional borrowing to fund mitigation and adaption policies
- Impacts on credit rating

Risk interactions  
Resilience

**Sources of variability**

**MODERATORS**

- Adaptive capacity
- Resilience
- Behavioural change

**AMPLIFIERS**

- Risk interactions
- Impact channel interactions

**POLICY CHOICES**

- Adaption
- Support for transition

Policy choices  
Impact interactions

# 3

## SOURCES OF CLIMATE-RELATED ECONOMIC AND FISCAL IMPACTS

### THIS SECTION:

explains how climate change and the transition to a low-emissions future are sources of economic and fiscal impacts

describes New Zealand's current climate-related commitments and strategies

discusses how climate-related impacts will depend on a range of domestic and international factors.

### Summary

- › New Zealand is already experiencing climate change effects, with higher temperatures, more frequent droughts and extreme storms, and rising sea levels. This trend is expected to continue over time, although the magnitude of impacts is hard to forecast with great certainty.
- › Median projections of **physical impacts** in New Zealand for the year 2040 (relative to 1986 to 2005) under low and high global emissions pathways range from:
  - a mean temperature increase of 0.7°C to 1.0°C
  - a 5% to 7% increase in the intensity of extreme rainfall events
  - sea-level rise of 23cm to 28cm (by 2050).
- › New Zealand has made several domestic and international commitments in line with global efforts to curb future climate change:
  - **Domestically** New Zealand has committed to:
    - a net-zero long-lived greenhouse gases target by 2050
    - a 24% to 47% gross reduction target for biogenic methane by 2050
    - the first three emissions budgets (across the period 2022 to 2035) that will act as stepping stones towards the 2050 targets – allowing a total of 835 Mt CO<sub>2</sub>e across the period.
  - **Internationally** New Zealand has committed to its first NDC under the Paris Agreement, which includes a target of a 50% reduction in net emissions below the country's gross emissions level in 2005 by 2030.
- › How climate change affects New Zealand will be shaped by future decisions and actions taken by government, business, iwi and households. Being a relatively small economy, global action and context will also play an important role. The bulk of physical climate change experienced by this country will be a function of global emissions, of which New Zealand only contributes 0.17%.





## 3.1 Physical climate change as a source of impacts



### What are the risks due to physical climate change?

Physical climate risks include increases to the severity and frequency of existing natural hazards (such as floods and droughts) or new natural hazards arising from climate change (such as widespread coastal inundation or increased risk of incursion of new tropical pest species). These risks can be connected with events (such as extreme storm or rainfall events) or gradual change (such as a permanent shift in seasonal rainfall patterns or greater ocean acidification). Importantly, the nature and severity of hazards will vary between different regions, communities and individual households.

**Table 3.1:** Examples of event-related and gradual risks exacerbated by climate change

Risk category	Hazards
 <b>EVENT-RELATED RISKS</b>	Inland flooding, coastal flooding, extreme winds, heatwaves, droughts, wildfires, slips
 <b>GRADUAL RISKS</b>	Temperature rise, sea-level rise, ocean acidification, changes in rainfall patterns, erosion, saltwater intrusion

### New Zealand is already feeling the impacts of climate change

New Zealand's average annual temperature has increased by 1.1°C over the last 100 years,<sup>14</sup> with 2022 being the warmest year since records began.<sup>15</sup> The country is experiencing more warm days and fewer frost days.<sup>16</sup> Rainfall patterns are changing, with southern and western areas becoming wetter and northern areas becoming drier.<sup>17</sup> The sea level around New Zealand is 0.2m higher on average than a century ago, and the rate of sea-level rise has accelerated to an average of 3.4mm per year today – doubling from 1.7mm over the last century.<sup>18</sup>

### The scale of future physical climate risk to New Zealand is highly dependent on global action to reduce greenhouse gas emissions

Physical risks – and their resultant costs – increase as more greenhouse gases (GHGs) are emitted and temperatures rise.

New Zealand accounts for about 0.17% of global gross emissions<sup>19</sup> and has relatively limited influence on international efforts to reduce emissions. The mitigation efforts of other countries, especially the world's largest economies, will have a large bearing on the scale of physical risk that New Zealand can expect in the future.

<sup>14</sup> Bodeker et al., 2022.

<sup>15</sup> NIWA, 2023.

<sup>16</sup> Bodeker et al., 2022.

<sup>17</sup> Bodeker et al., 2022.

<sup>18</sup> Ministry for the Environment, 2020.

<sup>19</sup> Ministry for the Environment, 2022a. Gross and net emissions are referred to throughout the CEFA. 'Gross emissions' refers to emissions from transport, energy and industry, agriculture, waste and fluorinated gases. 'Net emissions' refers to the overall balance of emissions and CO<sub>2</sub> removals. It is the sum of gross emissions, plus emissions and removals from land use, land-use change and forestry.





## Physical climate impacts are anticipated to worsen even under the most optimistic global emissions pathways

Warming and other climatic changes would continue to occur even if emissions were eliminated today. This is because of pre-existing concentrations of GHGs in the atmosphere.

Representative Concentration Pathways (RCPs) are scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) to model possible future

climate impacts. RCP scenarios consider different levels of GHG concentrations in the atmosphere through to 2100. Table 3.2 gives an overview of how specific climate variables (such as temperature) could change in New Zealand by 2040 and 2090 under a low-emissions (RCP 2.6) and high-emissions scenario (RCP 8.5).

**Table 3.2:** Projected changes to selected climate variables in 2040 and 2090 under RCP 2.6 and RCP 8.5 in New Zealand relative to 1986 to 2005<sup>20</sup>

Variable	Change in 2040	Change in 2090
 <b>Mean temperature</b> Mean temperature will increase overall, with the greatest changes at higher elevations and in summer and autumn	RCP 2.6: +0.7°C (0.2-1.3°C) RCP 8.5: +1.0°C (0.5-1.7°C)	RCP 2.6: +0.7°C (0.1-1.4°C) RCP 8.5: +3.0°C (2.0-4.6°C)
 <b>Intensity of daily rain with 20-year recurrence interval</b> Extreme rainfall event intensity will increase everywhere	RCP 2.6: +5% (2.8 to 7.2%) RCP 8.5: +7% (4.2 to 10.4%)	RCP 2.6: +5% (2.8 to 7.2%) RCP 8.5: (+12.6 to 31.5%) <sup>21</sup>
 <b>Drought</b> Droughts will increase in severity and frequency, especially in already dry areas	No data available for RCP 2.6. Some data is available for RCP 4.5 for 2050: > 5-10% additional time spent in drought in zones 1, 3 and 5 (upper North Island, Eastern lower North Island, Eastern South Island) <sup>22</sup>	No data available for RCP 2.6. RCP8.5: > Drought probability up 50-70% and time spent in drought up by 5-20% in zones 1, 3 and 5 <sup>23</sup> > Increase in potential evapotranspiration deficit: <sup>24</sup> - Northern and eastern North Island 100-200mm - Western North Island 50-100mm - Eastern South Island 50-200mm - Western South Island 0-50mm
 <b>Sea-level rise<sup>25</sup></b>	RCP 2.6 for 2050: +23cm RCP 8.5 for 2050: +28cm	RCP 2.6: +42cm RCP 8.5: +67cm

Source: Unless otherwise stated, all figures are projections sourced from Chapter 11 of the IPCC's Sixth Assessment Report, *Climate Change 2022: Impacts, Adaptation and Vulnerability*<sup>26</sup>, and are for the years 2040 and 2090.

20 All figures are arranged by RCP scenarios following the approach taken by the IPCC when describing New Zealand-specific projections. In future, these metrics are likely to be updated based on the IPCC's new Shared Socioeconomic Pathway (SSP) scenarios, which include assumptions about the socioeconomic drivers influencing future emissions. Uncertainty ranges (5th-95th percentiles) are provided where available.

21 The median projection is omitted for this data point, due to uncertainty over the published median figure of 2% (which lies outside of the uncertainty range published).

22 Clark et al., 2011.

23 Clark et al., 2011.

24 Potential evapotranspiration deficit (PED) is a measure of a lack of soil moisture as a cumulative sum over 12 months. Higher values represent greater levels of drying relative to baseline conditions.

25 This sea-level rise data published by the IPCC has since been supplemented by analysis of vertical land movement in New Zealand, which could further amplify or moderate exposure at a local level. For more information refer to: [environment.govt.nz/assets/publications/Files/Interim-guidance-on-the-use-of-new-sea-level-rise-projections-August-2022.pdf](https://environment.govt.nz/assets/publications/Files/Interim-guidance-on-the-use-of-new-sea-level-rise-projections-August-2022.pdf)

26 Lawrence et al., 2022 (p. 1593).

## Our understanding of physical impacts is likely to improve over time

Predicting how specific climate variables and associated risks will evolve is complex and challenging, especially over longer timeframes. Uncertainty ranges for future climate change impacts have narrowed over successive IPCC reports as climate science and modelling has continued to improve and should continue to reduce over time. In New Zealand, research programmes (such as the Deep South National Science Challenge) are working to improve our understanding

of how specific physical climate risks will respond under different emissions pathways and how best to respond to them.

We know more about some risks than others. For example, there is greater certainty about how sea-level rise will respond under a given amount of warming than about how the frequency and severity of surface and river flooding will respond.

### 3.2 The low-emissions transition as a source of impacts



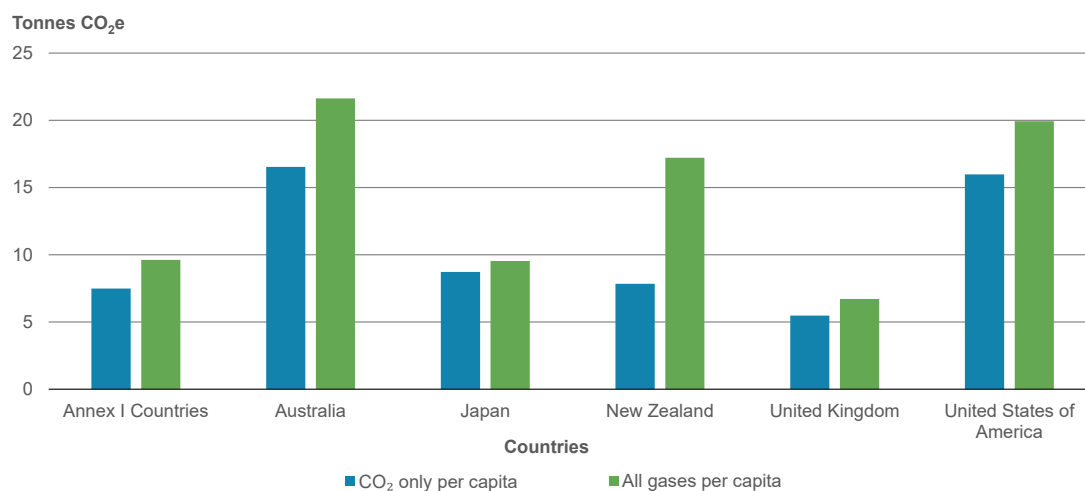
Successive governments have committed New Zealand to playing its part in the global effort to reduce net emissions to avoid the worst impacts of climate change. As noted, New Zealand contributes roughly 0.17% of global gross emissions.<sup>27</sup> However, on a per capita basis, the country's gross emissions are relatively high, especially compared to other developed nations (Figure 3.1).<sup>28</sup>

Despite its relatively small global emissions footprint, New Zealand can influence global emissions levels through trade and diplomacy channels, exporting research, science and innovation for emissions reduction technologies, and demonstrating the use of technologies and behaviours other countries could then follow.

Domestically, New Zealand's emissions footprint is mainly driven by the agricultural sector (50% of gross emissions) and transportation (17% of gross emissions).<sup>29</sup> The land-use and forestry sectors are also key drivers of New Zealand's net emissions levels, offsetting as much as 30% of the country's gross emissions in 2020.

Playing New Zealand's part in helping to reduce global net emission levels will require addressing key sources of gross emissions, as well as supporting the country's ability to continue to offset hard-to-abate emissions through robust emissions removals. The targets New Zealand sets, domestically and internationally, as well as the policy, legislative, technology and market-related changes from achieving these targets will drive impacts related to the low-emissions transition.

**Figure 3.1:** International comparisons for per capita gross GHG emissions in 2019<sup>30</sup>



Source: Ministry for the Environment, 2022a and UNFCCC (n.d.)

<sup>27</sup> Ministry for the Environment, 2022a.

<sup>28</sup> OECD, 2017a.

<sup>29</sup> Ministry for the Environment, 2022a.

<sup>30</sup> Annex I countries under the UNFCCC are those industrialised countries that were members of the OECD in 1992, as well as countries with economies 'in transition' (including Russia, Baltic countries and several Central and Eastern European Countries). See [unfccc.int/parties-observers](https://unfccc.int/parties-observers)

## New Zealand's domestic emissions reduction targets

New Zealand has legislated targets for domestic emissions reduction as stated in the Climate Change Response Act 2002 (CCRA). These are:

- › net-zero emissions of all GHGs (except biogenic methane) by and beyond 2050
- › a 10% gross reduction of biogenic methane emissions from 2017 levels by 2030
- › a 24 to 47% gross reduction of biogenic methane emissions from 2017 levels by 2050.

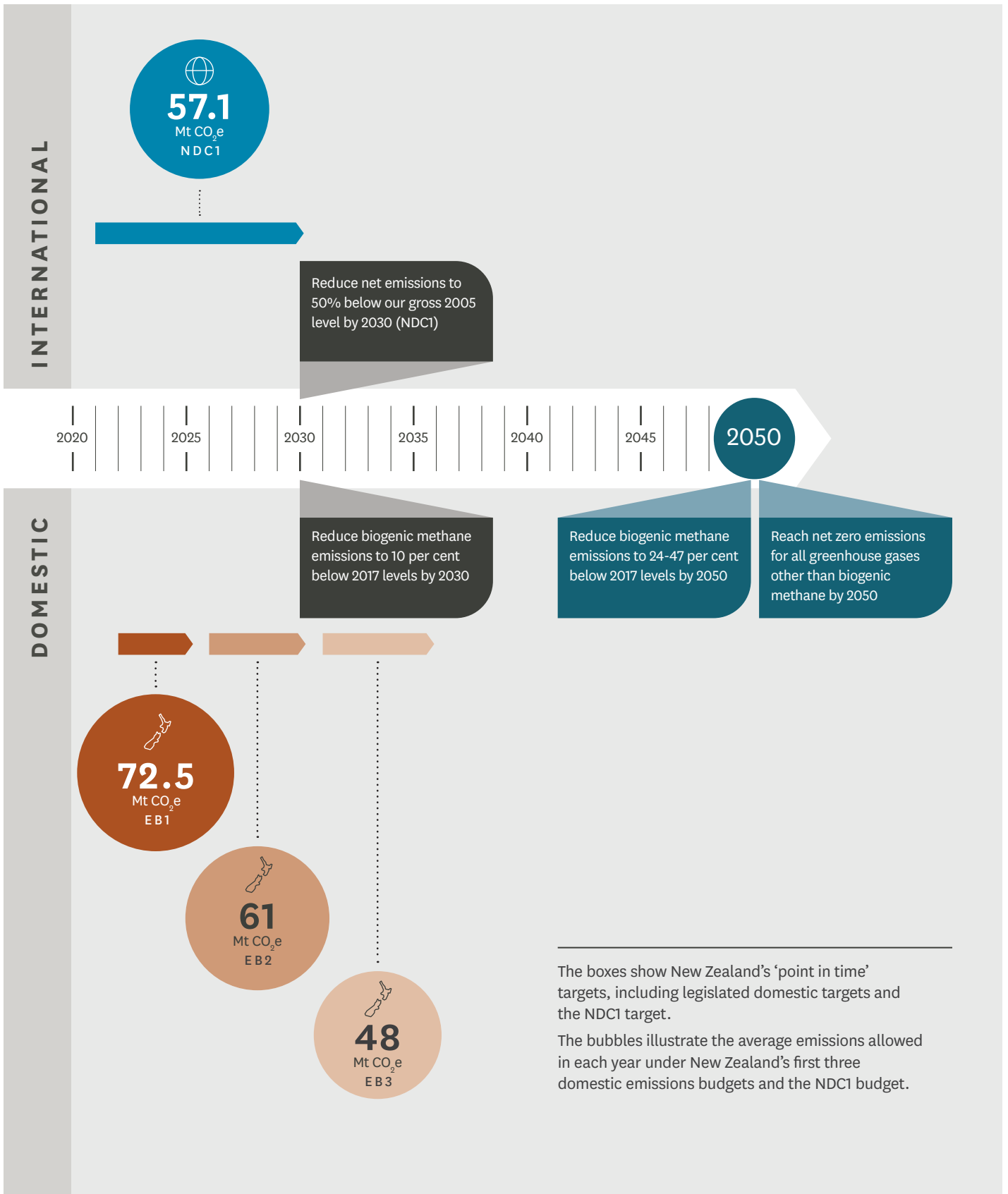
The CCRA also lays out an approach to meeting the country's 2050 targets by setting a series of five-yearly emissions budgets to act as 'stepping stones' towards the ultimate objective. These emissions budgets represent the total quantity of GHG emissions allowable during a defined budget period, represented in Mt CO<sub>2</sub>e. The Government's first three emissions budgets were published in the country's first Emissions Reduction Plan (ERP) in May 2022 and are presented in Figure 3.2 along with New Zealand's other emissions reduction commitments.

## New Zealand's international climate commitments

New Zealand is a Party to the Paris Agreement which sets the goal of holding the increase in the global average temperature rise to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C. Under the Paris Agreement, New Zealand must set NDCs that outline the contributions it intends to make towards delivering on the Agreement's goals.

The Government increased the ambition of New Zealand's first NDC (NDC1) in October 2021 to a 50% reduction of net emissions below the country's 2005 gross emissions level by 2030. To meet NDC1, cumulative domestic net emissions over the period 2021 to 2030 minus the volume of emissions reductions New Zealand funds offshore must not exceed the total (provisional) budget of 571 Mt CO<sub>2</sub>e.

**Figure 3.2:** New Zealand’s current domestic and international emissions reduction commitments



Source: Ministry for the Environment, 2022b & 2022c.



### Box 3.1

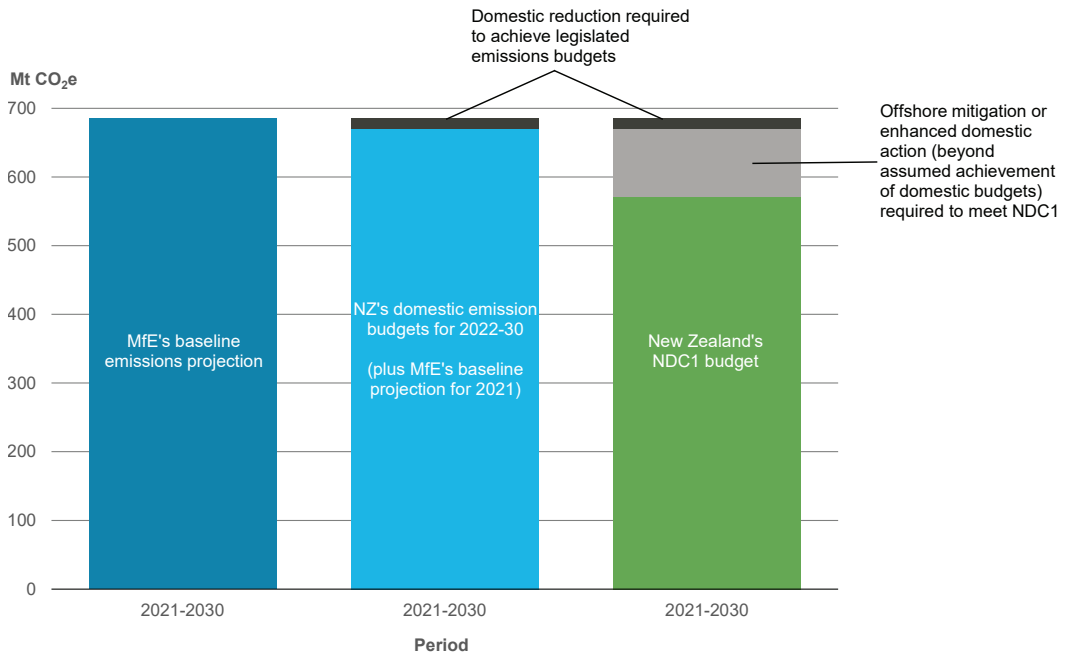
## Differentiating between New Zealand's NDCs and its domestic commitments

New Zealand's NDCs and its domestic emissions targets represent two different types of emissions objectives. Unlike for New Zealand's domestic targets, which legislation indicates should be met (as far as possible) through domestic action, the Paris Agreement explicitly allows for the use of international cooperation to drive greater emissions reductions.

- › **New Zealand's NDCs** are the country's targets for its overall contribution to *global* mitigation efforts. Both domestic and offshore mitigation (mitigation New Zealand supports in other countries) contribute to achieving these targets. Given climate change is a global issue, genuine emissions reductions have the same impact on the climate wherever they occur.
- › **New Zealand's domestic emissions targets** for 2030 and 2050 under the CCRA are focused on domestic action. Offshore mitigation is only expected to be used towards domestic targets in exceptional circumstances.

New Zealand's provisional budget for NDC1 is more ambitious than its domestic budgets over the corresponding time period (2021 to 2030). Therefore, based on New Zealand's domestic budgets, meeting NDC1 will require purchasing offshore mitigation. New Zealand's NDC1 budget over the period 2021 to 2030 is 571 Mt CO<sub>2</sub>e. Exactly achieving New Zealand's domestic emissions budgets is anticipated to result in net domestic emissions of 670.2 Mt CO<sub>2</sub>e over the same period.<sup>31</sup> In this scenario, meeting New Zealand's NDC1 would require purchasing 99.2 Mt CO<sub>2</sub>e of offshore mitigation.

**Figure 3.3:** New Zealand's domestic and international emissions reduction commitments compared to MfE's baseline emissions projection for the period 2021 to 2030



Source: Figure 3.3 is an adapted version of Figure 22.1 in the CCC's *Ināia tonu nei* report (He Pou a Rangī – Climate Change Commission, 2021). MfE's projection of baseline emissions is for 'Target accounting emissions' and is based on the 'With Existing Measures' scenario reported in New Zealand's Eighth National Communication and Fifth Biennial Report. This emissions data was retrieved from Ministry for the Environment (2022d).

<sup>31</sup> This figure assumes New Zealand's first (2022 to 2025) and second (2026 to 2030) domestic emissions budgets (which sum to 595 Mt CO<sub>2</sub>e) are exactly met and that net emissions in the year 2021 were the level as projected under MfE's latest baseline projection (about 75 Mt CO<sub>2</sub>e). Section 7 of this report provides additional detail on estimates of the anticipated volume of offshore mitigation that New Zealand may be required to purchase to achieve NDC1 under a number of illustrative scenarios, including one in which this country exactly achieves its domestic emissions budgets.

### 3.3 Sources of variability

#### **Choices made domestically by present and future governments will have significant implications for shaping impacts**

Domestically, policy decisions of present and future governments will be influential in shaping the size and timing of impacts and how costs may be borne across the economy and society. Box 3.2 describes the present institutional and governance arrangements underpinning the Government's climate response. Box 3.3 describes New Zealand's first ERP and first National Adaptation Plan (NAP), both published in 2022.<sup>32</sup>

Embedding Te Tiriti o Waitangi across present and future governments' climate response will be a key component of emissions reduction and adaptation strategies, with implications for how climate change will affect Māori. Box 3.4 below describes the links to Te Tiriti in the ERP and the NAP.

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<sup>32</sup> Ministry for the Environment, 2022b & 2022e.

## Box 3.2

### **Present institutional and governance arrangements underpinning the Government's climate response**

Climate change is a whole-of-economy and all-of-government issue. A dedicated institutional architecture and governance has been set up to support effective oversight and management across the plans, strategies and actions for delivering the Government's climate policy programme.<sup>33</sup>

#### **Climate Change Response (Zero Carbon) Amendment Act 2019<sup>34</sup>**

Amendments to the CCRA in 2019 established:

- › legislated domestic reductions targets for both net long-lived gases and biogenic methane (Section 3.2)
- › the requirement for and process of setting a series of emissions budgets to act as stepping stones towards these long-term targets (Section 3.2)
- › requirements for governments to develop and communicate plans and strategies for climate change adaptation and mitigation to achieve these emissions budgets and address identified climate risks (specifically, through regular ERPs and NAPs)
- › a new, independent CCC to give expert advice and monitoring to support successive governments to stay on track to meet these long-term goals.

#### **He Pou a Rangi – Climate Change Commission**

The CCC's purpose is to provide independent, evidence-based advice to the Government on key climate issues. It also monitors and reviews progress towards the country's goals for reducing emissions and adapting to a changing climate.

The CCRA requires the CCC to publish a NCCRA every six years, and for the Government to publish an updated NAP setting out how it will respond to the risks highlighted in it. The next risk assessment will be produced in 2026 and the next NAP is due to be published in 2028.

The CCC is also required to advise on the Government's emissions budgets.

#### **Minister of Climate Change**

This Minister is responsible for achieving successive emissions budgets and the long-term 2050 targets. Coordination with other Ministers and across government agencies to develop and implement policies and monitor progress is necessary.

The CCRA requires the Minister of Climate Change to ensure there are three consecutive emissions budgets in place at any one time (one current and two prospective).

#### **Climate Response Ministerial Group (CRMG)**

The CRMG is a group of Ministers whose portfolios underlie the climate change work programme. It was established in 2020 and is chaired by the Prime Minister. The group meets regularly to progress and direct the climate change work programme, including the emissions budgets, sub-sector targets and the Government's adaptation response.

#### **Climate Change Chief Executive Board (CE Board)**

This CE Board has recently been formalised as an Interdepartmental Executive Board under the Public Service Act 2020. It is responsible to the Prime Minister and is made up of the chief executives who are responsible for delivering the plans and strategies outlined in the ERP and the NAP.

<sup>33</sup> Ministry for the Environment, 2022b (p. 24).

<sup>34</sup> Ministry for the Environment, 2021.

### Box 3.3

## New Zealand's first emissions reduction and adaptation plans

### Emissions Reduction Plan

The Government published New Zealand's first ERP in May 2022. As legislated under the CCRA, it sets out the Government's plan to achieve the country's first emissions budget and lays the foundations for the achievement of the second and third budget. The ERP sets out the direction of policies and strategies over the next 15 years, both economy-wide and across the key emitting sectors, including transport, energy, industry, building and construction, agriculture, forestry, and waste and fluorinated gases.

Some key actions in the first ERP include:

- › improving access to affordable, sustainable transport options (for example increasing access to EVs, beginning the process of decarbonising heavy transport and freight, and helping more people to walk, cycle and take public transport)
- › supporting businesses to improve energy efficiency and move away from fossil fuels (such as coal) by continuing to roll out the Government Investment in Decarbonising Industry fund
- › introducing an emissions pricing mechanism for agriculture and accelerating the delivery of agricultural emissions reduction tools and technologies for farmers and farming businesses through the establishment of a new Centre for Climate Action on Agricultural Emissions.

The next ERP for the period 2026 to 2030 is due to be published in 2024.

### National Adaptation Plan

The Government published New Zealand's first NAP in August 2022. It sets out a long-term strategy to adapt to climate change, alongside key objectives and actions that government will take over the six years 2022 to 2028 to help reduce the harm caused by climate change and seize opportunities arising from a warmer climate.

Four priorities underpin the NAP:

- › enabling better risk-informed decisions (for example by providing access to the latest climate projections data to help New Zealanders assess climate risk and make adaptation decisions)
- › driving climate-resilient development in the right locations (for example by setting direction on natural hazard risk management and climate adaptation through the National Planning Framework)
- › laying the foundations for a range of adaptation options, including managed retreat (for example through a proposed resilience code for infrastructure and proposed managed retreat legislation)
- › embedding climate resilience across government policy (for example through the government's role in biosecurity, public housing, transport infrastructure, emergency management and health).

### Box 3.4

#### **Links to Te Tiriti o Waitangi in the Government's emissions reduction and adaptation strategies**

The ERP recognises that the transition will be more successful, and more equitable for Māori, if it upholds Te Tiriti o Waitangi, with the Government and tangata whenua working together in partnership to meet the challenges of climate change in a way that respects kāwanatanga (the Government's right to govern) and tino rangatiratanga (the Māori right to make decisions for Māori). This means ensuring the outcomes for Māori from the low-emissions transition are equitable and enable a Māori-led response. That will require building Crown–Māori relationships and capability to work together as equal partners on the climate response.

The NAP also recognises that upholding the principles of Te Tiriti o Waitangi is a central aspect of the Government's long-term adaptation strategy. This means developing adaptation responses in partnership with Māori, elevating te ao Māori and mātauranga Māori in the adaptation process and empowering Māori in adaptation planning for Māori, by Māori. This also means recognising the importance of mātauranga Māori in the climate response, such as the Rauora framework, as highlighted in the NAP. The Rauora framework brings together Māori values and principles into an indigenous worldview of climate change.<sup>35</sup>

Both the ERP and NAP include commitments to establish a platform for Māori climate action as a mechanism to support effective partnership.



<sup>35</sup> See Chapter 1 of New Zealand's first NAP for more information (Ministry for the Environment, 2022e).



## Factors outside of New Zealand’s control will also be important, including international policies

Being a relatively small economy on a global scale, the climate-related impacts New Zealand experiences will be shaped by global factors over which the country has limited influence (Table 3.3).

**Table 3.3:** Key sources of domestic and international variability

	Primarily based on factors outside of New Zealand	Based on factors within New Zealand	
		Government policy	Other factors
 <p><b>Physical climate change</b></p>	<ul style="list-style-type: none"> <li>› Global emissions pathways</li> <li>› Climate sensitivity (for example the extent of temperature increase in response to additional emissions)</li> <li>› Tipping points (non-linear environmental changes)</li> <li>› Resilience of environmental systems</li> </ul>	<ul style="list-style-type: none"> <li>› Adaptation policy, including regulations and cost sharing arrangements</li> </ul>	<ul style="list-style-type: none"> <li>› Business, household and local government decisions about adaptation</li> </ul>
 <p><b>Low-emissions transition</b></p>	<ul style="list-style-type: none"> <li>› Developments in the global economy (such as globalisation, changes in consumer preferences, the pace and nature of technological change, variability in supply chains for clean energy technologies)<sup>36</sup></li> <li>› International climate policy (such as carbon border mechanisms)</li> <li>› Resilience of socio-economic systems</li> </ul>	<ul style="list-style-type: none"> <li>› Domestic and offshore mitigation policies</li> <li>› Tax and welfare policies</li> <li>› Response to other fiscal pressures (such as population ageing)</li> </ul>	<ul style="list-style-type: none"> <li>› Business and household decisions to invest in/adopt mitigation technologies</li> <li>› The economy’s ability to efficiently re-allocate resources (such as labour and finance)</li> </ul>

<sup>36</sup> International Energy Agency, 2022a.

# 4

## ECONOMIC IMPACTS FROM PHYSICAL CLIMATE CHANGE

### THIS SECTION:

summarises the expected impacts of physical climate change on the New Zealand economy based on current evidence

discusses how actions to adapt to climate change could mitigate these impacts

identifies areas where future research could be valuable.

### Summary

- › Physical climate risk is expected to worsen over the course of the century, even under the best-case scenario global emissions pathway. Current information on the extent of the costs and economic consequences to New Zealand indicate these could be significant.
- › Modelling indicates that sea-level rise of 30cm (expected to occur between 2045 and 2070) could expose an additional \$6 billion worth of buildings to at least a 1% chance of coastal flooding in a given year, compared to \$12.5 billion at the present sea level.
- › Asset damage and lost productivity from physical climate impacts are expected to have a net negative macroeconomic impact. The resilience and relative competitiveness of New Zealand's economy will have a large influence on the size of this impact.
- › Modelling carried out by the Treasury suggests that New Zealand's economy is relatively resilient to droughts and storms. The average of the modelled simulations indicated that the impact of increasing the frequency of severe and moderate droughts would cause GDP to be 0.5% lower in 2061 than the assumed counterfactual trend. A scenario with increased storms and/or floods estimates this impact would be a 0.7% decrease. To benchmark against past events, the drought in the 1997 to 1998 El Niño event was estimated to cause a loss of GDP of 0.9%.
- › The impacts of physical risks will not be evenly felt across sectors or society. For instance:
  - **Sectors** reliant on climate-sensitive natural resources (such as agriculture, forestry, fisheries and tourism) and those sectors reliant on networks of physical infrastructure will be more directly exposed.
  - **Households** in areas more exposed to physical risks (such as those near coasts and flood plains) will be disproportionately affected and face worsening insurance affordability and availability. Reserve Bank analysis estimated that, across the banks it surveyed, 2.5% of mortgaged properties would be in the flood zone with 50cm of sea-level rise.
  - **Māori** could experience disproportionate or unique impacts through their high representation in primary industries, and if culturally significant sites, taonga species and aspects of mātauranga Māori are threatened.
  - **Some localities and regions** will be more impacted than others (regions with economies dominated by primary production and those with a high percentage of the population and assets located in low lying coastal areas). The Department of Internal Affairs has identified many communities in New Zealand with high levels of vulnerability and exposure to flood hazard, especially in the upper half of the North Island.
- › New Zealand may be less vulnerable and better positioned to adapt to the impacts of climate change than many other jurisdictions, in part due to its strong institutions and economic and fiscal resilience. Also, primary agriculture may be less affected by climate change than in other countries, which could create demand for New Zealand products.
- › New Zealand's adaptation response could have a great influence on the long-run economic impacts arising from physical risks. Decisions of present and future governments on adaptation policies and the support of functioning financial and insurance markets will affect the size of these impacts and how and when they might occur.

## Key impacts of physical climate change to date

More frequent and severe droughts and floods may be the most significant source of economic losses attributable to climate change that New Zealand has experienced to date (Box 4.1).

### Box 4.1

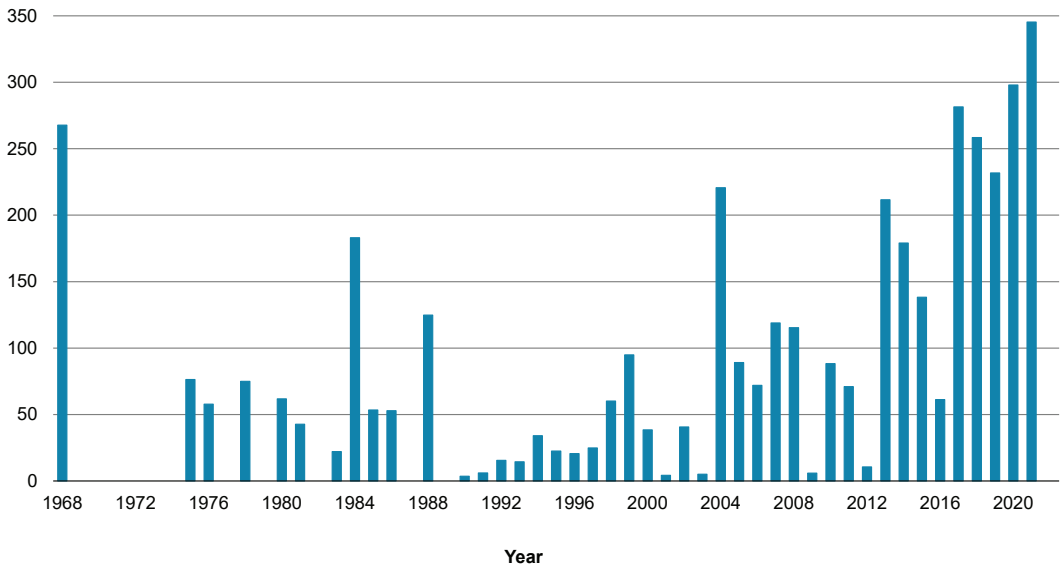
#### Climate change is already increasing the economic costs of droughts and floods



A Treasury-commissioned study from 2018 estimated climate change caused at least \$120 million of privately insured damages from floods and \$720 million in economic losses from droughts in the decade between 2007 and 2017.<sup>37</sup> These represent estimates of the costs from flood and droughts that are over and above those to be expected in the absence of climate change based on historical data. For flood-related losses over the period 2007 to 2017, the fraction of risk that was attributable to climate change ranged from 10% to 40% across the events examined.

Data from the Insurance Council of New Zealand shows a trend of increasing privately insured damages from weather-related events (such as storms and floods) over at least the last decade (Figure 4.1). While much of the increase in total insured losses is likely to reflect the rising number of insured assets and the increasing costs of reconstruction, there has been a marked decline in the frequency of years with little or no significant adverse weather events over the last 50 years. The last five years have all seen near record levels of insured losses.

**Figure 4.1:** Insured weather-related losses from 1968 to 2021 (in 2022 dollars)<sup>38</sup>



Source: Insurance Council of New Zealand, n.d.

<sup>37</sup> Frame et al., 2018.

<sup>38</sup> \$260 million of losses in 1968 were the result of the Wahine storm and include the costs from the loss of the *TEV Wahine*.

## 4.1 Macroeconomic channels



Physical climate change poses risks to the economy through a wide range of economic channels. Individual microeconomic impacts (such as business disruption after a flooding event) have the potential to affect macroeconomic variables (such as overall output, interest rates, inflation, monetary supply and government debt). Research by the European Central Bank and Sweden's Riksbank suggests that climate change could greatly reduce long-run real interest rates if it causes reduced productivity, or under scenarios with serious physical impacts.<sup>39,40</sup>

Climate change presents a range of macroeconomic risks:



› **On the supply-side**, gradual changes to New Zealand's climate (such as warming and changes to regional climates) could drive changes in land-use and the mix of goods produced, while increased climatic variability between seasons and years is likely to cause greater volatility in output from year-to-year and may drive long-term increases in food costs. Also, increasing frequency and severity of acute weather events could create a series of negative supply shocks, which could temporarily suppress output and increase prices. These impacts could in turn drive a lower long-run real interest rate.<sup>41,42</sup>



› **On the demand-side**, physical risks could damage household and corporate balance sheets, through their impact on employment, residential property values, and business profitability. Reduced business confidence and weakened balance sheets could result in reduced levels of investment, which could in turn worsen supply-side impacts.

Table 4.1 gives an indicative overview of some of the main possible impacts of physical climate change on the macroeconomy.

The impacts of physical climate change on the global economy are important for a small open economy like New Zealand. A study analysed by the IPCC found that a temperature rise of 3.66°C by 2100 could result in global GDP loss of 2.6%, compared with 0.3% under the 1.5°C scenario and 0.5% under the 2°C scenario.<sup>43</sup> New Zealand's reliance on trade means that economic impacts will be materially influenced by the impacts of climate change on other countries, particularly those New Zealand competes and trades with, and how climate change affects the cost of freight and trade. These factors will influence New Zealand's balance of trade with flow-on implications for the economy.

39 Mongelli et al., 2022.



40 Bylund & Jonsson, 2020.

41 There is general agreement that extreme weather events have negative short-term effects on GDP. While the evidence on their long-term effect is scarce and more mixed, most existing studies point to longer-term GDP losses (Batten et al., 2020).

42 Bylund & Jonsson, 2020.

43 Salinger & Porteous, 2014 (p. 256), and Burke et al., 2018.

**Table 4.1:** Possible macroeconomic impacts from physical climate change<sup>44</sup>

Impact channel	Possible impacts	
 <b>Supply</b>	<b>Labour</b> <ul style="list-style-type: none"> <li>↓ Loss of hours worked due to climate hazards.</li> <li>↓ Increased internal migration from displacement.</li> <li>↑ Increased immigration from other jurisdictions.</li> <li>↓ Reduced productivity from health and wellbeing impacts.</li> </ul>	
	<b>Land</b> <ul style="list-style-type: none"> <li>↓ Disruption and damage to land used for primary production.</li> <li>↕ Changes to viable land uses and crops.</li> </ul>	
	<b>Capital stock</b> <ul style="list-style-type: none"> <li>↓ Damage due to extreme weather events.</li> <li>↓ Loss of productive assets.</li> <li>↓ Increased cost of insurance and reduced availability due to impacts of global climate events on insurance and reinsurance industries.</li> <li>↓ Increased rates of depreciation.</li> <li>↕ Diversion of resources from innovation to adaptation capital.</li> </ul>	
	<b>Transport, energy, water and other inputs</b> <ul style="list-style-type: none"> <li>↓ Disruptions to supply chains, energy supply and water supply, wastewater and stormwater infrastructure and services provision.</li> <li>↓ Damages to infrastructure such as roads, power lines and pipes.</li> </ul>	
	<b>Technology</b> <ul style="list-style-type: none"> <li>↓ Diversion of resources from innovation to reconstruction and replacement of damaged technology.</li> </ul>	
	<b>Trade</b> <ul style="list-style-type: none"> <li>↕ Disruptions to global food production and markets could affect the supply and cost of food and New Zealand's relative competitive advantage in food exports.</li> <li>↓ Disruptions to transport and freight affecting import of goods.</li> </ul>	
	 <b>Demand</b>	<b>Consumption</b> <ul style="list-style-type: none"> <li>↓ Reduced consumption due to loss of income.</li> <li>↓ Reduced consumption due to wealth effects from changes in property values.</li> <li>↑ Increased summer energy demand for cooling due to warming.</li> <li>↓ Reduced winter energy demand for heating due to warming.</li> </ul>
		<b>Investment</b> <ul style="list-style-type: none"> <li>↓ Reduced investment confidence due to physical risk impacts.</li> <li>↓ Reduced investment confidence due to actual impacts.</li> <li>↓ Reduced household and corporate balance sheets due to actual or expected impacts.</li> <li>↑ Increased spending on repair and replacement of damaged assets and adaptation.</li> </ul>
		<b>Trade</b> <ul style="list-style-type: none"> <li>↕ Changes in demand for goods that New Zealand exports due to global impacts of physical risk.</li> <li>↕ General changes to patterns and volumes of trade.</li> </ul>

Source: The Treasury, adapted from Batten, 2018

<sup>44</sup> ↓ shows impacts that are expected to reduce supply or demand. ↕ shows impacts where the direction of impact on supply or demand is uncertain or mixed. ↑ shows impacts that are expected to increase supply or demand.



The Treasury carried out scenario modelling of the impacts of increasing drought frequency and storm/flood intensity in its Long-Term Fiscal Statement, *He Tirohanga Mokopuna 2021*.<sup>45</sup>

The average of the modelled simulations showed the impact of increased drought frequency causing annual GDP to be 0.5% lower than the assumed trend by the final year of the simulation in 2061. By way of comparison, the impact of the 1997 to 1998 drought was estimated at 0.9% of GDP.<sup>46</sup>

- › The average of the modelled simulations showed the impact of increased storm/flood intensity as a 0.7% decrease in GDP compared to the assumed trend in 2061.

- › The combined impact of the increased drought and storm impacts on net core Crown debt was estimated at 3.77% of GDP higher than trend in 2061 (median of modelled simulations). See more detail in Section 6 (Box 6.1) on the Treasury's modelling.

*He Tirohanga Mokopuna* concluded that, at the national level, the New Zealand economy and fiscal position were relatively resilient to natural disasters. However, it also acknowledged that impacts would be felt severely at the local level, other hazards were not yet taken into account, and that the climate may respond to increased emissions in unexpected ways, including irreversible impacts or the crossing of 'tipping points'.

## Box 4.2

### Impacts relative to other jurisdictions



**The impacts of climate change on New Zealand relative to other countries (and hence relative competitiveness) will depend on multiple factors, including:**

- › **the actual physical climate change different countries experience**
- › **the composition of their economies**
- › **their capacity to manage and respond to impacts.**

The make-up of New Zealand's economy may make it more vulnerable to physical risks than most other developed economies. This is because of the comparatively large contribution of land-based sectors (such as agriculture, forestry and tourism), which are likely to be among the most vulnerable to climate change (Section 4.2).

That said, agricultural production may be less impacted in New Zealand than in many other countries. Several studies have found that agricultural production in high latitude countries (such as New Zealand) may be positively affected due to climate change while production in low latitude countries, which are more vulnerable to climate change, will be negatively affected.<sup>47</sup> Disruptions to food production in other countries could increase demand for food products that New Zealand exports.

New Zealand's fiscal and economic resilience, and the strength of its institutions, also mean that it may better absorb and respond to climate impacts than many other countries. This is a key reason why New Zealand ranks among the least vulnerable and best prepared countries in a recent comparative study of physical climate change vulnerability across countries.<sup>48</sup>

<sup>45</sup> The Treasury, 2021c. The modelling in *He Tirohanga Mokopuna 2021* considered increased drought frequency and storm/flood intensity based on available research on drought and historical economic impacts of storms. While the scenarios cover a wide scale of possible impacts, they do not map directly to RCPs. The analysis does not attempt to capture the full cost of climate change. Rather, it considers two specific types of extreme weather events in isolation and does not include other impacts (such as gradual and ongoing sea-level rise or temperature increases) and does not consider any interactions between risks, including 'cascading' impacts that cause secondary impacts or potential 'tipping-points' that may be crossed and cause irreversible impact. Refer to Section 1.5 'The fiscal impacts of climate change' of the Treasury's report for more detail.

<sup>46</sup> Gardiner, 2001. As cited in Salinger & Porteous (2014).

<sup>47</sup> Smith et al., 2001. See also the first National Climate Change Risk Assessment (Ministry for the Environment, 2020).

<sup>48</sup> Notre Dame Global Adaptation Initiative, 2020.

## 4.2 Sectoral channels



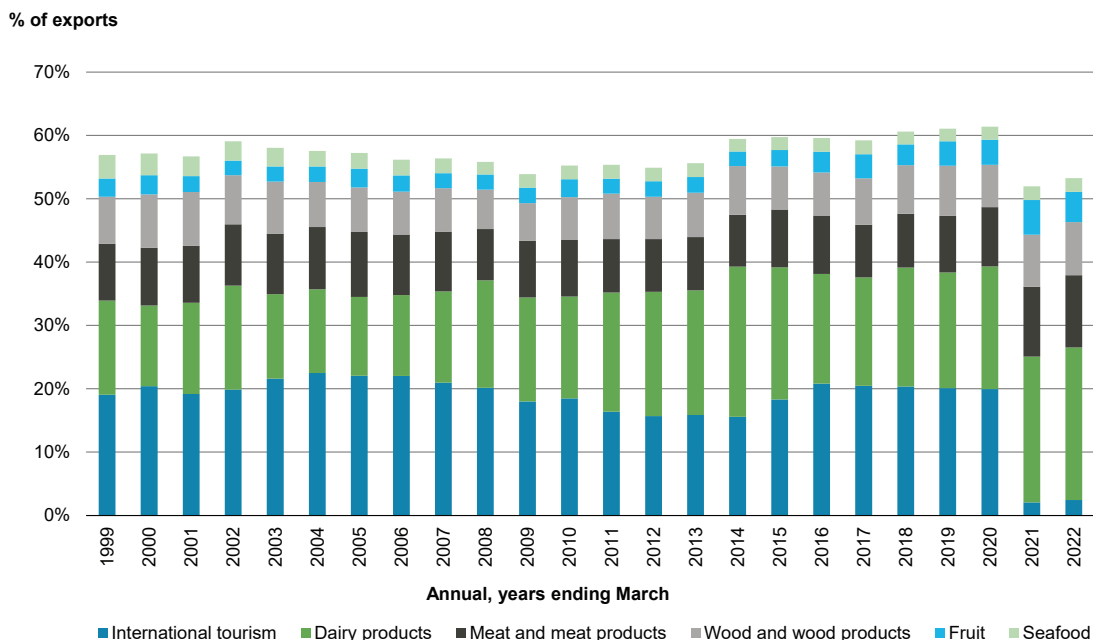
### Agriculture, forestry, fisheries, tourism, and energy and transport networks will be particularly exposed to climate change

The NCCRA noted that land-based primary industries (including agriculture and forestry), fisheries (including aquaculture), and tourism are New Zealand’s industries most exposed to climate change due to their dependence on climate-sensitive natural resources.<sup>49</sup> These sectors and their manufactured products form a large part of the economy. Figure 4.2 highlights their contribution to New Zealand’s total exports over recent decades.

The NCCRA also highlighted impacts on the transport and energy sectors with the potential to result in wider economic effects via supply chain and network disruptions, and on production and productivity in other sectors.<sup>50</sup>

The increased frequency and severity of droughts could pose more economic risks, given potential losses to agricultural production and the consequences for New Zealand’s balance of trade.

**Figure 4.2:** New Zealand’s exports for sectors with a relatively high exposure to climate change as a percentage of total exports of all goods and services, 1999 to 2022<sup>51</sup>



Source: Stats NZ, 2022a

49 Ministry for the Environment, 2020.

50 See also Paulik et al., 2019.

51 The group of export sectors included in Figure 4.2 does not include some primary products (such as wool). The figures for 2022 are provisional.

## Box 4.3

### The impact of droughts on agricultural output



Droughts have historically been the most economically costly weather-related natural hazard in New Zealand, due to their impacts on the land-based primary sector. For example, droughts in 2013 and 2007 to 2009 are estimated to have cost the economy \$1.5 billion<sup>52</sup> and \$2.8 billion<sup>53</sup> respectively in direct and indirect economic losses.

Macroeconomic modelling of the 2013 drought by the Reserve Bank of New Zealand (RBNZ) estimated that it could have been responsible for reducing GDP by 0.6% and reducing the exchange rate by 3% by early 2014 relative to the counterfactual.<sup>54</sup> It also found that a drought of similar scale could be expected to increase world dairy prices by around 10%, which would partially offset economic losses.

Research published in 2020 estimated that approximately 15% of the economic costs of the 2007-2008 drought (\$485 million 2017 NZD) and 20% of the costs of the 2012-2013 drought (\$315 million 2017 NZD) can be attributed to climate change.<sup>55</sup>

As well as imposing costs on the primary sector, more frequent and severe droughts are expected to pose risks to the banking sector (Box 4.4).

Some aspects of climate change may also provide opportunities or benefits for some sectors. Warmer temperatures and increased CO<sub>2</sub> concentration could increase primary sector productivity through enhanced plant growth and reduced animal mortality from cold

weather events. As noted, New Zealand could maintain comparative advantages in food production. There are also likely to be new opportunities for individual businesses to address new or enhanced demand for climate adaptation-related goods and services.<sup>56</sup>

**Table 4.2:** Impacts of physical climate risk on selected sectors of the economy

Sector	Key physical risks	Potential impacts
<b>Agriculture</b>	Droughts, heatwaves, temperature rise, changes to rainfall patterns	<p>The number, duration and severity of droughts will increase over the coming decades.<sup>57</sup> More extreme and frequent high temperatures, and changes to rainfall patterns, could affect agricultural production and livestock health. Warming could also create favourable conditions for new and existing pests and diseases.</p> <p>Many impacts are likely to be event-based and localised due to different projected impacts of climate change in different parts of New Zealand. Rising temperatures are also expected to shift agroecological zones, creating risks and opportunities, and potentially increase plant growth rates.</p>
<b>Fisheries</b>	Temperature change, ocean acidification	<p>A projected increase in seawater temperature of between 1°C to 3°C over the next 80 years and increased acidification, among other stressors, will expose the fisheries sector to risks from changes in the characteristics, productivity and spatial distribution of fish stocks.</p> <p>The sector is also expected to face greater risk of invasive species becoming established and spreading. The direction and size of the impacts of these changes are likely to vary across the sector.<sup>58</sup> Wild and cultivated shellfish have been identified as being one of the most at-risk fisheries, while aquaculture is projected to adapt more easily to mitigate climate impacts.<sup>59,60</sup></p>

52 The Treasury, 2013.

53 Minister of Agriculture, 2009.

54 Kamber et al., 2013.

55 Frame et al., 2020.





56 See section 5.8 of the first National Climate Change Risk Assessment (Ministry for the Environment, 2020).

57 Ministry for the Environment, 2020.

58 Cummings et al., 2021.

59 Capson & Guinotte, 2014.

60 Richards et al., 2015.

Sector	Key physical risks	Potential impacts
 <b>Forestry</b>	Droughts, heatwaves, wildfires, temperature rise, changes to rainfall patterns	<p>Key physical risks to the forestry sector include the increasing likelihood of wildfires, droughts and erosion. Days spent in 'very high' and 'extreme' fire risks are predicted to increase by about 71% by 2040 and 83% by 2090 relative to a 1970 to 1999 baseline.<sup>61</sup> Changes in rainfall patterns and warmer temperatures will also impact forest health and growth rates, but the impacts are likely to be mixed.</p> <p>The forestry sector's exposure to these hazards is also likely to increase as New Zealand invests in afforestation as part of achieving its climate targets, representing a transition risk.</p>
 <b>Tourism</b>	Flooding, wind damage, droughts, temperature rise, changes in rainfall patterns, sea-level rise	Climate change is already impacting resources and infrastructure that the tourism industry relies on, including natural heritage and outdoor attractions (such as glaciers). <sup>62,63</sup> Warmer temperatures and changing weather patterns pose a great risk to the viability of ski fields and glacier tourism.
 <b>Transport</b>	Flooding, sea-level rise	More frequent and severe coastal flooding will affect low-lying airports, and coastal railways and roads. Research by NIWA shows that in the next 25 to 50 years, sea-level rise of 30cm could expose an additional 409km of roads and one airport to coastal flooding (Box 4.6). More frequent and severe inland flooding will cause erosion and landslides that could impact roads and rail.
 <b>Energy</b>	Flooding, wind damage, droughts, changes in rainfall patterns, sea-level rise	Landslides, erosion, and coastal flooding could damage low-lying transmission infrastructure. Heatwaves, storms, and extreme winds can also damage energy infrastructure. <sup>64</sup> Conversely, increased rainfall in the southwest of the South Island could increase potential hydro-electricity generation, although decreased summer rainfall may increase summer supply risks in dry years. <sup>65</sup>

## Physical climate change poses risks for the financial system

Banks, insurers and investors in New Zealand lend money towards, own stock in, and insure an array of climate-exposed physical assets (such as buildings, agricultural land, transport infrastructure, and energy networks). The increase in the frequency and severity of climate-related hazards exposes these assets to increased risk of damage, potential for higher insurance claims, and loss of financial value for owners and investors.

In recent years, the costs of weather-related catastrophes to insurers in New Zealand has been consistently higher than long-term averages, with higher costs likely in the future.<sup>66</sup>

The RBNZ notes that while the current value of weather-related claims is manageable for the insurance industry, the direction of the trend warrants attention, given that the relationships between temperature rise, physical risks and economic risks may not be linear.<sup>67</sup>

Recognising their exposure to climate impacts, banks in New Zealand have been developing their capabilities to assess, monitor and manage physical climate risk. The five major banks have begun voluntarily reporting on climate impacts in line with TCFD principles, ahead of mandatory disclosure requirements (Section 1).<sup>68</sup>

Starting in 2023, the Financial Sector (Climate-related Disclosures and Other Matters) Amendment Act 2021 requires banks and other large financial market participants in New Zealand to make climate-related disclosures. The law aims to improve transparency of climate-financial risks within New Zealand markets and encourages firms to consider these when making business and investment decisions. For these disclosures, the External Reporting Board (XRB) has issued Aotearoa New Zealand Climate Standards based on the recommendations of the TCFD and recent International Sustainability Standards Board developments.<sup>69</sup>

61 Watt et al., 2019.

62 Paulik et al., 2019.

63 Wang & Zhou, 2019.

64 For example, Genesis Energy (2022) in its 2022 *Climate Risk Report* notes that climate change could alter hydro lake levels due to less inflows from warmer temperatures and less snowpack. General water shortages could result in less water being available for electricity generation as it may be required for agricultural production. Increased temperatures could also reduce generation capacity of hydro assets. For instance, higher water temperatures could increase weed proliferation, which constrains hydroelectric generation sites.

65 Purdie, 2022.

66 Reserve Bank of New Zealand, 2021a.

67 Reserve Bank of New Zealand, 2021b.

68 While mainly used by the private sector, the TCFD framework has also been reported against domestically in a voluntary manner by public sector organisations such as the New Zealand Superannuation Fund, Auckland Council and Waka Kotahi.

69 XRB External Reporting Board, 2022.

## Box 4.4

### Voluntary climate disclosures by New Zealand banks



Five major New Zealand banks (ANZ, ASB, BNZ, Kiwibank and Westpac) have released reports which look at the risks and opportunities climate change poses to their operations and portfolios.<sup>70</sup>

To varying degrees, each bank's climate report uses the structure of the TCFD recommended disclosure framework, meaning they consider how climate-related risks and opportunities fit within their approaches to governance, strategy, risk management, and the setting of metrics and targets. Disclosures cover both physical and transitional risks.

Both ASB and Westpac have modelled and assessed how physical and transition-related climate impacts might affect different sectors in their lending portfolios. Both banks' analyses suggest the physical and transition-related impacts of climate change will not be evenly distributed across New Zealand's economic sectors.

About 12% of bank lending in New Zealand is directed to the agricultural sector, which faces relatively high exposure to climate change.<sup>71</sup> The banks' reports identify increasing drought risk to rural sectors (such as livestock) as a key source of physical risk exposure in their portfolios. For example, ASB notes that 44% of its rural customers may face high or extreme drought risk by 2050 (currently only 5% of customers).

Reports also note potential credit risks from home lending losses due to flooding and other extreme weather events.

- › Kiwibank estimates that 1.2% of properties in its home lending portfolio are currently at risk of coastal flooding, rising to nearly 1.8% by 2050 under their high-emissions scenario.
- › ASB notes that 2.3% of residential properties in its portfolio are at risk of inland flooding, with a potential increase to 3% by 2050 under their high-emissions scenario.

Banks attribute higher transition-related risks in their lending portfolios to higher-emitting sectors and those that face barriers to aligning their businesses with a low-emissions future. Westpac's analysis attributed 62% of the emissions in its New Zealand lending portfolio to agriculture, which it and other banks note is a sector where low-carbon solutions and technologies are still evolving.

The reports also recognise opportunities in sustainable finance. Banks are setting targets to increase delivery of financing 'green' or 'sustainable' products and services through to 2025 and 2030. For example:

- › Westpac and BNZ have each set a target of delivering \$10 billion in sustainable finance by 2025.
- › ASB has set an initial target of delivering \$6.5 billion by the 2030 fiscal year.
- › Kiwibank has committed to delivering \$2 billion by the 2030 fiscal year.

Standardised requirements for climate disclosures are expected to enable better access, quality and comparability of information on climate risks and opportunities in New Zealand's financial system.

<sup>70</sup> For example: ASB, 2022; Kiwibank, 2022; Westpac NZ, 2022; BNZ, 2021; ANZ, 2022.

<sup>71</sup> Reserve Bank of New Zealand, 2022a.

## Insurance-related impacts and growing flood risk could impact household balance sheets

Homeowners could be impacted by increasing flood damage to houses and property, rising insurance premiums, and the flow-on implications of these for the value of their assets. New Zealand currently enjoys high market penetration of insurance, and recent surveys by the Insurance Council show 96% to 98% of private homes are insured, but there is limited use of risk-based pricing.<sup>72</sup> This could change with a shift to greater risk-based pricing for flood insurance, and with

insurance becoming unaffordable for the most at-risk houses. Box 4.5 highlights the combined impacts that potential changes in residential flood insurance and growing flood risk could have.

The number of houses that could face insurance access or affordability issues will grow over the coming decades due to sea-level rise and more frequent and severe extreme rainfall events (Box 4.6).

### Box 4.5

#### Impact of growing flood risk and greater risk-based insurance pricing on households



Both the cost of insurance for homes in high-risk areas and the number of homes facing these growing costs could increase over time due to two factors:

› **Insurers are expected to adopt greater use of risk-based pricing for flood risks.**

In 2021, Tower Insurance announced that it would be shifting to greater risk-based pricing for river and surface flood risks. This means that their customers will face lower or higher premiums depending on their exposure to these flood risks.<sup>73</sup> The wider insurance market is yet to introduce greater 'risk-based' pricing, but the general trend is expected to continue.

› **The number of households facing high flood risk will increase in the coming decades.**

This is due to both sea-level rise and more extreme weather events increasing the frequency and severity of river and surface flooding. Box 4.6 highlights the value of assets that may be exposed to regular flooding under different levels of sea-level rise.

Recent analysis has been carried out to look at climate-related impacts on insurance access. Research for the Deep South Science Challenge projects that around 10,000 houses in Auckland, Wellington, Christchurch and Dunedin could become uninsurable by 2050 because of coastal flooding hazards from sea-level rise.<sup>74</sup> While this represents less than 1% of the housing stock in the areas included in the study, the impacts on households and communities exposed to sea-level rise could be large.

The highest risk homes may also face increased excesses, peril exclusions, or insurance withdrawal. The impact of changes to flood insurance price and availability will depend on how natural hazard risks change at local levels, and the extent to which insurers can, and choose to, reflect the underlying risk in premiums and underwriting decisions.

If these trends were to result in long-term reductions in insurance penetration, it could reduce New Zealanders' capacity to recover from large natural disasters quickly and fully, with implications for long-run GDP growth. How effectively flood risks are managed in New Zealand, including adapting to the changing climate, will influence the scale and timing of any insurance issues.

<sup>72</sup> Insurance Council of New Zealand, 2022.

<sup>73</sup> Allen, 2018.

<sup>74</sup> Storey et al., 2020.



## Box 4.6

### Impacts of sea-level rise on physical assets



Sea-level rise will expose a growing number of assets in coastal and low-lying areas to inundation in the coming decades.

A 2019 NIWA study estimated the number and value of assets exposed to a 1% or greater chance of being flooded in a given year under different levels of sea-level rise.<sup>75</sup> It found that 30cm of sea-level rise above present day levels would expose an additional \$6 billion worth of buildings (replacement value), 409km of roads and one airport to coastal flooding.<sup>76</sup> This level of sea-level rise is expected to occur by around 2045 to 2070, depending on the trajectory of global emissions in the intervening years.

**Table 4.3:** Population and replacement value of buildings projected to be in the coastal flood zone under different levels of sea-level rise

Sea-level rise (cm)	Population exposed	Replacement value of buildings	Date expected to occur under RCPs 8.5 and 2.6
Present	72,065	\$12.5 billion	n/a
30	98,782 (increase of 26,717)	\$18.5 billion (increase of \$6 billion)	2045 – 2070
60	132,650 (increase of 60,585)	\$26.2 billion (increase of \$13.7 billion)	2070 – 2130
90	166,798 (increase of 94,733)	\$35.1 billion (increase of \$22.6 billion)	2090 – 2200

Source: Paulik et al., 2019

In its November 2022 financial stability report the RBNZ highlighted the growing residential mortgage exposure to coastal flood risk.<sup>77</sup> Across the banks it surveyed, it reported that 2.5% of mortgaged properties would be in the flood zone with 50cm of sea-level rise, and that this would increase to 3.8% under 1m of rise.

Coastal flood exposure under present and future sea levels varies greatly between and within regions. This is because of the varied concentration of low-lying homes and other assets, and differences in the rate of land uplift or subsidence.<sup>78</sup>

### Physical risks could have health and food security impacts

Some families and households could face growing health costs from climate change, affecting human capability and the healthcare sector. These include temperature-related mortality and morbidity, changes to air quality, extreme weather events, vector-borne diseases, water-related illness, food safety and mental health.<sup>79</sup>

Physical risks could threaten global food security through the combination of reduced production and disruptions to supply chains. Both factors could drive short-and long-term increases in food prices, impacting household balance sheets and flow-on macroeconomic effects (such as increased inflation). Any increase in food prices would disproportionately impact households and individuals with lower disposable incomes.

<sup>75</sup> The coastal flood zone is defined as areas exposed to a 1% or greater chance of being flooded in a given year.

<sup>76</sup> Paulik et al., 2019.

<sup>77</sup> Reserve Bank of New Zealand, 2022b.

<sup>78</sup> NZ SeaRise provides a visual tool for understanding how sea-level rise could vary across locations – see [www.searise.nz/maps-2](http://www.searise.nz/maps-2)

<sup>79</sup> Royal Society Te Apārangi, 2017.

## Costs of wider wellbeing impacts

The first NCCRA noted that climate change presents great risks to wellbeing. The report singled out the risk to social cohesion and community wellbeing from the displacement of individuals, families and communities due to climate change impacts, and of worsening existing inequities and creating new ones.

The economic and wellbeing impacts of climate change may differ. For example, while the wellbeing impacts of natural disasters are overwhelmingly negative, their impact on GDP after an initial output shock can be quite modest and sometimes even positive due to the economic activity involved in reconstruction. In the long run, the cumulative impact of natural disasters may reduce the potential growth rate of GDP due to the opportunity cost of using more capital on reconstruction.

Māori may be particularly vulnerable to some physical risks. With lower-than-average per capita incomes, Māori whānau on average have fewer resources to adapt to physical climate impacts. Climate change displacement will be especially relevant for whānau, hapū and iwi (affecting social cohesion) given the importance of whenua for Māori wellbeing. Māori will also experience some unique impacts from damages to cultural and natural taonga (Box 4.7).

### Box 4.7

#### Māori will face unique impacts from risks to sites of cultural significance, taonga species and Māori agribusinesses



Physical risks to culturally significant sites (marae and urupā) include increased flooding and erosion. Climate and biological risks could also threaten native species, including culturally significant and taonga species. Potential changes to te Taiao from climate change could put the continuity of mātauranga at risk. Tikanga and mātauranga Māori are associated with resources from awa (rivers), moana (ocean/sea) and ngāhere (forests/bushland), which could be altered or lost.

Māori businesses also own considerable assets, worth an estimated \$68.7 billion (in 2018) across Māori business, trusts and entities, over \$23 billion of which sits in the agriculture, forestry and fishing industries.<sup>80</sup> Land-based Māori agricultural and forestry businesses may face a greater vulnerability to increased erosion from more extreme weather events because of the higher-than-average erosion susceptibility of Māori-owned land.<sup>81</sup>

<sup>80</sup> Reserve Bank of New Zealand & BERL, 2018.

<sup>81</sup> Manaaki Whenua – Landcare Research, 2018.

## Many physical risks are likely to be localised, with some regions more impacted than others

Different parts of New Zealand are likely to experience different changes in precipitation, temperature and sea-level rise.<sup>82</sup> These variations, combined with differences in the concentration of the people and assets located in low-lying coastal areas, will mean that impacts will vary greatly between localities and regions.

The make-up of regional economies will also make some regions more vulnerable to physical risks than others. For example:

- › Regional economies that are heavily dependent on tourism (such as Queenstown and the West Coast) could be particularly impacted if tourist attractions (such as glaciers) experience considerable retreat or skiing seasons are reduced.

- › Regional economies heavily reliant on agriculture (such as Waikato and Tairāwhiti) will be more susceptible to the impacts of more frequent and severe extreme weather events (such as droughts and storms).

Recent analysis by the Department of Internal Affairs identified several regions with communities that face high levels of vulnerability and exposure to flood hazards.<sup>83</sup> Northland, Tairāwhiti, Waikato, and Bay of Plenty each have clusters of vulnerable communities highly exposed to flood risk. In the South Island, some communities in the West Coast, Canterbury, and Otago also face high exposure.

### 4.3 Sources of variability

The economic impacts outlined in this chapter are subject to variabilities in natural systems and global actions to mitigate climate change (Section 3.1). The next section considers opportunities to manage the impacts of physical climate change through adaptation measures.

## Adaptation can dampen negative economic impacts by mitigating losses and unlocking climate change opportunities

Timely and evidence-based adaptation by households, communities, businesses, and local and central government can help reduce the long-term economic and fiscal costs arising from physical risks.

The total long-term losses and indirect impacts from damages to the built environment from increased flood risk could be mitigated by:

- › constraining future urban growth from occurring in high-risk areas, or preventing it altogether
- › investing in measures to control exposure to physical risks
- › relocating infrastructure and other assets away from high-risk areas when the benefits of doing so outweigh the costs.

Table 4.4 provides an overview of some specific measures that could be used to manage or reduce exposure or vulnerability to different climate-related hazards. Research conducted by NZIER for the Department of Internal Affairs in 2020 suggests flood risk is particularly amenable to cost-effective risk mitigation measures, but notes investment in these can face barriers due to high upfront costs and uncertain or undervalued benefits.<sup>84</sup> Overseas analyses highlight the potential benefits of investing in flood resilience, including at the household, community and catchment level.<sup>85</sup> The costs of resilience measures will vary on a case-by-case basis.






<sup>82</sup> Ministry for the Environment, 2018 & 2020.

<sup>83</sup> Department of Internal Affairs, 2022.

<sup>84</sup> NZIER, 2020.

<sup>85</sup> Task Force on Flood Insurance and Relocation, 2022.

**Table 4.4:** Examples of resilience measures across different natural hazards

Hazard	Examples of resilience measures	
	Community level	Household level
 <b>Coastal flooding</b>	Dykes, sea walls, evacuation routes	Raised ground floors, raised power points
 <b>Coastal erosion</b>	Sea walls, soft defences (for example mangroves and dunes)	
 <b>Surface and riverine flooding</b>	Dams, dykes and stopbanks; water retention rules, centralised co-ordination of water use	Raised ground floors, raised power points
 <b>Drought</b>	<b>Supply-side measures</b> – dams, small-scale water storage <b>Demand-side measures</b> – water restriction rules, flexible water reallocation	
 <b>Wildfire</b>	Managing fuels with vegetation clearance, ensuring functioning water tanks	Fire-resilient home construction

Eliminating risk will not always be possible or economically sound. It may be necessary to relocate assets and people away from areas that are subjected to repeated damage, or where there is a great risk to life. Benefits of timely relocation can also include reduced overall costs and mitigated wellbeing impacts. High-value investment in climate-resilient social and commercial assets could also have co-benefits (such as improved service delivery and energy efficiency). Choices faced by present and future governments will play an important role in determining what the

long-run economic costs from physical risk to New Zealand will ultimately be. Opportunities to mitigate these costs include choices around:

- › supporting those responsible for managing risks to understand the risk they face and the options for managing it, and ensuring they are incentivised to manage down the level of that risk
- › supporting investment in risk mitigation
- › actions to reduce the risk faced by public assets.

## 4.4 Improving our understanding in the future

Valuable areas of future research to improve our understanding of the economic impacts from physical climate change are:

- › Macroeconomic impacts, such as:
  - a more robust view of the long-term macroeconomic implications of physical risks from climate change for New Zealand’s economy (including, but not limited to, updated estimates of impacts on GDP, aggregate demand and supply, labour markets, inflation, exchange rates, and implications for investment and balance of trade)
  - improving our understanding of sectoral impacts, including building a more sophisticated understanding of how physical risks may impact different sectors and regions, and through which channels.
- › A better understanding of the effects of tipping points, compounding or cascading risks on economic impacts.
- › Continuing to build our evidence base to support public and private sector decision-making on effective adaptation actions, such as:
  - a deeper understanding of the relative net benefits of different adaptation responses and whether these rankings vary under different circumstances
  - more work around determining the efficacy of different adaptation policies intended to address physical risks both *before* and *after* they are realised (such as policy efficacy around risk elimination or mitigation versus efficacy in a policy response to an event that has already occurred).

# 5

## ECONOMIC IMPACTS FROM THE LOW-EMISSIONS TRANSITION

### THIS SECTION:

summarises the expected impacts of the transition to a low-emissions future on the NZ economy based on current evidence

discusses key factors that will influence these impacts

identifies areas where future research could be valuable.

### Summary

- › There are multiple possible ways that New Zealand can achieve its emission targets each with different economic and fiscal implications. The actual effects will depend on choices made by present and future governments, the private sector and households, both domestically and internationally.
- › The CCC has estimated that achieving New Zealand's domestic targets in line with its modelled demonstration pathway would result in GDP in 2050 being 1.2% lower than under its modelled counterfactual.
  - This estimate is within the range of broader scenarios considered by wider studies before the setting of New Zealand's domestic targets that estimated the range of GDP impact in 2050 could be 0.84% to 12.81% below modelled counterfactual levels.
  - Based on variation across considered scenarios and studies, adverse impacts on GDP are expected to be greater with:
    - greater levels of ambition for domestic abatement
    - constrained opportunities for sequestration to offset hard-to-abate emissions
    - a slower pace in the development and uptake of key mitigation technologies.
- › The CCC has roughly estimated that achieving New Zealand's emissions budgets in line with its demonstration pathway will require an extra \$38 billion of investment beyond already significant assumed counterfactual levels in key mitigation technologies. Investment in these technologies is expected to support operational cost savings in the longer term.
- › Even the more modest estimates of 2050 GDP levels mask a number of finer impacts at both the sector and household levels, including:
  - **Changes to the composition of the economy** – sectors with comparatively high abatement costs and/or limited options to make deep emissions reductions are likely to face potentially greater disruption, while those that are relatively less emissions intensive or have more economic options to reduce emissions may grow. Land-based primary industries and the energy sector are expected to be some of the most impacted.
  - **Impacts to household expenditure over time** – especially through changes in fuel and food costs, which are likely to disproportionately affect low-income households.
- › Māori are disproportionately vulnerable to transitional impacts. Māori account for 23% of the workforce in emissions-intensive industries (such as in sheep and beef farming, meat manufacturing and road and rail transport), while only making up 17% of the national population. Low-emitting sectors of the Māori economy could benefit from opportunities afforded by the transition, for example forestry and low-emissions horticulture.
- › Policy choices, technological change and the economy's capacity to adapt will affect the nature and scale of change and the impacts faced by different groups. Beyond deciding the level of future emissions targets, significant policy choices involve the balance of:
  - effort toward domestic and offshore mitigation
  - effort toward gross and net emissions reductions
  - emissions pricing, regulation and other levers for reducing emissions.

## 5.1 Macroeconomic channels



Deepening our understanding of the avoided economic costs to New Zealand from additional emissions reductions is an important area of further work. Since this work is still being developed, this section focuses on the economic impacts that arise directly from New Zealand's efforts to reduce emissions.

### Modelling of the GDP impacts of the transition shows the economy will continue to grow, but at a slower rate

Several studies have assessed the GDP impact of New Zealand's domestic low-emissions transition. Results from modelling carried out by the CCC, NZIER and Westpac are summarised in Table 5.1.

Key implications of the studies are listed below.

- › The New Zealand economy will grow during the transition, but at a lower rate than otherwise would have been the case.
- › The impact on GDP from achieving New Zealand's targets will depend on multiple factors, such as the specific emissions reduction pathway the country follows, but under most considered scenarios is not expected to be a material departure from business-as-usual.
- › Based on the drivers of the variation in estimates across studies and considered scenarios, the following are expected to drive greater negative impacts on GDP:
  - greater levels of ambition for domestic abatement
  - constrained opportunities for sequestration to offset hard-to-abate emissions
  - a slower pace in the development and uptake of key mitigation technologies.

While all the studies cited in Table 5.1 should be considered illustrative, since the CCC's modelling was the only one to be completed after the formal establishment of New Zealand's domestic emissions reduction targets, its results can be considered the closest to an estimate for the low-emissions transition pathway New Zealand has started to undertake.<sup>86</sup>

**Table 5.1:** Summary of modelled GDP impacts of New Zealand's low-emissions transition<sup>87</sup>

Source (and year of study)	Estimated GDP growth rate across the considered period to 2050			Estimated impact on GDP in 2050 compared to modelled counterfactual
	Under modelled counterfactual	Under modelled scenario(s)	Difference	
CCC (2021) – considers the domestic targets New Zealand has legislated <sup>88</sup>	1.86%	1.82% under the Commission's 'demonstration pathway'	(0.04%)	1.2% lower
NZIER (2019) <sup>89</sup>	2.15%	1.58%–2.03%, depending on the scenario considered	(0.12%)–(0.57%)	0.84%–12.81% lower, depending on the scenario considered
Westpac (2018) <sup>90</sup>	2.04%	2.005%–2.015%, depending on the scenario considered	(0.025%)–(0.035%)	0.85%–1.23% lower, depending on the scenario considered

<sup>86</sup> The NZIER and Westpac studies cited in Table 5.1 predate the setting of these targets and therefore the range of impacts in their estimates reflects a broader consideration of the level of ambition for New Zealand's targets, considerations of split versus non-split gas targets, possible roles for sequestration and different technological and innovation pathways.

<sup>87</sup> Estimates across the studies referenced in Table 5.1 are based on various assumptions, structural modelling choices and differing scenario definitions. Key factors that explain the variation in the results include different: scenarios modelled; counterfactuals (including the consideration of differing policy baselines, partially as a function of the different points in time during which each analysis was undertaken); assumptions about the options and costs of abatement (including both technological and behavioural options); and structural modelling approaches.

<sup>88</sup> He Pou a Rangī – Climate Change Commission, 2021. Based on calculations over the period 2020 to 2050.

<sup>89</sup> NZIER, 2019. Based on calculations over the period 2020 to 2050.

<sup>90</sup> Westpac NZ, 2018. Based on calculations over the period 2015 to 2050.



International evidence yields similar findings to CCC and Westpac modelling. Modelling from the IPCC in 2022 projected that mitigation pathways that limit global temperature rise to 2°C above pre-industrial levels would result in a reduction in global GDP of 1.3%-2.7% in 2050 compared to pathways that assume a continuation of policies implemented by the end of 2020.<sup>91</sup> On the other hand, pathways that limit temperature rise to 1.5°C

would result in a 2.6% to 4.2% reduction. Importantly, the IPCC's modelling does not consider the economic benefits of mitigation from avoided climate damages.

By contrast, OECD modelling from 2017 suggested a positive 'green growth' effect from implementing a mix of economic and climate policy reforms, projecting that GDP in 2050 could be 2.8% higher on average across G20 countries, relative to a continuation of existing policies.<sup>92</sup>

## Additional investment is expected to be required in key mitigation technologies and could support cost savings in the longer term

The impact of the low-emissions transition on aggregate GDP is only one way to understand its likely macroeconomic implications. Considering the level of investment expected to be required to achieve New Zealand's targets can provide further insight.

The most comprehensive analysis to date of this anticipated investment has been carried out by the CCC in support of its 2021 advice to the Government about the setting of the first emissions budgets and formation of the first ERP.<sup>93</sup> These figures remain the best available information on these potential costs at this point in time.

The CCC's estimates of the additional net investment needed to achieve New Zealand's emissions budgets come from its bottom-up sector model (ENZ), which looks at the capital investment costs from key technologies that support critical abatement alongside associated operating costs. Box 5.1 includes key caveats and limitations, reflecting that the model requires various assumptions and some key sectors were not looked at.

### Box 5.1

#### Insights from the CCC's estimates of capital investment costs from achieving New Zealand's domestic 2050 targets

The CCC's analysis indicates that achieving New Zealand's domestic emissions target requires a sustained increase in capital investment across the economy. More specifically, to achieve New Zealand's emissions budgets in line with the Commission's 'demonstration pathway', the CCC has estimated an extra \$38 billion (in 2020 dollars) of capital investment in key sectors may be required out to 2050 beyond investment levels assumed in its counterfactual policy reference scenario (about \$275 billion in the same technologies across the period).

As an annual average across the modelled period, the estimated total extra investment across all considered sectors represents an additional \$1.3 billion per year (in 2020 dollars) compared with the counterfactual policy reference scenario (an increase of 14%). For reference, \$1.3 billion is 1.7% of the total investment across all sectors of the economy for the 2019/20 financial year.<sup>94</sup>

Of this total estimated additional capital expenditure, roughly 70% is assumed to be for new electricity generation and native afforestation. While the analysis also shows significant investment in EVs, a large amount of this investment is already assumed to occur in the counterfactual scenario.

91 IPCC, 2022 (p. 37).

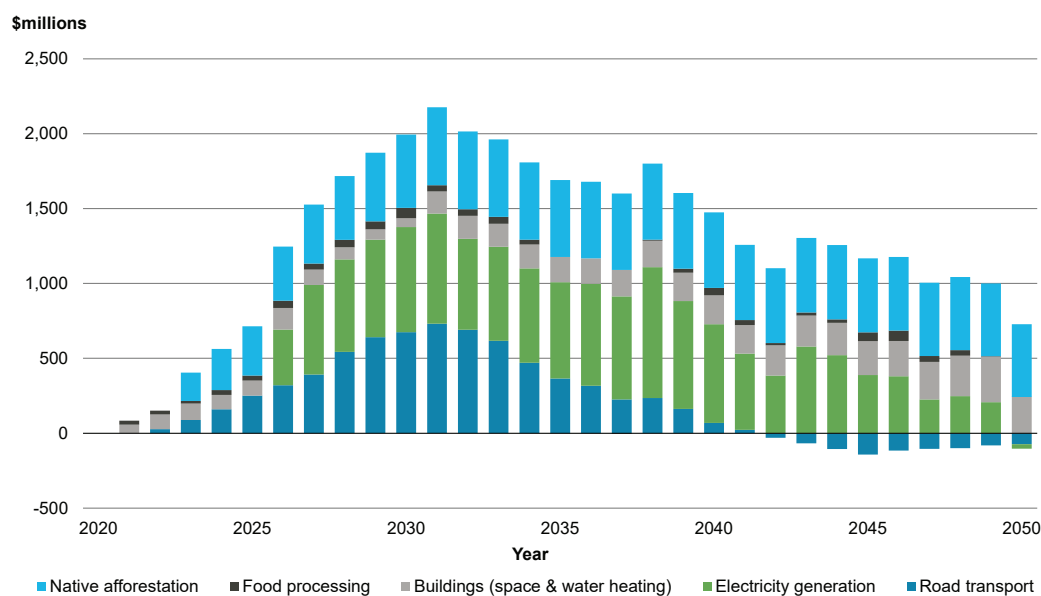
92 OECD, 2017b. The combination of policies modelled assumes a 'high-investment, high-innovation and low-carbon transition path' and is comprised of additional fiscal investment (for example in infrastructure and research and development) in support of climate objectives) and structural reforms to improve economic flexibility and resource allocation.

93 He Pou a Rangī – Climate Change Commission, 2022.

94 Stats NZ, 2021a.

Some of the required capital investment is expected to support longer-term operational cost savings. Most of these savings are expected to come from the electrification of road transport since EVs are assumed to have higher efficiency and lower running costs relative to internal combustion engine vehicles. In its 2021 advice to the Government, the CCC estimated that in time future cost savings are likely to outweigh the capital investment, and by the 2040s New Zealand could be saving around \$2 billion per year.<sup>95</sup> Importantly, given this analysis did not include consideration of energy efficiency improvements, mode shift and reduced travel demand, both investment and savings could be greater.

**Figure 5.1:** Net additional annual investment costs beyond considered counterfactual levels to meet New Zealand’s 2050 targets based on the CCC’s analysis, 2020 dollars<sup>96</sup>



Source: He Pou a Rangi – Climate Change Commission, 2022

### Key limitations to the CCC’s analysis

In publishing its analysis on the annual capital investment required in key areas of emissions reduction under its counterfactual policy reference scenario and demonstration pathway, the CCC notes several key limitations.<sup>97</sup> Examples of areas excluded from the CCC’s estimates are:

- > mitigation costs in the agriculture sector
- > road, rail, port and airport infrastructure
- > changes in transport demand (including through mode shift), and
- > energy efficiency in buildings and process heat.

While not comprehensive, the CCC’s analysis provides a first-order, ballpark estimate that highlights the estimated investment in key sectors and core mitigation technologies that drive achievement of New Zealand’s domestic targets under their demonstration pathway. In reality, these costs could be both higher or lower.

<sup>95</sup> He Pou a Rangi – Climate Change Commission, 2021 (p. 142)

<sup>96</sup> Costs are estimated as in-year capital expenditure.

<sup>97</sup> For more information about the CCC’s analysis, see [www.climatecommission.govt.nz/public/Advice-to-govt-docs/Capital-investment-in-ITN-scenarios-Summary-note.pdf](http://www.climatecommission.govt.nz/public/Advice-to-govt-docs/Capital-investment-in-ITN-scenarios-Summary-note.pdf)

## 5.2 Sectoral channels



### **Moderate projections of aggregate GDP impacts mask potentially significant structural changes, especially for land use and the energy sector**

While many scenarios for New Zealand's low-emissions transition showed relatively small GDP impact in 2050, looking at aggregate GDP impact masks finer indications that some sectors may grow under the transition, while others may shrink or even disappear.<sup>98</sup>

Sectors that are relatively emissions-intensive with limited opportunity to invest in lower-emissions technologies and those facing physical climate change disruptions are more likely to contract. It is expected that some of the largest changes will take place within the land-based primary industries and the energy sector. Several of these are listed below.

- › Impacts on land use will likely be material, due to the prominence of livestock farming and forestry in New Zealand's economy and emissions profile, and the exposure of the sector to physical climate change (see Section 4 for more detail).
  - Livestock farming faces relatively high marginal abatement costs compared to other sectors. Practices vary across farm types and opportunities do exist for some farming systems to maintain or enhance profitability while reducing production, but technically feasible options to achieve substantive emissions reductions across the sector without reducing output (and potentially farm profitability) are limited.
  - The development of effective and affordable methane-abating technologies over the next couple of decades (such as a cost-effective and widely available methane vaccine) would mitigate the amount of land-use change required to meet New Zealand's 2050 targets. The impact of these technologies will depend on the timing and efficacy of their development.
  - Pricing agricultural emissions (as set out in the Government's recent report on how it intends to price them from 2025 onwards<sup>99</sup>) is likely to have important implications for the sector, including land-use change (summarised in Box 5.2).
- › Changes within the energy sector are also likely to be marked, as a continued shift towards renewable energy is expected to be a key part of New Zealand's transition. Section 4 also highlighted how the sector is exposed to physical climate risks. However, increased electrification across the energy sector, particularly for transport, has a benefit of reducing New Zealand's reliance on fuel purchased offshore and can therefore improve resilience against international price shocks (such as for oil).
- › Potential increases in emissions prices through the NZ ETS will create challenges for other industries that are heavily reliant on fossil fuels (such as coal) or production processes that are emissions intensive and costly to abate.

<sup>98</sup> He Pou a Rangī – Climate Change Commission, 2021 (p. 172).

<sup>99</sup> For more information about the Government's proposed pricing system, see: [environment.govt.nz/assets/publications/Pricing-agricultural-emissions-report-under-section-215-of-the-CCRA.pdf](https://environment.govt.nz/assets/publications/Pricing-agricultural-emissions-report-under-section-215-of-the-CCRA.pdf)

## Box 5.2

### Modelled impacts of the low-emissions transition on land use

New Zealand has historically navigated periods of major changes in land use. For example, the total area of land used for agriculture declined by 14% from 2002 to 2019.<sup>100</sup> Dairy cattle numbers increased over the same period following dairy conversions in the early 2000s, while sheep and beef livestock numbers have experienced declines since the mid-1970s.<sup>101</sup> Future changes will be influenced by both the low-emissions transition and physical-related risks faced by land-based businesses.

The coverage of forestry activity within the NZ ETS currently provides an incentive for land-use change from pastoral farming to forestry, given the current relative costs and benefits of the two activities. The introduction of a scheme for pricing agricultural emissions is likely to further alter the relative profitability of different land-based activities, leading to further shifts in land use.

While agriculture is expected to remain an important part of New Zealand's economy in the future, recent modelling shows that introducing a price on agricultural emissions could lead to high levels of land-use change. Modelling by Manaaki Whenua – Landcare Research (MWLR) estimated that depending on the design of the scheme and the emissions price set, pricing agricultural emissions could lead to the following land-use change by 2030 relative to the considered baseline:<sup>102</sup>

- › a decrease of between 7.1% and 15.6% of land used for sheep and beef and a decrease of between 1.9% and 4% for dairy
- › an increase of between 6.5% and 14.2% in land used for scrub and indigenous forests, an increase of between 1.7% and 3.5% for fruit, an increase of between 2.4% and 5.1% for vegetables, and an increase of between 1.9% and 3.8% for forestry.

MWLR modelling is directionally consistent with other modelling carried out to support consideration of pricing agricultural emissions, including by the CCC and He Waka Eke Noa (the Primary Sector Climate Action Partnership). However actual land-use change may occur at a slower rate than estimated by MWLR for several reasons, including that:

- › switching costs or other frictions (for example behavioural and socio-cultural factors) were not considered by MWLR's model
- › the partial equilibrium focus of the modelling may also overstate impacts within the primary industries, without considering the economy-wide shifts in economic output.

MWLR's modelling also shows that pricing agricultural emissions could reduce aggregate net revenue for agriculture between 4.3% and 5.9%. This outcome reflects a balance of some sub-sectors growing (such as arable and horticulture) while others shrink (sheep and beef most materially and dairy to a lesser extent).

Pricing agricultural emissions and driving reductions from the sector is likely to have broader impacts across the economy. While modelling shows the cost of pricing these emissions, it also suggests several possible benefits. For example, emissions reductions could support the sector to secure green product premiums, to retain access to high-value export markets and to play a greater role in achieving New Zealand's emissions targets.

<sup>100</sup> Stats NZ, 2021b.

<sup>101</sup> Ministry for the Environment & Stats NZ, 2021.

<sup>102</sup> Manaaki Whenua – Landcare Research et al., 2022.

## The financial system faces transition-related risks, but is also a key influencer of levels of domestic low-emissions investment

As well as risks from the economic impacts of physical climate change, the financial sector faces risks from lower-profit margins and firm closures that might arise from the low-emissions transition. Box 4.4 discusses some of the current actions that banks are taking to identify climate-related risks.

The financial system directly influences the course and pace of low-emissions investment through its influence over the direction and flow of private capital. The level of sustainable finance is accelerating, both domestically and globally, as policy settings, technology development and changes in consumer preferences are making more 'sustainable' investments commercially viable.

In New Zealand sustainability-themed investments have grown from roughly \$22 billion in 2020 to \$40 billion in 2021.<sup>103</sup> Integration of Environmental, Social, and Governance (ESG) risks and opportunities within financial management and investment decisions have also increased.<sup>104</sup>

Through international channels, such as the Network for Greening the Financial System and Net-Zero Banking Alliance, actors in the New Zealand financial system are also engaged in global efforts to reallocate capital from emissions-intensive assets and activities towards lower-emitting alternatives.

## Many of the costs and benefits of the transition will affect households through changes in consumer prices and the impacts of structural change

The costs and benefits from the transition will not fall evenly across households, as shown by recent analysis of the impact of NZ ETS prices on household expenditure (Box 5.3).

Over the next five to 10 years, the overall impact of the transition on consumer prices is expected to be mitigated by changes in spending patterns as consumers substitute away from high-emissions goods. Technological advancements that have the effect of lowering the cost of low-emissions goods (such as reduced upfront costs of EVs) could benefit a number of households and support adjustments over time. However, costs are likely to be greater for households where spending behaviour is entrenched or capacity to switch to low-emissions alternatives is more limited.<sup>105</sup> Recent economic developments (such as rising rates of inflation) have implications for these estimates.

As sectors decarbonise, the wages and employment opportunities they offer will change. Modelling from the CCC shows relatively small net employment impacts, although some industries and regions will be more affected than others, especially in the short-to-medium term.<sup>106</sup>

Structural change will create economic and wellbeing costs for employees in disrupted businesses and sectors. Some high-emitting businesses and sectors are large employers in smaller regions and communities, so closures can have large local impacts. The workforce in emissions-intensive industries is more likely to be male, Māori and have lower qualification levels, and is concentrated in rural regions.

103 These refer to investments in assets that specifically aim to improve social or environmental sustainability, while delivering financial returns. Investments related to climate change, natural capital, green property, circular economy, and sustainable transport represent most sustainability-themed investments in New Zealand (Banhalimi-Zakar et al., 2022).

104 Banhalimi-Zakar et al., 2022.

105 Reserve Bank of New Zealand & BERL, 2018.

106 He Pou a Rangī – Climate Change Commission, 2021.

### Box 5.3

## Impacts of NZ ETS prices on household expenditure

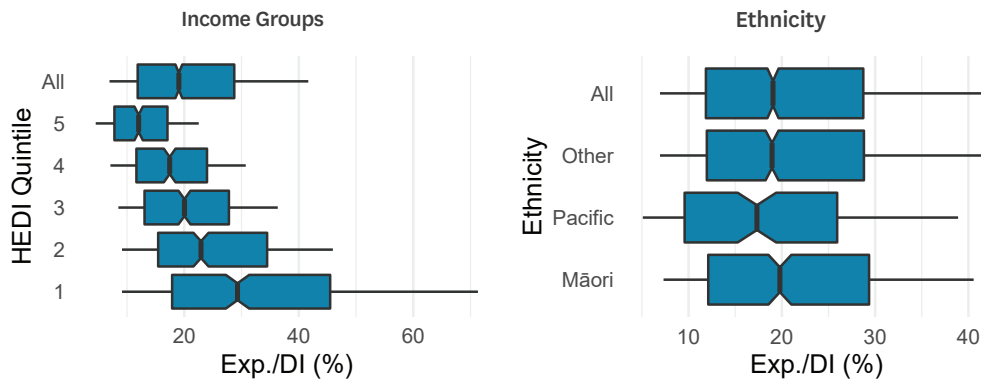


Recent analysis by the Treasury<sup>107</sup> considered the impact of a range of NZ ETS prices on household expenditure towards fuel (electricity, petrol, diesel, gas) and food.<sup>108</sup> Households were grouped by equivalised disposable income<sup>109</sup> (as modelled by the Treasury's tax and transfer microsimulation model) and ethnicity.<sup>110</sup>

Key findings of the analysis are listed below.

- Household electricity expenditure is relatively constant across the income distribution given almost all houses need electricity. Any extra consumption in higher income households can be offset by efficiency measures, so electricity expenditure impacts as a percentage of disposable income are larger for low-income households.
- Petrol price impacts of carbon price increases are also regressive, as are the combined effects of fuel and food.
- Māori households are more negatively affected by increased carbon prices, particularly due to impacts on electricity and petrol prices. The median household expenditure on petrol for Māori households was twice that for other households.

**Figure 5.2:** Modelled impact of NZ ETS price changes on household fuel and food expenditure for different income groups and ethnicity groups<sup>111</sup>



Source: The Treasury, 2022b

<sup>107</sup> The Treasury, 2022b.

<sup>108</sup> These are only first-order approximations due to simplifying assumptions, which include full and instant pass through of increased carbon costs to households, and households not adjusting their level of consumption in response to increased prices.

<sup>109</sup> The modified OECD equivalisation scale is used to calculate equivalised incomes. This enables comparison between households of different size and composition.

<sup>110</sup> Access to the data used in this study was provided by Stats NZ under conditions designed to give effect to the security and confidentiality provisions of the Statistics Act 1975. The results presented in this study are the work of the author, not Stats NZ or individual data suppliers.

<sup>111</sup> In these plots, the bold line in the centre of the box is the estimated median of the population. The notch that surrounds this gives the 95% confidence interval of the median estimate. The edges of the box represent the lower (LQ) and upper (UQ) quartiles. The whiskers represent the 10th and 90th percentile. DI refers to disposable income and HEDI refers to household equivalized disposable income.

## Regions could face different impacts based on the emissions intensity of their industries

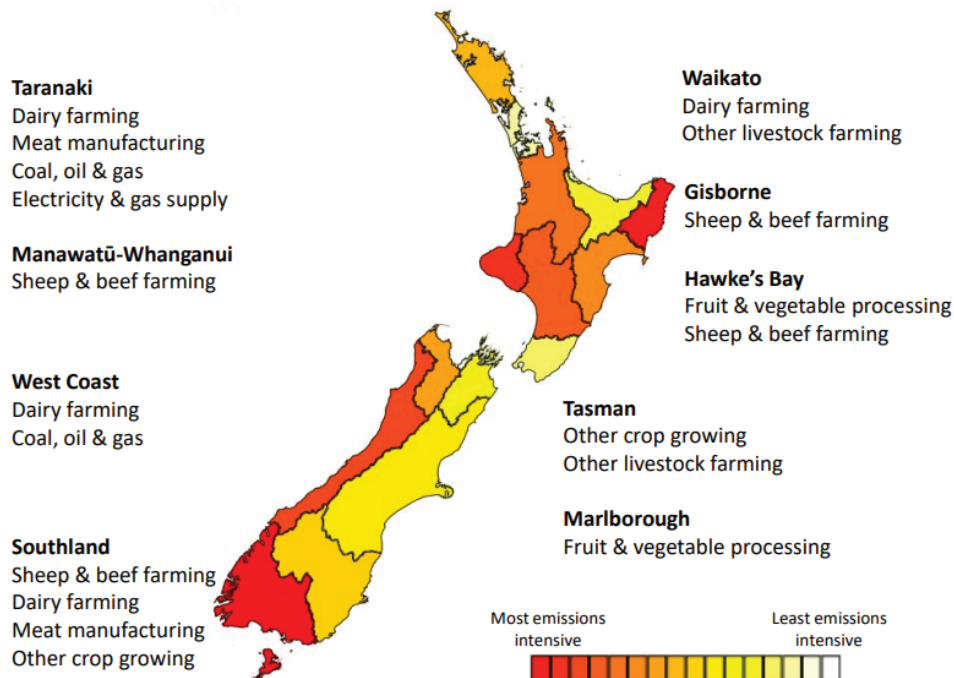
The workforces of New Zealand's regions have different emissions intensities due to the different industries they tend to be employed in. In general, the workforces of rural regions are more likely to be employed in high-emissions-intensity industries (such as agriculture, food manufacturing, heavy manufacturing, and extraction and distribution).<sup>112</sup> The regions with the largest proportion of their workforce employed in high-emissions-intensity industries are Southland, Tairāwhiti (Gisborne), Taranaki and the West Coast, while Wellington, Auckland and Nelson have a very low proportion of their workforce employed in these.

As the economy transforms, emissions-intensive regions and industries are likely to be more impacted through changes to regulations, prices and consumption, but the impacts of the transition on these workforces and regions are hard to predict based purely on their current emissions intensity. Some industries may have access to low-cost abatement opportunities or be able to pivot their production. Others may face high abatement costs and be more disrupted by the transition.

## The collective actions of individuals and households could have an impact on whether emissions reduction targets are achieved

A material proportion of New Zealand's emissions is connected to individuals and households, either directly (such as through emissions-related travel and energy consumption) or indirectly (such as through consuming goods produced using high-emissions processes). Behavioural changes (such as switching to a lower-emissions transportation mode or diet) lessens an individual's emissions footprint and could lead to aggregate impacts and less need for government intervention if widely adopted.

**Figure 5.3:** Map of emissions intensity (emissions per dollar of output) of industry by region across New Zealand, with significant high-emissions-intensity industries noted



Source: Ministry of Business, Innovation and Employment, 2021

<sup>112</sup> Ministry of Business, Innovation and Employment, 2021.



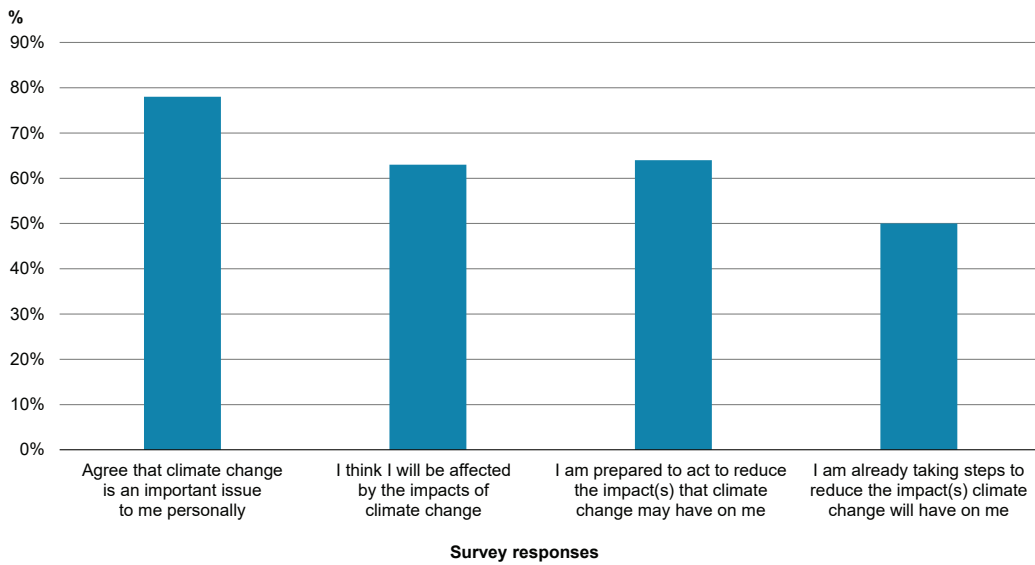
## Box 5.4

### New Zealanders' attitudes about climate change

Survey data from 2022 indicates that most New Zealanders (78%) consider climate change to be an important issue and expect to experience more frequent and extreme physical climate impacts in the next decade (Figure 5.4).

Despite the high proportion of New Zealanders considering climate change to be important, only 50% of survey respondents report they are already taking steps to reduce its impacts. Available research suggests this is due to both information and perceived cost barriers, as well as perceptions about who should take climate action, for example businesses or governments.<sup>113</sup>

**Figure 5.4:** New Zealanders' attitudes toward climate change based on 2022 survey data



Source: IAG, 2022

113 IAG, 2022.



## Māori are especially vulnerable to the costs of the low-emissions transition, but opportunities exist for Māori businesses

The impacts from the transition on the economic wellbeing of Māori are potentially significant. Māori are especially vulnerable because they are disproportionately represented among low-income earners. As noted in Box 5.3, Māori households are more negatively affected by increased carbon prices, particularly due to impacts on electricity and petrol prices.

Māori businesses are disproportionately represented in some high-emitting or climate-exposed sectors. As of 2018, the primary sector (agriculture, forestry and fishing) made up \$23.4 billion (34%) of the Māori asset base, with sheep and beef farming accounting for \$8.6 billion and dairy for \$4.9 billion in assets, respectively.<sup>114</sup>

The Ministry of Business, Innovation and Employment (MBIE) estimated that Māori account for around 23% of the workforce in emissions-intensive industries<sup>115</sup>, despite making up roughly 17% of the national population.<sup>116</sup> This is due to their high representation in industries like manufacturing, sheep and beef farming, and road and rail transport. Māori also make up a

smaller proportion of the workforce in low-emissions industries (14%), whereas the group ‘European or other’ have a comparatively high representation in these industries (see Figure 5.5).

The transition may also present economic opportunities for some Māori businesses and entrepreneurs. For example:

- › The business models used by many Māori businesses are consistent with a low-emissions economy. These approaches align with kaitiaki obligations towards te Taiao and future generations and may also resonate well in some global markets.
- › The transition could present opportunities to expand low-emissions industries that are already well-established parts of the Māori economy (such as forestry and low-emissions horticulture).

More broadly, transitioning land use to carbon sequestration options (such as afforestation) may present risks as well as opportunities, depending on how the balance of incentives for afforestation and other land uses evolves.<sup>117</sup>

## The transition has the potential to provide substantial co-benefits

In addition to providing potential opportunities for some sectors of the economy, the transition to a low-emissions future could lead to significant wider benefits for the wellbeing of New Zealanders. Well-documented co-benefits include improved public health, environmental outcomes and reduced household bills from resource efficiency. For example:

- › Reducing air pollution from vehicles will have a material social benefit. Recent estimates suggest that the social cost of vehicle-related air pollution in New Zealand could be \$10.5 billion per year.<sup>118</sup>

In addition, increased uptake of active transport modes (such as walking and cycling) have health benefits due to improved cardiovascular and mental health.<sup>119</sup>

- › Improved housing quality (for example better insulation and ventilation options) reduces emissions by improving the energy efficiency of heating and air conditioning. These solutions are also shown to reduce disease risk and improve community health outcomes.<sup>120</sup>

<sup>114</sup> Reserve Bank of New Zealand and BERL, 2018.

<sup>115</sup> Ministry of Business, Innovation and Employment, 2021.

<sup>116</sup> Stats NZ, 2022b. MBIE's analysis uses employee data from the 2017 calendar year, whereas Stats NZ's population estimates are for 2022.

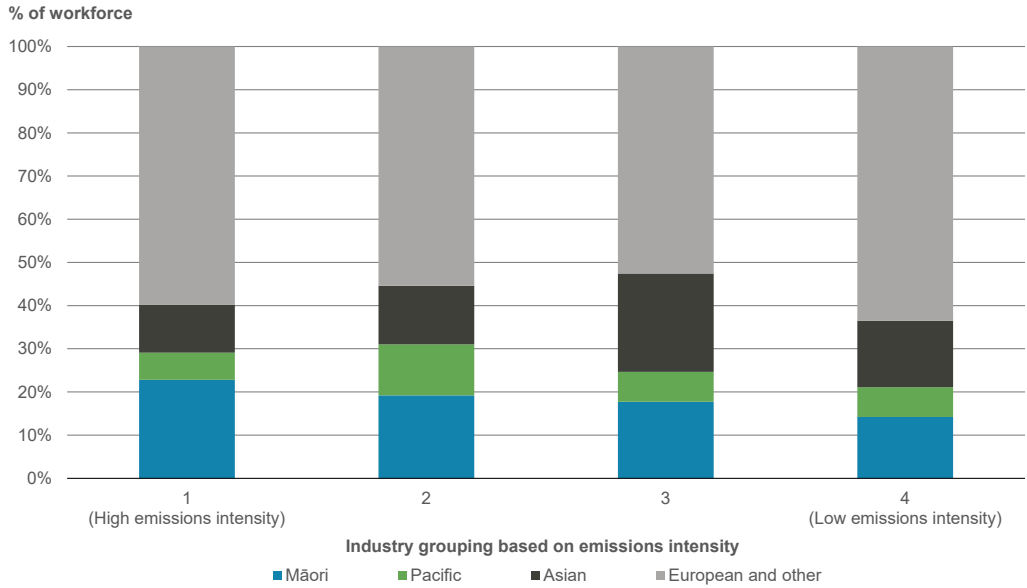
<sup>117</sup> Meade, 2021.

<sup>118</sup> Kuschel et al, 2022. The study considered costs from air pollution for the year 2016.

<sup>119</sup> Environmental Health Intelligence New Zealand, n.d.

<sup>120</sup> World Health Organization, 2011.

**Figure 5.5:** Workforce ethnicity across industry groups differentiated based on level of emissions intensity, 2017<sup>121</sup>



Source: Ministry of Business, Innovation and Employment, 2021

<sup>121</sup> MBIE’s analysis grouped industries into four different levels of emissions intensity. ‘High emissions intensity’ refers to the most emissions-intensive grouping. ‘Low emissions intensity’ refers to the least emissions-intensive grouping. Refer to Section 3 of MBIE’s report for a description of the industry emissions-intensity groupings.

## 5.3 Sources of variability

### Technological innovation, the economy's capacity to adapt, and the mix and timing of policy changes will influence overall impacts

Key factors that will influence the overall impacts of the transition are summarised in Table 5.2 below. To show how technological change and uptake across the economy could have implications for New Zealand's transition, the CCC modelled a number of scenarios. For example, while the CCC modelled GDP under its demonstration pathway in 2050 as being 1.2% lower than under its counterfactual scenario, a scenario with slower EV uptake is modelled to result in GDP being 2.1% lower in 2050 (just under twice as much as under its demonstration pathway).<sup>122</sup>

**Table 5.2:** Key factors that will influence New Zealand's low-emissions transition

Factor	Implication
The pace of technological innovation	Technological development, availability and cost will have implications for the pace and cost of New Zealand's transition. Given New Zealand's historic position as a technology-taker internationally, it is likely to be important for this country to be a fast-follower in most areas. However, in some areas (such as agriculture) New Zealand also faces the opportunity to act as world-leading. The degree to which New Zealand can successfully take up key technologies will be a function of its capacity to absorb and diffuse new technologies across the economy.
The economy's adaptive capacity	The economy's ability to efficiently reallocate both capital and labour towards, and enhance productivity in, low-emissions activities will be critical in supporting flexible and resilient future economic growth. How businesses and households respond to shifting price signals and trends (domestically and internationally) will be a key determinant in whether the transition incurs relatively greater cost or supports relatively greater new opportunities. The economy's ability to attract, scale and deliver the capital and labour resources required to achieve New Zealand's emissions targets will also play a key role.
The timing of domestic policy action	The pace, timing and levels of certainty around domestic policy action will be critical for the efficiency and speed with which key shifts and new investments are made across the economy.
Relative emphasis on gross reductions and offsets	New Zealand will face choices around how to balance gross emissions reductions with investment in offsets to address hard-to-abate emissions (such as through long-term forestry sinks).
The impact of social change	Climate change's disruptive impact on the relationships that bind society together and enable the economy to function well is yet to be fully determined. What these implications ultimately are will depend on the scale and distributive impacts of structural change, and broader economic developments.
International context	Domestic policy action will affect New Zealand's international competitiveness. International climate policy (or lack of it in some jurisdictions) will also affect New Zealand's economy. Policy and private sector choices about managing and balancing costs and risks from domestic emissions pricing and international market demands and opportunities will be key components of the ultimate economic impact of New Zealand's transition.

<sup>122</sup> He Pou a Rangi – Climate Change Commission, 2021. See [www.climatecommission.govt.nz/public/Inaia-tonu-nei-a-low-emissions-future-for-Aotearoa/Modelling-files/C-PLAN-GDP-results-sensitivities-2021-final-advice.xlsx](http://www.climatecommission.govt.nz/public/Inaia-tonu-nei-a-low-emissions-future-for-Aotearoa/Modelling-files/C-PLAN-GDP-results-sensitivities-2021-final-advice.xlsx)

## 5.4 Improving our understanding in the future

Areas where further analysis would help improve our understanding of the economic impacts of the low emissions transition are listed below.

- › Economy-wide impacts, such as:
  - the implications of different transition paths, for example accelerated, slower, or more disorderly paths
  - the medium- to long-run emissions price paths that support different transition paths to achieve net zero by 2050
  - the economic impacts of meeting New Zealand's NDC1 with different mixes of domestic and international mitigation
  - the impacts of the global climate response on trade and investment in New Zealand and the implications of our response for global trade relationships and flows
- regional or sector-level transition impacts, including where multiple or compounding risks may be experienced.
- › The role that new and future technology can play in supporting different transition paths, including how it could support New Zealand's ability to transition at a relatively lower cost.
- › The unique implications of the transition for Māori, for instance by exploring how different impact channels could interact.
- › The social cost of carbon to New Zealand, and therefore an indication of the economic and societal costs or benefits from additional (or avoided) tonnes of emissions.

# 6

## FISCAL IMPACTS

### THIS SECTION:

identifies potential areas of fiscal pressure due to climate change, both for revenue and expenses

explains how the NZ Emissions Trading Scheme affects the Crown's fiscal position and helps to fund the climate response

identifies areas where future research could be valuable.

### Summary

- › Climate change will create multiple cost pressures for the Crown and is likely to negatively affect its tax base through changes to economic activity.
- › The choices governments make, including around revenue and expenditure and the balance of spending and non-spending levers they use as part of a wider climate policy portfolio, will be key drivers of any fiscal impacts.
- › More frequent and severe climate-related natural disasters will increase the Crown's liabilities from existing cost sharing arrangements for response and recovery and damages to public assets. Modelling carried out by the Treasury and NZIER shows that:
  - increased frequency of droughts and storms or floods in New Zealand could increase net core Crown debt by 3.77% of GDP in 2061
  - climate change could cause an increase in the annual growth of the Crown liability for natural hazards from 5.3% to 5.5%-5.7% through to 2050, and this liability could grow faster than revenue over that period.
- › Further sources of potential direct fiscal cost include:
  - funding to support the domestic transition (such as decarbonising central government agencies) and offshore mitigation toward NDC1
  - funding to support adaptation measures (such as risk reduction for Crown-owned assets)
  - any financial support or compensation for disrupted households, businesses or communities.
- › Increased and more frequent severe weather events are likely to expose Crown assets to greater risk.
- › Indicative calculations based on CCC modelling show that the fiscal cost of direct support for additional investment in a range of key mitigation technologies through to 2050 could be around \$4 billion to \$12 billion, assuming the Crown contributes 10% to 30% of investment costs. These costs exclude areas such as transport infrastructure and on-farm emissions reductions.
- › Indirect fiscal costs are likely to arise due to changes to the tax base. There will be implications for transport-related charges and taxes, and through environmental taxes, including the NZ ETS.
- › The establishment of the CERF, using proceeds from the NZ ETS, provides a mechanism for government to use revenue from emitters for funding climate policy action. To date, \$3.8 billion has been committed through the CERF. Additional spending has also occurred through existing agency baselines.
- › The NZ ETS is a core element of New Zealand's transition with a broad fiscal impact, which depends on several factors, including auction price control and volume settings, and supply and demand in the market.

## 6.1 Summary of potential fiscal impacts



The economic impacts from physical climate change and the low-emissions transition will create fiscal pressures in multiple areas. Table 6.1 summarises the range of potential impacts to expenditure and revenue across different sectors.

The actual size of the impact on Crown revenue and expenditure will be determined by present and future governments' policy directions, investment decisions and revenue strategies in response to these pressures. Some fiscal pressures are less discretionary (such as repairing Crown's assets) while others are more so (such as the extent to which costs are allocated to emitters or taxpayers through publicly funded mitigation programmes).

Decisions on the mix and balance of spending and non-spending levers governments use will affect direct and indirect fiscal impacts.<sup>123</sup> For the low-emissions transition, a number of factors will decide the role of public spending in driving the transition and the implications for the Crown's fiscal position (such as changes in revenue or expenditure). These include choices about:

- › the roles of emissions pricing and other regulatory measures, and more direct interventionist policies to address market failures (such as access to capital)
- › how to manage the equity impacts of climate change.

**Table 6.1:** Potential impacts of climate risk on different areas of government expenditure and revenue

Area	 From physical climate change	 From the low-emissions transition
<b>Research, innovation and economic development</b>	Increased spending on areas such as research on understanding and managing the physical risks from climate change.	Increased spending on areas such as innovation to unlock long-term emissions reductions, support for lower-emissions activities, and industry or region-based funding to support an equitable transition.  Greater private investment in low-emissions technology could increase the cost of R&D tax credits.
<b>Energy</b>	Resilience or security of supply measures employed to support energy infrastructure.	Support for investment in renewable energy generation and any support for potentially significant system-wide upgrades in transmission and distribution investment beyond typical levels to enable the electrification of transport, process heat and space heating.
<b>Infrastructure and transport</b>	Crown investment in making public infrastructure more resilient and any additional support for building resilience in physical infrastructure across the economy.  Direct costs from the Crown repairing its own damaged assets and potential contributions to the repair of local government assets.	Changes to investment in transport infrastructure, for example from prioritising low-emission objectives.  Impacts of changes in the transport system (such as lower emissions intensity vehicles and reduced vehicle kilometres travelled) on fuel and vehicle related taxes and duties, subject to any future changes in funding settings.  Any funding of policies to incentivise shift to low-emissions transport options.
<b>Education and workforce</b>	Any additional Crown investment required for any potential strengthening or relocation of school property.	Fiscal pressure for employment and training-related support in response to closures of significant employers.

<sup>123</sup> For a general discussion on the value of taking a portfolio approach to climate policy, refer to Craxton (2022), *The value of taking a portfolio approach to climate policy*.



Area	 <b>From physical climate change</b>	 <b>From the low-emissions transition</b>
<b>International</b>	Expectation of aid to Pacific countries and broader international climate finance to support developing nations as the impacts of climate change they face become more pronounced.	Costs from international cooperation and offshore mitigation to meet NDCs and international climate finance commitments to support developing nations to reduce their emissions.
<b>Health</b>	Additional fiscal pressure on the health system due to temperature-related mortality and morbidity, changes to air quality, extreme weather events, vector-borne diseases, water-related illness, food safety and mental health.	Co-benefits (such as reduced air pollution, better insulated homes) could lessen fiscal pressures from the health system.
<b>Addressing impacts on iwi/Māori</b>	Costs from addressing unique climate change impacts Māori face, as well as unique adaptation needs, in a way that meets the Crown's Treaty and settlement obligations.	Costs from addressing the risk of the transition disproportionately impacting Māori and ensuring compliance with the Treaty and settlements.
<b>Natural resources</b>	Measures to address adverse impacts of climate change on natural resources, including conservation estate, flora and fauna.  Measures to support resilience or adaptation for affected primary industries.	Measures to support the low-emissions transition for the agricultural sector or other primary industries.
<b>Social services and community</b>	Any adverse impacts of physical climate risk on unemployment, hardship or incomes could create some fiscal pressure (such as via the welfare system).	Any adverse impacts of the low-emissions transition on unemployment, hardship or incomes could create some fiscal pressure.
<b>Other</b>	Spending on support for those unable to meet costs due to physical risk.  Increased emergency management activity and costs.  Indirect impacts to tax revenue due to impacts to economic activity.	Indirect impacts to tax revenue due to impacts to economic activity.  Costs from decarbonising the public sector (for example through the Carbon Neutral Government Programme), including measuring and reporting emissions, transitioning to low-emissions alternatives and purchasing offsets, as well as overall programme management. Decarbonising the public sector may produce savings from efficiencies.  Impacts to revenue from the changing price and volume of auctioned NZ ETS units on fiscal flows, as well as broader supply and demand interactions driving the secondary market price.  Costs of legal cases related to climate legislation.  Other costs from achieving an equitable transition.

## 6.2 Impacts on expenses

### Existing commitments

Some climate-related spending commitments have already been made by the Government, including through the CERF.

The CERF has been established to provide dedicated support for public investment in climate-related initiatives, distinct from main Budget allowances. It is an enduring multi-year fund, designed to encourage longer-term planning through enhanced funding certainty. Its size is based on the forecast cash proceeds of the NZ ETS, and its balance is updated regularly at Economic and Fiscal Updates (EFUs) to reflect changes to these forecasts.

The CERF was initially set up with \$4.5 billion in late 2021. As at Budget 2022, the Government had allocated \$3.8 billion from the CERF to climate initiatives across the period 2021/22 to 2025/26. Figure 6.2 below shows the sectoral makeup of these allocations. Since then the CERF has been topped up based on updates to NZ ETS forecasts, leaving \$3.6 billion remaining in the fund.

There are also areas of existing climate-related spend outside of and/or pre-dating the CERF.

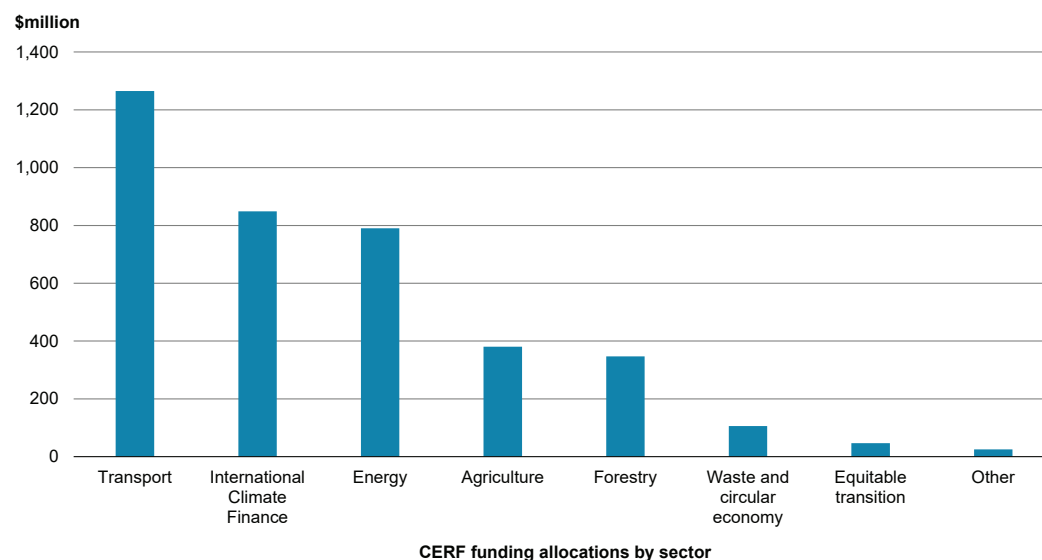
- › The Government Investment in Decarbonising Industry Fund, set up in 2020, was allocated \$69 million on its establishment.
- › A commitment of \$840 million for international climate finance made in Budget 2022 added to existing overseas development assistance, bringing New Zealand's total commitment to \$1.3 billion between 2022 and 2025.<sup>124</sup>

Existing funding sources also contribute to climate goals. The National Land Transport Fund can support transition-aligned investments for the transport system.

**Figure 6.1:** Size of the CERF and funding allocated from it as at the Budget Policy Statement for Budget 2023

\$ billions	Budget 2022	Budget 2023	Budget 2024	Budget 2025	Budget 2026
Funding allocated from the CERF	3.8				
Funding remaining in the CERF				3.6	

**Figure 6.2:** Funding allocations for the CERF for the period between 2021/22 and 2025/26, by sector



Source: New Zealand Government, 2022a

<sup>124</sup> New Zealand Government, 2022b.



## Future impacts of physical climate change on government expenditure

Modelling of the overall fiscal risk from physical climate risk for New Zealand is not yet available, but fiscal costs are likely to be substantial and to grow over time. The scale of these impacts is also highly dependent on the level of mitigation action globally.

Areas of fiscal costs from physical climate change and adaptation measures include:

- › natural disaster response and recovery
- › risk reduction for government-owned assets and potential contributions to risk reduction for assets not government-owned
- › support for affected households, businesses and communities and measures to manage impacts.

## Physical risks will add to existing costs of managing and responding to natural hazard risks

Extreme weather events and sea-level rise are expected to present the greatest risks to the value of the physical assets owned by the Crown. Exposed assets are social assets (roads, schools, hospitals) and commercial assets (rail assets and transmission lines).

Developing a comprehensive and transparent assessment of the risks posed by physical climate change is increasingly important. An action for Te Waihangā (New Zealand Infrastructure Commission) in the NAP is to develop guidance for assessing risk and impact on physical assets and the services they provide. This will support agencies to assess physical climate risk at a finer level.

Increased natural hazard risks from climate change is likely to add to the fiscal costs of natural hazards in the following ways:

- › Government contribution to the costs of restoring damaged assets and infrastructure, as set out in the National Civil Defence Emergency Management (CDEM) Plan 2015. Central government contributes 60% of the costs of restoring damaged essential infrastructure to the pre-disaster level of service after an event (over a threshold of event magnitude).<sup>125</sup>

- › Government costs for hazard response and recovery, and civil defence. In an emergency, local authorities incur costs as part of response and recovery activities, but can seek reimbursement for some types of expenses from the Government.

Sources of further fiscal risk in cases where other actors are unable to meet their share of the costs include:

- › additional Crown contributions above 60% towards repair and recovery<sup>126</sup>
- › ad hoc forms of support for impacted businesses and communities<sup>127</sup>
- › financial support and/or compensation for relocation from at-risk areas
- › greater support for risk reduction if local authorities are unable to meet the full costs.

A recent example of fiscal costs is the Government's \$100 million contribution to the recovery programme in the Buller district after the July 2021 flooding in Westport,<sup>128</sup> including an \$8 million financial assistance package in the immediate aftermath.<sup>129</sup>

<sup>125</sup> National Emergency Management Agency, n.d.

<sup>126</sup> In addition to the contribution to local authorities' costs under the CDEM, the Government has historically made additional contributions when local authorities have been unable to cover their costs.

<sup>127</sup> The Government has also historically provided various forms of support for communities and businesses impacted by event-related physical impacts such as floods and droughts.

<sup>128</sup> Minister for Emergency Management, 2022.

<sup>129</sup> Minister for Emergency Management, 2021.

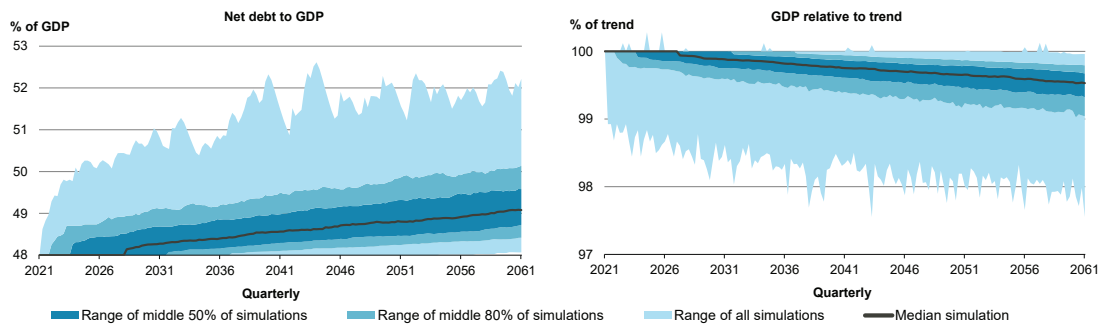
## Box 6.1

### Measuring the potential fiscal impact of physical risks

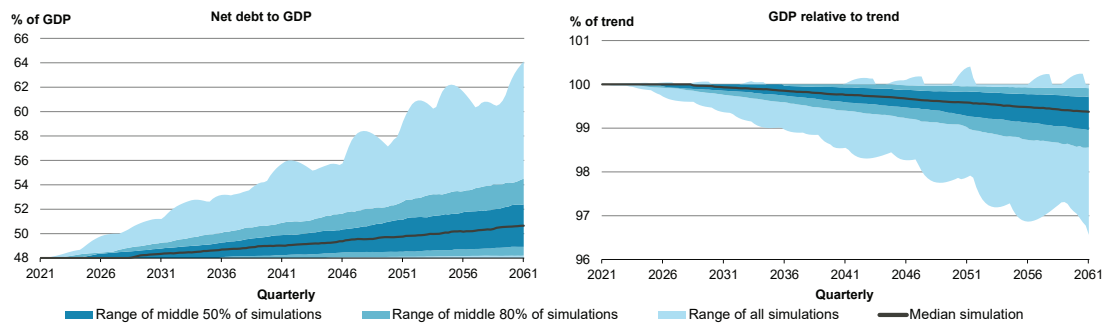
Two initial studies suggest the New Zealand economy and the Crown's financial position are resilient to an increase in the frequency of severe climatic events such as storms and drought.

Median simulations in the Treasury's 2021 Long-Term Fiscal Statement (LTFS), *He Tirohanga Mokopuna*, show that net core Crown debt could be higher by 3.77% of GDP in 2061 from increased storms and/or floods and droughts due to climate change. Figures 6.3 and 6.4 below show these impacts and the large uncertainty bounds. The LTFS acknowledges that impacts would be felt severely at the local level.

**Figure 6.3:** Impact of increasing frequency of severe and moderate droughts on net debt and GDP



**Figure 6.4:** Impact of increasing storms and/or floods on net debt and GDP



Source: The Treasury, 2021c

A 2020 NZIER study (commissioned by Department for Internal Affairs)<sup>130</sup> modelled the effect of climate change on the costs from storms and floods. It projected that climate change could cause an increase in the annual growth of the Crown liability for natural hazards from 5.3% to 5.5%-5.7% (about 0.2 to 0.4 percentage points higher) through to 2050. It also projected that the Crown's liability from all natural hazards would grow faster than its revenue over that period (projected to grow at a rate of 4.8% per annum).

At Budget 2022, the Government adopted a fiscal rule to keep net debt below 30% of GDP. This ceiling provides headroom for economic shocks and is set at a conservative level.<sup>131</sup> At the December 2022 *Half Year Economic and Fiscal Update* (HYEFU), net debt was forecast to peak at 21.4% of GDP in 2023/24. This suggests the Government's financial position is likely to be resilient to negative shocks of the size in the studies referenced above, at least in the near term.

#### Limitations

The simulations run by the Treasury to inform the scenario modelling it undertook for the LTFS reflect a range of estimated economic and fiscal impacts across different scenarios. These are driven by differing assumptions around the frequency and severity of certain extreme events, what the productivity or capital shock would be, and how government spending and private actors might respond.

Both studies modelled a limited number of physical risks and looked at impacts independently. In reality, climate impacts will interact and have the potential to compound. As noted in the LTFS, the climate may respond to increased emissions in unexpected ways, including irreversible impacts or the crossing of 'tipping points'. These studies should therefore be seen as initial steps in understanding how resilient New Zealand's public finances are to climate change.

<sup>130</sup> NZIER, 2020.

<sup>131</sup> Treasury analysis suggested a maximum debt limit of 90% of GDP under the previous core Crown debt measure, which corresponds to 70% of GDP under the new debt metric (The Treasury, 2022c).



## Impacts of the low-emissions transition on government expenditure

Key areas of fiscal costs from the low-emissions transition are:

- › government funding of measures to support domestic emissions reduction, including decarbonising the central government
- › purchasing the offshore emissions reductions needed to meet international commitments
- › international climate finance contributions (such as support for developing economies to decarbonise)
- › support for disrupted households, businesses and communities and measures to ensure an equitable transition.

### Measuring the potential fiscal impacts of the low-emissions transition

The Government's first ERP gives its plans, strategies and intended actions to meet New Zealand's domestic emissions targets. Detailed cost estimates are not yet available for the entire range of policies covered in the first ERP, so the likely fiscal costs of meeting domestic targets through the plan have not been fully calculated.

Sources of information are available that give insight into the potential scale of the possible fiscal costs of New Zealand's low-emissions transition. The CCC's modelling of net additional investment costs to support its 'demonstration pathway' (above levels assumed under its 'current policy reference' scenario) provides one source of information that helps understand potential fiscal costs.<sup>132</sup> Further detail on the Commission's modelling of investment costs to achieve New Zealand's 2050 targets is given in Box 5.1.

To show how these additional whole-of-economy investment costs (beyond assumed counterfactual levels) could translate into fiscal costs, Table 6.2 gives illustrative estimates of the portion of total net additional investment in key sectors the Crown may choose to directly support. The estimates were arrived

at by applying a range of assumptions about what share of the net additional investment costs identified by the Commission in each sector may be borne by the Crown.

The degree to which the Crown directly funds or supports such investments depends heavily on the choices of present and future governments on the balance of spending and non-spending levers that form their climate policy portfolio and broader decisions around the role of government intervention. The figures should therefore be considered illustrative only.

### The transport and energy sectors show how the fiscal risks to the Crown are expected to vary materially between sectors

Since the Commission undertook its modelling, further information on the energy and transport systems has become available that improves our understanding of the potential fiscal implications in these sectors. See Box 6.2 on the fiscal implications of electrification within the energy system, and Box 6.3 on the fiscal implications of transport mode shift.

### Government will also face direct costs to decarbonise its own activities

As well as the funding the Government may provide to support the transition across New Zealand's economy, direct costs will also be incurred to deliver the Carbon Neutral Government Programme (CNGP) objectives, set up in 2020.

The CNGP goal is for public sector organisations to be carbon neutral from 2025. Through the programme covered entities are expected to report on their emissions, make and carry out their own emissions reduction plans and offset any remaining emissions.

The State Sector Decarbonisation Fund has been set up with \$219.5 million to help fund these reductions across the state sector. Additional funding may also be required for further decarbonisation and investment in any necessary offsets.

<sup>132</sup> He Pou a Rangī – Climate Change Commission, 2022.

**Table 6.2:** Illustrative estimates of potential levels of direct Crown investment to support additional investment costs identified by the CCC to achieve New Zealand’s 2050 targets in line with its demonstration path, beyond considered counterfactual levels

Sector	Proportion of total net additional investment costs met by the Crown for each sector		
	10%	20%	30%
Road transport	\$0.6 billion	\$1.2 billion	\$1.9 billion
Electricity generation	\$1.3 billion	\$2.6 billion	\$4.0 billion
Buildings (space & water heating)	\$0.5 billion	\$1.0 billion	\$1.5 billion
Food processing	\$0.1 billion	\$0.2 billion	\$0.3 billion
Native afforestation	\$1.3 billion	\$2.6 billion	\$3.9 billion
<b>Total</b>	<b>\$3.8 billion</b>	<b>\$7.7 billion</b>	<b>\$11.5 billion</b>

Source: Treasury calculations based on CCC analysis (He Pou a Rangī – Climate Change Commission, 2022)

## Box 6.2

### The fiscal implications of transport mode shift

The transport sector has a significant role to play in achieving New Zealand’s emissions targets, as it contributes about 17% of the country’s gross emissions. Mitigation opportunities for the sector include:

- › switching from internal combustion engine transport to electric (or other low emissions) vehicles
- › shifting to other lower-emission modes of travel (for example public transport, walking and cycling).

The CCC’s modelling includes assumptions about rates of vehicle switching. The first ERP sets out plans for ‘mode shift’ from cars to other forms of transport and a reduction in vehicle kilometres travelled (VKT) by the light fleet of 20% by 2035.

Early estimates based on CCC modelling and the transport targets set out in the ERP suggest new transport capital expenditure to unlock emissions reductions could be upwards of \$20 billion over 10 years from 2025 to 2034, depending on the scale and type of new investments.<sup>133</sup> This includes significant investments beyond business-as-usual activities, such as decarbonisation of the public transport fleet and walking and cycling improvements.

<sup>133</sup> Based on analysis from the Land Transport Revenue Review Working Group.

### Box 6.3

#### The fiscal implications of electrification within the energy system

The transition to low-emissions energy is a critical enabler for achieving gross emissions reductions in multiple sectors and will require substantive investment. More investment in renewable energy generation, as well as system-wide upgrades in transmission and distribution infrastructure, is needed to enable the electrification of transport, process heat and space heating. A Boston Consulting Group (BCG) report<sup>134</sup> suggests that such changes can enable the electricity sector to support a reduction of 70% of the emissions reductions required for New Zealand to achieve its 2050 net-zero target.

The private sector is likely to fund significant investment in the energy sector. The Crown currently owns around 51% of three generation companies (Genesis, Mercury and Meridian – all listed on the NZX) and 100% of Transpower, a State-owned enterprise that owns New Zealand's transmission network. To the extent that these companies wish to make investments that they are not able to fund from their balance sheets, one or more of them could seek to raise equity. Given the Crown's ownership interests there could be potential fiscal implications, depending on whether equity was sought by the companies from their shareholders, and (if so) whether the Crown agreed to provide some of the equity. As the four companies are all commercial, any equity provided to them would be expected to earn a commercial return.

Energy policy typically looks to balance objectives across the energy trilemma of sustainability, affordability/equity and security of supply. The transition towards increased reliance on renewable electricity poses challenges for how to ensure an affordable and secure energy system.

- › The transition will see changes to both demand and supply in the electricity market. Intermittent renewable energy (such as wind and solar) is expected to be the main source of supply growth in New Zealand. This energy tends to be less consistent than traditional baseload electricity generation since it relies on weather conditions. Expanding this generation source will therefore affect the country's electricity supply profile. Increased electrification throughout the economy will also see shifts in the demand profile, with winter peak demand forecast to rise. Electrification in other sectors, especially transport, will also have implications for demand patterns throughout the day.
- › Ensuring that supply is consistently able to meet demand, while balancing the energy trilemma, will require new tools and solutions. These could include new market instruments and structures, and physical or technological solutions (for example new solutions to address dry-year risks and peaking energy demand such as pumped hydro, demand management or other storage technology). While necessary to achieve the energy transition, this new innovative environment also comes with greater and more novel investment risk.

Large-scale investment in the electricity system is likely to be required in the coming decades. The CCC's modelling shows that meeting its demonstration pathway would require an additional \$3.3 billion investment in transmission infrastructure and \$2.9 billion in renewable generation from 2020 to 2030. Work carried out by BCG suggests similar, if not greater, levels of investment will need to be sustained at least until the 2040s and 2050s. BCG's report presents a scenario where faster and greater emissions reductions for the electricity system are achieved compared to under the CCC's demonstration pathway. To deliver this scenario, the BCG estimates required investment in the 2020s of \$42 billion, made up of \$8.2 billion for transmission, \$22 billion for distribution, \$10.2 billion in renewable generation and \$1.9 billion in new flexible generation and demand resources to cater for peak demand and dry period.

Unlike the CCC's modelling of net additional investment required, BCG's figures include investments that may or may not already be planned or expected. Along with the more aggressive investment and emissions reductions from the electricity sector compared to the CCC's demonstration pathway, this is a reason why BCG's figures are greater than the CCC's.

Both studies show that billions of dollars of investment are needed in the sector to enable it to support New Zealand's low-emissions transition.

<sup>134</sup> Boston Consulting Group, 2022.



## 6.3 Impacts on revenue

Overall impacts of physical climate risk and the transition on fiscal revenue will very much depend on changes to broader economic activity (such as business investment, profitability, and consumption) that affect the overall tax base. The overall direction of impact on fiscal revenue is likely to be negative. This is because physical climate risk will likely have a net negative impact on economic output (Section 4.1) and modelling shows the possibility of slightly lower economic growth due to the low-emissions transition (Section 5.1).

Specific channels of impacts on the Crown's core revenue sources include:

- › gains in corporate income tax and GST from expanding low-emissions activities, due to higher profits and greater investment
  - › losses in corporate income tax and GST from declining high emissions activities, due to lower profits, business closures and reduced investment
  - › potential wider net losses across core tax sources due to broader physical and transitional impacts on aggregate variables (such as output, consumption, incomes, employment and investment).
- Three further channels of potential revenue impacts for the low-emissions transition are:
- › impacts of changes in the transport system on fuel and vehicle related taxes and duties (Box 6.4)
  - › revenue impacts of the NZ ETS (discussed below)
  - › any future changes to environmental tax policy settings. The ERP includes an action to investigate long-term options to address emissions leakage (such as a carbon border adjustment mechanism).

### Box 6.4

#### Revenue impacts from changes in the transport system

Some climate-related changes will have varying impacts on revenue in the transport sector.

- › The Government has a target of reducing total VKT for the light vehicle fleet by 20% by 2035 relative to the expected VKT with current policy. Achieving this goal will require a number of changes including those that support a substantive shift from high private vehicle use to less-emissions-intensive modes like public transport, walking, and cycling. Although forecast scenarios show a rise in land transport revenue (due to, for example, population and economic activity growth), achieving the VKT reduction target would see a much smaller increase compared to under the baseline counterfactual forecast (eg, due to reduced fuel consumption).
- › The uptake of more efficient petrol vehicles, including hybrids, will result in less revenue from excise duty than would be collected without further uptake.
- › Once the current exemption of light EVs from road user charges ends, the shift to zero-emission vehicles is not expected to have a material impact on transport revenue. This is because vehicles powered by a source other than petrol (such as diesel) are subject to road user charges and are charged for distance travelled rather than litres of fuel consumed. The current exemption of EVs from these charges is legislated to end on 31 March 2024. Any policy deviation from this will have a material impact on revenue.

Forecast scenarios suggest that existing revenue sources, such as the National Land Transport Fund (funded primarily through Fuel Excise Duty and Road User Charges), may be insufficient to meet the additional expenditure needed to deliver transportation system changes.<sup>135</sup> The funding gap that may arise due to climate-related changes could be offset by rate changes, or the net fiscal impact could be mitigated through limiting expenditure on lower-priority areas of road investment.

<sup>135</sup> Based on analysis from the Land Transport Revenue Review Working Group.

## 6.4 Fiscal impacts of the NZ ETS

### Explaining the NZ ETS

The NZ ETS is the country's main emissions pricing tool, covering about 50% of New Zealand's emissions. The NZ ETS plays an important role in ensuring producers and consumers of products recognise the emissions cost of their activities. By placing a price on emissions across the economy, the NZ ETS incentivises emissions reductions and removals (through activities such as forestry) that drive New Zealand's domestic net emissions down.

### The NZ ETS has material fiscal impacts for the Crown as a net revenue activity

Overall, the NZ ETS is fiscally positive, generating revenue for the Government and decreasing net debt. However, different events within the NZ ETS can have impacts on both Crown revenue and Crown expenses, as well as net debt and net worth (Table 6.3).

The Treasury publishes forecasts factoring in the fiscal impacts noted above at each EFU. These forecasts are based on projections of auction volumes as set out in regulations, unit flows, and current secondary market prices. Fiscal flows depend on the impact of different price and volume assumptions as follows:

Item	Calculation
Auction proceeds	Auction volume × auction price
NZU stockpile liability	Stockpile volume × secondary market price
Surrender revenue	Surrender volume × secondary market price
Expenses	Allocation volume × secondary market price

**Table 6.3:** Four parts of the ETS have fiscal impacts

ETS activity	Fiscal impact
<b>Auction proceeds</b>	<ul style="list-style-type: none"> <li>› NZ ETS auction volumes are decided by the Government and published five years in advance on a rolling basis.</li> <li>› Proceeds from these auctions represent a cash inflow for the Crown.</li> <li>› The total value of auction proceeds depends on the price received at auction.</li> </ul>
<b>NZU stockpile liability</b>	<ul style="list-style-type: none"> <li>› The volume of NZUs in private ownership represents a liability on the Crown's balance sheet.</li> </ul>
<b>Surrender revenue</b>	<ul style="list-style-type: none"> <li>› Mandatory NZ ETS participants must surrender NZUs to the Government annually to settle the obligations that arise from their emissions in the previous year.</li> <li>› This constitutes revenue for the Crown as its NZU stockpile liability decreases.</li> <li>› Participants must surrender one NZU for every tonne of CO<sub>2</sub>e they emit, so surrender volume equals emissions in sectors covered by the NZ ETS.</li> </ul>
<b>Allocation expenses</b>	<ul style="list-style-type: none"> <li>› Allocating units to NZ ETS participants at no cost represents an expense for the Crown as its stockpile liability increases without it receiving an asset in return.</li> <li>› NZU allocation is provided for forestry activity and through industrial allocation.</li> </ul>

### Scenarios for NZ ETS fiscal flows

Unit flows and secondary market prices are subject to change based on policy decisions and market drivers. This means that actual NZ ETS fiscal flows could deviate from EFU forecasts. Some illustrative scenarios for how the fiscal impacts of the NZ ETS could vary depending on different NZU prices over time are given below.

These scenarios are intended to complement the formal fiscal forecasts included in the EFUs, and they are not predictive or a forecast projection. A full analysis and description of supporting information and assumptions is given in the forthcoming Technical Appendix 1.

Three NZU price scenarios have been calculated. Unit volumes (auction, surrender, allocation and stockpile volumes) are consistent across scenarios and are based on regulated auction volumes for the calendar years 2023 to 2027 and projections collected by MfE.

The range in Table 6.4 shows the impact of price on the fiscal flows within the NZ ETS. There are many events that have implications for the NZ ETS's fiscal flows. Table 6.5 shows how a number of these events have flow-on impacts for Crown cash, stockpile liability, revenue, expenses and gains/losses.

### NZ ETS cash proceeds are currently the basis for the size of the CERF

NZ ETS cash proceeds have been used as the basis for the size of the CERF since it was established in late 2021. The balance of the CERF has been regularly updated at EFUs to reflect changes to the Treasury’s four-year forecasts of NZ ETS cash proceeds. As at the HYEFU in December 2022, the current CERF balance

was \$3.6 billion. The balance of the CERF may be adjusted in the future to reflect changes in NZ ETS forecast cash proceeds.

The relationship between the size of the CERF and NZ ETS cash proceeds is not hard-wired. The size of the CERF is the Government’s choice. In future, the Government could choose to allocate less or more than available NZ ETS proceeds to the CERF.

**Table 6.4:** Illustrative NZ ETS fiscal flows for 2023 to 2026 based on different NZU price scenarios

	Auction proceeds	Surrender revenue	Allocation expenses
<p><b>Scenario 1: Relatively low NZU price</b></p> <p>Assumes NZU prices in each year align with the ‘auction reserve price’ as defined in the recently updated (December 2022) NZ ETS regulations. This is considered to be ‘relatively low’ as it reflects the minimum price at which NZUs will be sold at auction. While the price floor does not prevent market participants from trading NZUs in the secondary market for a lower price, it serves as a signal of the Government’s long-term expectation of the minimum value of NZUs.</p>	\$2.4 billion	\$6.9 billion	\$3.4 billion
<p><b>Scenario 2: Central NZU price</b></p> <p>Assumes NZU prices in each year align with the mid-point between the regulated auction reserve price and ‘trigger price’ as defined in the recently updated (December 2022) NZ ETS regulations for each year.</p>	\$4.3 billion	\$12.5 billion	\$6.2 billion
<p><b>Scenario 3: Relatively high NZU price</b></p> <p>Assumes NZU prices in each year align with the ‘trigger price’ as defined in the NZ ETS regulations. This is thought to be ‘relatively high’ because it reflects an upper bound on what prices the Government considers to be ‘acceptable’ within the NZ ETS.</p>	\$6.2 billion	\$18.1 billion	\$9.0 billion

**Table 6.5:** How various events within the NZ ETS translate to fiscal impact

Event	Fiscal impact	Cash	Stockpile liability	Revenue	Expenses	Gains/Losses
<p><b>1 NZU enters market, either through:</b></p> <p><b>Government auctions</b> – Participants can bid for a predetermined volume of NZUs at quarterly government-run auctions.</p>	<p>NZU auctions produce a cash inflow for the Crown, but also create a liability for the Crown because it has an obligation to accept NZUs as participants surrender them. Because both an asset and a liability of equal size has been created, no revenue is recognised at this point. Auctions are therefore <b>revenue neutral</b>.</p>	↑	↑			
<p><b>Free allocation</b> – Some emissions-intensive, trade-exposed businesses receive free NZUs from the Government to address the risk of emissions leakage.</p>	<p>Free allocation of NZUs is an expense for the Government, because its liabilities have increased without getting anything in return.</p>		↑		↑	
<p><b>Forestry sequestration and other removal activities</b> – Forestry participants earn NZUs for the carbon sequestered by their forests, and some participants receive NZUs for exporting, embedding or destroying emissions.</p>	<p>NZUs allocated to registered foresters who earn them for sequestering carbon in their forests are an expense for the Crown because its liabilities (the NZUs) have increased without getting anything in return. The identical impact occurs when allocating for other removal activities.</p>		↑		↑	
<p><b>2 NZU sits in stockpile<sup>136</sup></b></p> <p>Excess NZUs held by participants that are not immediately used towards surrender obligations are referred to as the NZ ETS ‘stockpile’. There is currently a large stockpile due to the accumulation of past allocations of NZUs to participants.</p>	<p>The NZU stockpile is a <b>liability</b> for the Crown; it allows the holders of NZUs to emit in the future but when they do, they must surrender the NZUs to the Crown. As the NZUs are surrendered, the liability is cancelled. This liability is valued as the number of outstanding NZUs multiplied by the market price for them. <b>It therefore fluctuates whenever the volume or price changes</b>. Fluctuations in the value of this stockpile are Gains and Losses for the Crown and are therefore reflected in the Operating Balance.</p>		↕			↕
<p><b>3 NZU on-sold through ‘secondary market’<sup>137</sup></b></p> <p>Participants can also purchase NZUs from other participants.</p>						
<p><b>4 NZU surrendered</b></p> <p>NZ ETS participants must surrender NZUs back to the Government equivalent to their surrender obligation.</p>	<p>When NZUs are surrendered, the stockpile of NZUs reduces, decreasing the Government’s liability. This decrease in liabilities is Crown revenue. The Government does not actually receive any cash inflow at this point.</p>	↓		↑		

<sup>136</sup> There is no fiscal impact at this stage, but these NZUs do form the stockpile liability while they sit in the stockpile.

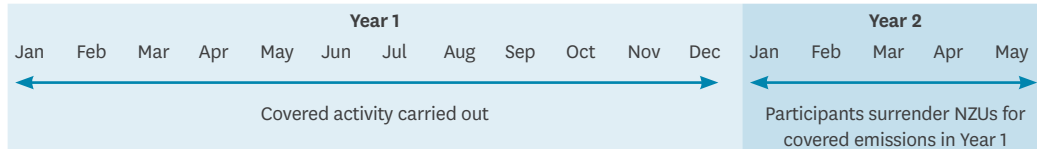
<sup>137</sup> This may not happen for all NZUs.

## Box 6.5

### How the NZ ETS works

Participants in the NZ ETS must surrender one emissions credit, called a 'New Zealand Unit' (NZU) for every tonne of CO<sub>2</sub>e they emit each calendar year.

The volume of NZUs participants must surrender each year is called their 'obligation' and is calculated from the activities (like importing or refining petrol) carried out in the previous calendar year. Participants have until 31 May each year to surrender NZUs for their previous calendar year's activities:

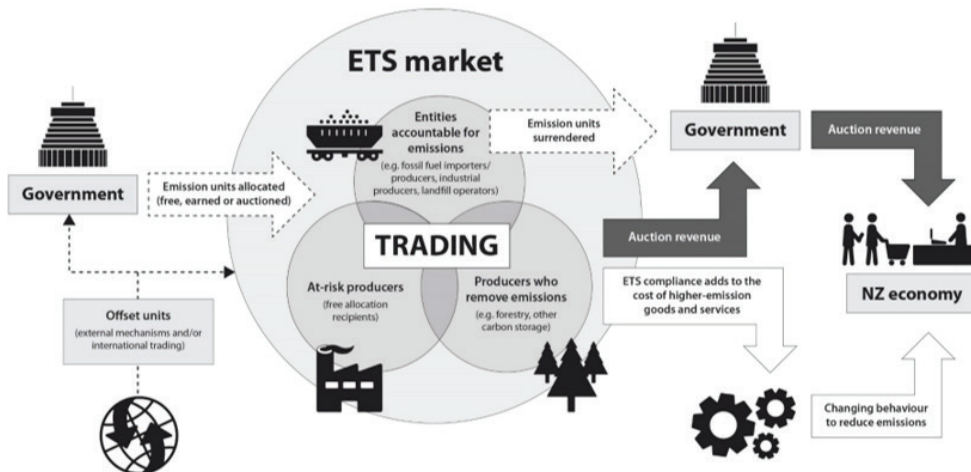


Participants can acquire NZUs in five ways:

1. **Government auctions** – Participants can bid for NZUs at quarterly government-run auctions. The volume of units available at each auction is set out in regulations.
2. **Free allocation** – Some emissions-intensive, trade-exposed businesses receive NZUs from the Government to address the risks of competitiveness issues for New Zealand businesses impacted by emissions pricing costs in the global marketplace.<sup>138</sup>
3. **Forestry sequestration** – Forestry participants earn NZUs for the eligible carbon sequestered by their forests.
4. **Secondary market** – Participants can purchase NZUs from other participants.
5. **Other removal activities** – People who export, embed or destroy emissions that were assumed to occur in New Zealand and priced by the NZ ETS are eligible to receive NZUs (for example exporters of synthetic GHGs).

Participants can dispose of NZUs by surrendering them to the Crown to meet their emissions obligations or by selling them in the secondary market. They can also hold NZUs indefinitely. NZUs held by participants that are not immediately used towards surrender obligations are referred to as the NZ ETS 'stockpile'. The stockpile is due to the build-up of past allocations of NZUs to participants, including NZUs earned by forestry participants.

Figure 6.5: How the NZ ETS works



Source: Leining, 2022 (p. 5)

<sup>138</sup> For more information on industrial allocation, see Ministry for the Environment (2022f).

## 6.5 Overall impacts on the balance sheet

Physical climate change and the transition to a low-emissions economy is likely to affect the assets and liabilities the Crown holds, and how it manages them. The overall balance sheet impact will depend on how effectively the Crown manages its exposure to explicit and implicit climate risk over time. Examining implicit and explicit climate liabilities can support more efficient long-term risk-reduction investment.

The global transition due to climate change also presents opportunities. For example, as an investor with a long-term focus, the New Zealand Superannuation Fund can use its risk appetite to take advantage of climate investment opportunities in overseas and domestic markets.

The Government may choose to use its balance sheet to support climate objectives directly, for example through investment in climate-aligned assets with risk/return profiles that may be unattractive to private sectors alone (such as investing to bring together otherwise uncoordinated private sector actors). This is the role of New Zealand Green Investment Finance Ltd (NZ GIF).

Across government, there is no one approach for agencies to systematically assess the risks and opportunities of climate change on their activities and balance sheets. Some entities (such as Waka Kotahi) are voluntarily preparing disclosures to begin reporting on these risks and opportunities. Crown financial institutions with more than \$1 billion in assets under management (such as ACC and the New Zealand Superannuation Fund) are also subject to new climate-related disclosures requirements as of 1 January 2023.

Developing a comprehensive and transparent assessment of the risks and opportunities posed by climate change to the Crown's balance sheet will become more and more important. Such information can be used to support more efficient long-term investment and the management of climate risks and opportunities.

## 6.6 Choices that can influence fiscal impacts

A range of choices that New Zealanders and present and future governments make can influence fiscal impacts. Some of the major strategic choices are outlined below.

<b>Level of ambition</b>	Future choices about the level of New Zealand's NDCs and domestic budgets will influence fiscal impacts. Stricter emissions targets entail larger fiscal costs, but if additional warming can be avoided through international efforts it will mitigate costs of climate change for New Zealand.
<b>Choice of policy interventions</b>	For physical impacts, central government will have choices over the mix of regulation, information or funding and financing tools that it uses, influencing how costs are shared with local government, private asset owners, banks and insurers.  In reducing emissions, the following will influence fiscal impacts: <ul style="list-style-type: none"> <li>› the balance of emissions pricing, other forms of regulation and other complementary measures</li> <li>› the balance of net versus gross emissions reductions used to meet emissions targets.</li> </ul>
<b>Roles of government, businesses, communities and individuals</b>	Policy decisions will implicitly influence where costs are borne in the economy. Market-based and regulatory interventions could see costs borne more by private actors, while public investments and more generous support for addressing impacts on individuals would see a greater share of costs borne by taxpayers.
<b>Timing of policy interventions</b>	Present and future governments will have choices about when to instigate interventions. Where actions involve costly adjustments for some households and businesses, decisions will involve weighing up the economic and fiscal benefits and costs of slower and faster changes (for example the underlying trade-offs and tensions between spending early to derive greater certainty and mitigate the risk of potential 'long-tail' costs of waiting versus allowing time for lower-cost technologies to develop and commercialise).

<b>Balance of domestic mitigation and international emissions reductions</b>	As covered in Section 7, meeting New Zealand’s international commitments is expected to require a combination of domestic and offshore mitigation. Both will bring fiscal costs, but their relative costs are not fully clear.
<b>How and to what extent differing impacts on communities and individuals are addressed</b>	Present and future governments have choices about the degree to which they smooth transitions (such as for those directly impacted by structural change) and redistribute costs across households, firms, sectors, regions and generations. Tax and welfare system settings are key levers for affecting the distribution of costs.
<b>Funding or financing</b>	Present and future governments have a range of tools for managing choices about public investments, including the annual Budget process and the CERF. They also have several tools for financing the climate transition including: <ul style="list-style-type: none"> <li>› NZ GIF, a Crown-owned investment vehicle set up in 2019 with a mandate to invest in commercial opportunities that accelerate the reduction in emissions and provide a commercial return on investment</li> <li>› New Zealand’s Sovereign Green Bond Programme launched in 2022, which aims to promote the development of domestic green finance markets, as well as provide investors with opportunities to deploy funds to green assets.</li> </ul>

## 6.7 Improving our understanding in the future

Areas where further analysis and evidence would help improve our understanding of potential fiscal impacts include:

- › Continuing to build the evidence base on the fiscal costs of both domestic and international mitigation opportunities. For example:
  - further refining our understanding of the potential fiscal costs of investments likely to be needed in the transport and energy sectors to support decarbonisation across the economy
  - further developing our understanding of the likely costs of various potential sources of offshore mitigation to achieve New Zealand’s NDCs.
- › Building a better understanding of risks to the Crown’s balance sheet from assets exposed to climate change risks.
- › Better understanding the wider extent of community exposure to physical risks that could give rise to the need for government contributions to future costs (such as for community relocation or investment in resilience measures).



# 7

## NEW ZEALAND'S FIRST NATIONALLY DETERMINED CONTRIBUTION – SCENARIO ANALYSIS OF FISCAL RISK FROM OFFSHORE MITIGATION

### THIS SECTION:

describes our approach to estimating the potential costs of purchasing offshore mitigation toward our first NDC, using a scenario analysis

explains the uncertainties involved in estimating these costs

presents cost estimates based on the nine scenarios considered.

### Summary

- › Achieving New Zealand's NDC1 of reducing net emissions by 50% below the country's gross 2005 level by 2030 will almost certainly require domestic and offshore mitigation. To meet NDC1, our domestic net emissions over 2021 to 2030 less offshore mitigation that New Zealand supports must not exceed 571 Mt CO<sub>2</sub>e.
- › The cost of purchasing offshore mitigation to achieve New Zealand's NDC1 presents a significant fiscal risk. For all scenarios considered, our analysis estimates this cost to be multiple billions over the period 2024 to 2030.
- › Our analysis includes a significant range of cost estimates, reflecting uncertainty around both required volume and purchase price. Variability in price is a relatively greater driver of this range. Our analysis of fiscal cost estimates is based on a number of illustrative scenarios for both volume and price.
- › In a scenario where the price of New Zealand's offshore mitigation purchases aligns with the average of current prices for well-established international emissions markets, purchase cost estimates range from \$7.7 billion to \$9.9 billion, depending on how New Zealand's domestic emissions track in relation to emissions budgets.
- › However, the future price of international reductions is uncertain, reflecting that many markets are at early stages or yet to be developed.
  - In a scenario where the price of New Zealand's offshore mitigation purchases aligns with the carbon price assumed by the IEA for emerging and developing economies (about \$41 per tonne of CO<sub>2</sub>e on average), the cost of purchases could range from \$3.3 billion to \$4.2 billion.
  - In a scenario where the price of New Zealand's offshore mitigation purchases aligns with the carbon price assumed by the IEA for advanced economies under a scenario of enhanced global climate action (about \$227 per tonne of CO<sub>2</sub>e on average), the cost of purchases could range from \$18.3 billion to \$23.7 billion.
- › Domestic policy decisions will materially influence the amount of domestic mitigation New Zealand is able to achieve and at what cost. This will have important implications for what volume of offshore mitigation New Zealand may look to procure to achieve its NDC1.
- › The broader international context and decisions made domestically will also affect what sources of offshore mitigation New Zealand ultimately procures and at what cost. Key factors include what type of offshore mitigation activities New Zealand opts to partake in (such as decisions about driving additional co-benefits and environmental integrity or how different cooperative arrangements may be leveraged). It also includes the choices and actions of other countries both by potential host countries for additional offshore mitigation and other countries also seeking to leverage international cooperation to achieve their NDCs.
- › We intend to update this analysis to provide up-to-date estimates on the fiscal cost of New Zealand's NDC1 as the uncertainty range narrows and future policy decisions are taken.

## 7.1 Context

### The role of offshore mitigation in meeting NDC1

The Government has expressed its intention to meet New Zealand's NDC1 through a combination of domestic and offshore mitigation, prioritising domestic action.

This approach is consistent with recommendations from the CCC. It advised that attempting to achieve New Zealand's previous NDC1 by driving domestic action significantly beyond its recommended emissions budgets would likely lead to severe social and economic costs on communities, people and businesses. The CCC recommended strengthening New Zealand's NDC1, which the Government did in late 2021. However, it noted that offshore mitigation would be critical to meeting New Zealand's NDC1 and in line with the spirit of the Paris Agreement, which explicitly recognises that international cooperation can serve the goals of increasing ambition and promoting sustainable development and environmental integrity.<sup>139</sup>

Offshore mitigation could be procured through a number of mechanisms, such as:

- › direct investment in offshore emissions reductions activities
- › investment in international carbon funds (through the new centralised market mechanism agreed under Article 6 of the Paris Agreement)<sup>140</sup>
- › purchasing from other established emission trading schemes, including through linking the NZ ETS with these schemes.

The Government is in the early stages of developing a portfolio for accessing offshore mitigation, including exploring options to:

- › source or support offshore mitigation activities that meet the requirements for environmental integrity, prioritising those in the Asia-Pacific that also promote sustainable development and resilience
- › link the NZ ETS to international markets that meet the requirements for environmental integrity.<sup>141</sup>

Several countries have publicly stated their intention to use international carbon markets to meet their NDCs and are already engaging with potential partners.<sup>142</sup> However, international markets for trading emissions reductions between countries to contribute towards NDCs are currently in a relatively nascent state.

New Zealand's level of reliance on offshore mitigation to meet its NDC1 is expected to be high relative to others. This is because it has an atypical emissions profile for a developed country, with a significant portion of emissions from the transport and agriculture sector, and relatively few emissions from the electricity sector.<sup>143</sup> Such a profile means that New Zealand currently has relatively fewer opportunities for driving significant emissions reductions at relatively low-cost compared to other countries.

Supporting and contributing to global reductions in line with the ambition of the Paris Agreement's temperature goals and in a way that helps both New Zealand's economy and the wellbeing of New Zealanders, will therefore require supporting reductions outside of New Zealand.

<sup>139</sup> The Paris Agreement reaffirms the obligation for developed countries to assist developing countries. Article 3 states that the efforts of all Parties will represent a progression over time, while recognising the need to support developing countries (UNFCCC, 2015).

<sup>140</sup> Article 6 of the Paris Agreement allows countries to voluntarily cooperate with each other to achieve emissions reduction targets set out in their NDCs, and is ultimately expected to support the establishment of international compliance carbon markets governed by the rules of the Paris Agreement where countries can trade carbon credits (UNFCCC, 2015). At this point in time these markets remain in a state of active development.

<sup>141</sup> Ministry for the Environment, 2022c.

<sup>142</sup> For example, Switzerland, Japan, Singapore and the Republic of Korea.

<sup>143</sup> For example, in New Zealand agricultural emissions make up approximately 50% of total emissions as compared to the UK (10%), Australia (12%), the EU (12%), the USA (10%) and Canada (8%).

## 7.2 Methodology for estimating fiscal costs of offshore mitigation



The sections below provide an overview of the methodology used to support our analysis on the potential cost of purchasing offshore mitigation toward New Zealand's NDC1. Technical Appendix 2<sup>144</sup> presents our approach in greater detail. Specific detail on the information used to support the emissions projection inputs to our analysis can be found in Technical Appendix 3.<sup>145</sup>

### The fiscal cost of offshore mitigation will depend on a number of factors, including the future volume and price of purchases

To estimate the anticipated fiscal cost of the offshore purchases needed to achieve NDC1 our approach multiplies the expected volume required to be purchased by an assumed purchase price in each considered year. Estimated costs are then discounted to present value.

Table 7.1 summarises some of the key uncertainties around this calculation. Some of these will be reduced over time as significant policy decisions are made while others are likely to be more enduring.

**Table 7.1:** Key uncertainties for estimating the fiscal risk of anticipated offshore mitigation purchases required to achieve NDC1

Type	Uncertainty	Description
Related to price of offshore mitigation	<b>Source/type of offshore mitigation</b>	The full set of sources of offshore mitigation New Zealand could purchase to support its NDC1 remains uncertain. What sources are pursued, in what volumes, through what type of cooperation regime (for example investment in specific projects or linkages with established international carbon markets), and whether sources have additional co-benefits or a higher standard of integrity that fetches a premium, will have significant implications for the price New Zealand pays for its offshore mitigation. Where New Zealand pursues a portfolio of options, it is also likely that different prices will be paid across this portfolio, depending on the source.
	<b>General price uncertainty and volatility</b>	For a given source of offshore mitigation, the price per tonne New Zealand could face is likely to depend on general market volatility and fluctuations, and the actions of others, including other governments and private sector actors.
	<b>Exchange rate fluctuations</b>	Currency values will affect the price of offshore mitigation.
	<b>Timing</b>	The timing of when different sources and volumes of mitigation will become available is uncertain and will affect price. How and when New Zealand acts to gain access to offshore mitigation will affect its price. Also, how and when countries like New Zealand stimulate demand in nascent Paris Agreement markets is likely to influence the supply and price of the offshore mitigation available.
Related to volume of offshore mitigation purchases	<b>Domestic emissions performance</b>	The volume of offshore mitigation needed to close the gap between domestic abatement and the level required to achieve NDC1 will depend on how much domestic mitigation is achieved.
	<b>Source uncertainty</b>	Given the relative nascence of Paris Agreement markets, there remains general uncertainty around the precise sources and volume of offshore mitigation available to be purchased and count towards countries' NDCs.
	<b>NDC ambition</b>	New Zealand may change its NDC at any time. The total required volume of offshore mitigation could therefore be different than under the currently stated NDC1 if it were to be further updated.

<sup>144</sup> Release forthcoming.

<sup>145</sup> Release forthcoming.

## Our analysis considers nine different illustrative scenarios for the volume and price of offshore mitigation purchases made to meet NDC1

To reflect these uncertainties in our analysis we have considered nine scenarios, based on differing assumptions around the volume of offshore mitigation required to be purchased and its per tonne purchase cost. Each scenario reflects a different combination of three distinct volume and price sub-scenarios. Importantly, each scenario could be considered to capture a range of underlying pathways and

international contexts (for example different courses for the development and uptake of mitigation technologies or different ways international carbon markets may develop). Considered scenarios should therefore be thought of as illustrative and capturing a number of possible futures, rather than giving any specifics.

### Constructing scenarios for required purchase volumes

The volume of required offshore mitigation purchases to achieve NDC1 will be the difference between New Zealand's domestic net emissions reduction levels over the NDC1 period (2021 to 2030) and its NDC1 budget. Given New Zealand's NDC1 budget is provisionally set, the required offshore purchase volume will depend on the level of domestic net emissions reductions achieved over the period.

Our analysis considers three volume purchase sub-scenarios based on three different potential pathways for domestic emissions. Table 7.2 below describes each of these scenarios based on the underlying assumptions around New Zealand's domestic emissions levels across the NDC1 period.

Volume Scenarios 1, 2 and 3 can be thought of as representative of situations in which New Zealand under-achieves, exactly achieves or over-achieves its domestic emissions budgets, respectively. Under, exact, or over-achievement may be due to a number of factors (such as different technology pathways, shifts in New Zealand's underlying economic structure, and broader shifts in domestic and international consumer and household behaviours and demands). The construction of Volume Scenarios 1, 2 and 3 did not consider such developments in detail.

**Table 7.2:** Considered required purchase volume scenarios

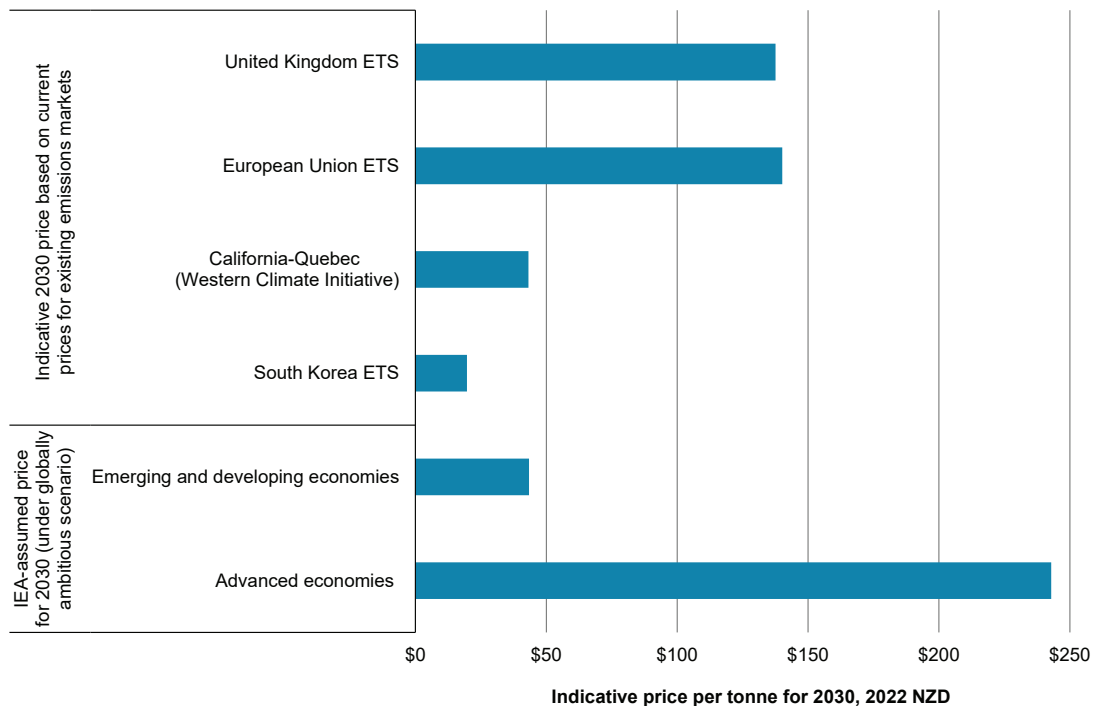
	Volume Scenario 1	Volume Scenario 2	Volume Scenario 3
<b>Domestic emissions level assumption</b>	<b>Based on MfE's baseline projection under current policies for domestic emissions</b>	<b>Based on meeting New Zealand's domestic emissions budgets</b>	<b>Based on MfE's 'lower-emission' projection under current policies</b>
<b>Description</b>	Based on MfE's baseline emissions projection published in 2022. 'Current policies' refers to currently implemented and adopted policies and measures, as at 31 July 2022. This excludes approved policies with expected emissions reduction impacts that have not yet been implemented (including several that have been signalled within the first ERP).	Based on the volume of emissions in New Zealand's domestic budgets for 2022 to 2025 and 2026 to 2030 as set out in the ERP. Since the domestic budget periods do not cover emissions for the year 2021 (which is included in the NDC1 period), emissions estimates for 2021 are based on MfE's baseline projection used for Volume Scenario 1.	Based on MfE's projection that alters several assumptions in the baseline projection (used for Volume Scenario 1) to represent a lower emissions outcome under current policies. This includes assuming a higher carbon price and lower GDP and population growth. See Technical Appendix 3 for more details about these assumptions.
<b>Domestic emissions assumed for the NDC1</b>	685.1 Mt CO <sub>2</sub> e	670.2 Mt CO <sub>2</sub> e	659.0 Mt CO <sub>2</sub> e
<b>Implied volume of offshore mitigation needed (based on a provisional NDC1 budget of 571 Mt)</b>	<b>114.1 Mt CO<sub>2</sub>e</b>	<b>99.2 Mt CO<sub>2</sub>e</b>	<b>88.0 Mt CO<sub>2</sub>e</b>

## There is a wide range of potential prices for offshore mitigation

Future prices for offshore mitigation are uncertain because these opportunities are still being developed, with many international carbon markets still relatively immature. Prices will also vary across different types of mitigation sources and locations. As part of a broader risk management approach, it is likely that New Zealand will pursue a portfolio approach to procuring offshore mitigation. This makes it difficult to estimate the likely average price per tonne across the portfolio.

Figure 7.1 shows the large range in indicative offshore mitigation prices across a number of sources and countries which supports our analysis. All prices in Figure 7.1 are presented as indicative prices for the year 2030. Our approach to undertaking relevant calculations to represent prices for this year is provided in more detail in Technical Appendix 2.<sup>146</sup>

**Figure 7.1:** Indicative prices per tonne of offshore mitigation in 2030, as calculated to support the construction of our price scenarios (\$NZD, 2022 dollars)<sup>147</sup>



Source: Current prices for emissions markets were retrieved on 13 January 2023 from Statista (n.d.), EEX (n.d.), California Air Resources Board (2022), and KRX (n.d.), with all prices as of November 2022. The International Energy Agency's (IEA's) assumed prices were retrieved from the IEA World Energy Outlook 2022.<sup>148</sup>

<sup>146</sup> Release forthcoming.

<sup>147</sup> To give an indicative price for emissions market prices in 2030, current prices are assumed to increase by between 2022 and 2030 based on implied price trajectories (approximately 2.3% per year) from analysis by the High-Level Commission on Carbon Prices (2017). The IEA's assumed CO<sub>2</sub> prices were inputs to its 2022 World Energy Outlook. The IEA price for advanced economies includes. The IEA price for emerging and developing economies excludes China, India, Indonesia, Brazil and South Africa (International Energy Agency, 2022b). Refer to forthcoming Technical Appendix 2 for more detail.

<sup>148</sup> International Energy Agency, 2022b, p. 465.

## Constructing purchase price scenarios

Our analysis considers three different per tonne purchase price scenarios that show the range of potential purchase prices New Zealand may face for its offshore mitigation purchases to achieve NDC1. Price Scenarios 1, 2 and 3 can be considered representative of worlds in which offshore mitigation prices are aligned with emerging and developing economies, aligned with current prices for selected well-established emissions markets, or with advanced economies, under a scenario of greater global action, respectively.<sup>149</sup> Table 7.3 describes each of these scenarios based on the information source used for their construction.

Our price scenarios were constructed based on information from two key sources:

- › **Current prices in well-established emissions markets**, which capture market expectations about future price changes
- › **Prices assumed by the International Energy Agency** for its 2022 World Energy Outlook, for advanced, emerging and developing economies under different global scenarios.

In all price scenarios, it is assumed that New Zealand starts its purchase of offshore mitigation in 2024 and continues through to 2030 (the end of the NDC1 period). The purchase prices considered across each scenario are therefore those that have been calculated for the 2024 to 2030 period, based on the source information relied upon. More detail on the assumptions and approach carried out to derive these price scenarios can be found in Technical Appendix 2.

**Table 7.3:** Considered purchase price scenarios<sup>150</sup>

	Price Scenario 1	Price Scenario 2	Price Scenario 3
<b>Price assumption</b>	Based on the IEA's price for emerging and developing economies in its 2022 World Energy Outlook under an ambitious global scenario	Based on the average of current prices for selected markets	Based on the IEA's price for advanced economies in its 2022 World Energy Outlook under an ambitious global scenario
<b>Scenario description</b>	This reflects a scenario in which New Zealand purchases offshore mitigation primarily from less-advanced economies.	This reflects a scenario where the cost of offshore mitigation purchases is aligned with market expectations of prices in well-established emissions markets.	This reflects a scenario in which New Zealand purchases offshore mitigation primarily from advanced economies with policies to achieve net zero ahead of 2050.
<b>Proxy measure used for setting price assumption</b>	The price for emerging and developing economies in 2030 provided by the IEA in its 2022 World Energy Outlook under a global scenario of achieving net-zero emissions by 2050.	Averaging and time-adjusting current prices across four selected established carbon markets (the European Union, South Korea, United Kingdom and California-Quebec).	The price for advanced economies in 2030 provided by the IEA in its 2022 World Energy Outlook under a global scenario of achieving net-zero emissions by 2050.
<b>Calculated price trajectory for 2024 to 2030 (\$NZD 2022)</b> <i>(average price over this period)</i> <i>(rounded to nearest figure)</i>	\$38–\$43 (\$41)	\$89–\$102 (\$95)	\$212–\$243 (\$227)

<sup>149</sup> Price Scenario 2 is most comparable to the analysis undertaken by MfE to support Cabinet decisions on enhancing New Zealand's NDC1 in 2021 (Office of the Minister of Climate Change, 2021), which also leveraged information from currently well-established international emissions markets. Refer to forthcoming Technical Appendix 2 for more detail on our approach.

<sup>150</sup> Emerging and developing economies for Price Scenario 1 (based on the IEA analysis) exclude the following economies – China, India, Indonesia, Brazil and South Africa. Advanced economies for Price Scenario 3 (based on the IEA analysis) include all OECD countries except Mexico (International Energy Agency, 2022b).

## 7.3 Analysis

Table 7.4 provides estimates of the total fiscal cost of purchasing offshore mitigation to achieve New Zealand's NDC1 under each of the nine considered scenarios, based on different combinations of the three volume and three price scenarios. Figure 7.2 presents the same information, in chart form.

Estimates from our analysis vary substantially, with costs ranging from \$3.3 billion to \$23.7 billion. Variation across the price scenarios is a key driver of this range.

These costs range from 3.9% to 28% of the new operating expenditure that will be made available

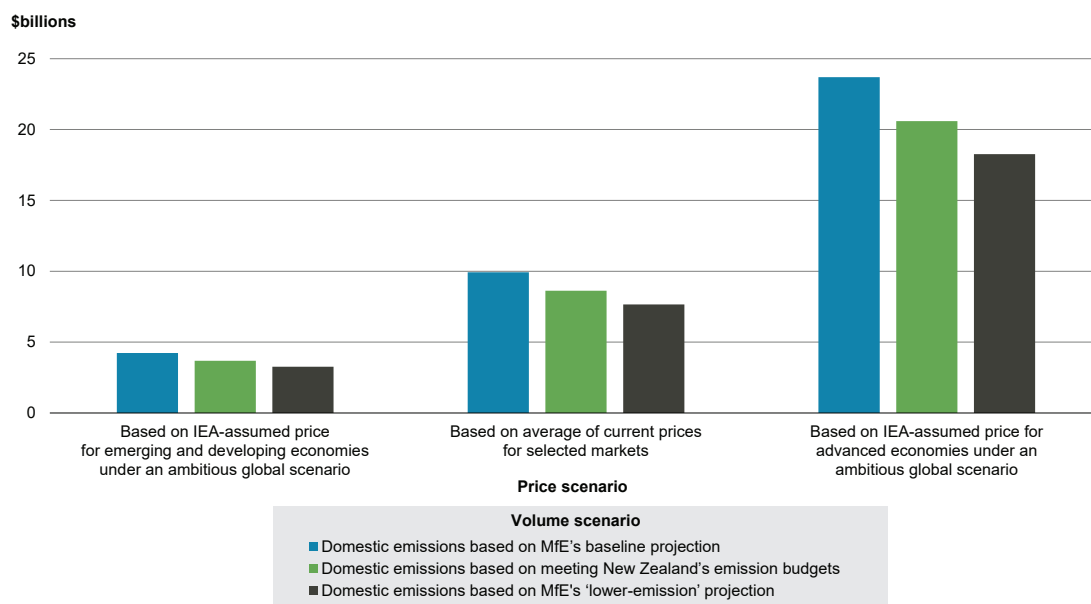
through Budgets 2024 to 2030 from 2024/25 to 2030/31.<sup>151</sup> However, the source of funding for these costs is subject to future policy decisions; comparison to the operating allowances is used here to provide a sense of scale.

Technical Appendix 2 tests the sensitivity of estimated costs under each scenario to changes in assumptions for other variables in our analysis (beyond the price and volume of offshore mitigation purchases), such as the discount rate used and the assumptions underlying our construction of purchase price time series.<sup>152</sup>

**Table 7.4:** Estimated fiscal costs of anticipated offshore mitigation purchases required to achieve NDC1 (\$NZD, 2022 dollars)

		Price Scenarios		
		Based on IEA-assumed price for emerging and developing economies under an ambitious global scenario	Based on the average of current prices for selected markets	Based on IEA-assumed price for advanced economies under an ambitious global scenario
Volume scenarios	Based on MfE's baseline projection for domestic emissions	\$4.2 billion	\$9.9 billion	\$23.7 billion
	Based on domestic emissions meet New Zealand's domestic emissions budgets	\$3.7 billion	\$8.6 billion	\$20.6 billion
	Based on MfE's 'lower-emission' projection under current policies	\$3.3 billion	\$7.7 billion	\$18.3 billion

**Figure 7.2:** Estimated fiscal costs of anticipated offshore mitigation purchases required to achieve NDC1 (\$NZD, 2022 dollars)



<sup>151</sup> Indicative Budget allowances over the period from 2024 to 2030 are \$3 billion per annum over the forecast period. The allowances then grow by 2% each Budget in the projection period (from Budget 2027 to Budget 2030).

<sup>152</sup> The discount rate used for the analysis is based on Treasury's risk-free discount rate, adjusted for inflation (using Treasury's projected Consumer Price Index). The assumptions underlying our construction of purchase price time series are based on the rate of change in international carbon prices modelled by the High-Level Commission on Carbon Prices (2017).



## 7.4 Interpreting the analysis

### NDC1 represents a significant fiscal cost

Our analysis estimates the fiscal cost of purchasing offshore mitigation to achieve NDC1 to be multiple billions of New Zealand dollars over the period 2024 to 2030. As noted in Table 7.1, a number of things will have implications for both the volume New Zealand purchases and the purchase price at which it does so. Decisions that will impact what this cost ultimately may be include:

- › the type of offshore mitigation activities New Zealand opts to partake in (for example decisions around driving additional co-benefits, broader decisions around environmental integrity, or how different cooperative arrangements may be leveraged)

- › the timing of New Zealand's offshore mitigation purchases over the NDC1 period
- › policy choices about the balance of domestic versus offshore action, including weighing up the relative costs of purchasing offshore mitigation as compared to the costs and benefits from enhanced domestic mitigation action.

### The estimates are illustrative only

The analysis in this chapter relies on large assumptions and is grounded in a number of uncertainties. The estimates provided above **should therefore be treated as highly illustrative and not as forecasts or projections**. The intent of the analysis is to demonstrate the broad size of the potential fiscal cost of the purchase of given volumes of offshore mitigation to achieve New Zealand's NDC1.

In reality, the total fiscal cost that achieving NDC1 ultimately presents will depend not only on the costs of international emissions reductions, but also the direct and indirect fiscal costs of supporting New Zealand's domestic transition. Further, the extent of the fiscal cost of offshore mitigation to the Crown will depend on the strategy pursued to purchase these emissions reductions, for example how contributions by the public and private sectors are drawn on.

Key caveats of our analysis are listed below.

**Our sole focus is on the expected per tonne direct purchase cost of offshore mitigation. Given the specific sources of offshore mitigation New Zealand will purchase in future to support achievement of NDC1 remain uncertain, so do these 'broader' costs.**

Purchasing offshore mitigation will likely involve a broader range of costs than just the purchase cost (costs of setting up institutional arrangements to identify, fund, and access mitigation opportunities, and managing a potential portfolio of offshore mitigation in line with New Zealand's objectives).

What sources of offshore mitigation New Zealand ultimately procures will have cost implications. Establishing new cooperative arrangements are likely to have additional costs compared to leveraging carbon market institutions already in place (such as existing emissions trading schemes). The estimates for scenarios leveraging Price Scenario 1 are especially likely to under-estimate the full cost of such an approach, since emerging and developing economies are less likely to have well-established schemes in place and therefore require greater effort to establish new cooperative arrangements.

**Our assumptions around the timing of purchases and our assumed price trajectories across the purchase period.**

Our analysis assumes that New Zealand's purchase of offshore mitigation is evenly distributed across the period 2024 to 2030. In reality, purchasing could occur earlier or later, although given the groundwork required to start purchasing it is more likely to be later. New Zealand may also choose to purchase more units upfront or wait until closer to 2030 to invest heavily in offshore mitigation, which are critical choices for present and future governments. Our analysis has also assumed offshore mitigation prices increase over the 2024 to 2030 period in all scenarios at the same rate. In reality, these prices could fluctuate over time, making the precise timing of purchases a key factor in influencing total costs.

**Our simplifying assumption that the entirety of the direct purchase cost of offshore mitigation will be borne by the Crown.**

It is assumed for the purpose of our analysis that the entirety of the cost of purchasing offshore mitigation is financed by the Crown. This has yet to be determined. The estimates produced can therefore be thought of as an upper bound on the fiscal risk due to the direct cost of purchasing offshore mitigation in each scenario.

## We intend to update this analysis in the future

We expect that the information for estimating the fiscal risk of achieving New Zealand's NDC1 (and subsequent NDCs) will materially improve over time as:

- › offshore mitigation opportunities are further developed
- › the price volatility of international trading schemes settles
- › key policy decisions are made, including the ambition of future NDCs
- › the volume of offshore mitigation needed is clearer.

This improved information will enable future reporting to continue to provide the most up-to-date estimates, based on the best available information.

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# GLOSSARY

<b>ASB</b>	ASB Bank	<b>He Waka Eke Noa Partnership</b>	The Primary Sector Climate Action Partnership, established to develop recommendations to Government on a farm level system to reduce agricultural methane and nitrous oxide emissions. Representatives from MfE, Ministry for Primary Industries, and various industry-related stakeholders participate in the Partnership.
<b>BERL</b>	Business and Economic Research Limited	<b>IEA</b>	International Energy Agency
<b>CCC</b>	He Pou a Rangī – the Climate Change Commission	<b>Insurance retreat</b>	When an application for insurance coverage or the renewal of existing coverage is declined based on a property's exposure and vulnerability to an escalating hazard.
<b>CCRA</b>	Climate Change Response Act 2002	<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>CDEM</b>	National Civil Defence Emergency Management Plan 2015. Central government contributes 60% of the costs of restoring damaged infrastructure to pre-disaster level of service, and sometimes more if local authorities are unable to cover their costs.	<b>Iwi</b>	Extended kinship group, tribe, nation, people, nationality
<b>CEFA</b>	Climate and Economic Fiscal Assessment (Ngā Kōrero Āhuarangi me te Ōhanga)	<b>Kaitiaki</b>	Guardian(s)
<b>CERF</b>	Climate Emergency Response Fund	<b>Kāwanatanga</b>	The concept of governance
<b>CO<sub>2</sub></b>	Carbon dioxide	<b>Living Standards Framework</b>	The Treasury's framework to understand the drivers of wellbeing and to consider the broader impacts of its policy advice in a systematic and evidenced way.
<b>Co-benefits</b>	Beneficial outcomes from climate action, not directly related to climate change mitigation, for example improved air quality and job creation.	<b>Mana āheinga</b>	Aspirations and capability
<b>EFU</b>	Economic and Fiscal Update. Reports published by the Treasury detailing the Government's financial performance and financial position over the current year and next four years (our forecast period). These forecasts are usually published twice a year.	<b>Mana whanake</b>	Sustainable prosperity
<b>ERP</b>	Emissions Reduction Plan	<b>Marae</b>	Communal and sacred meeting house that serves a central social purpose in Māori communities.
<b>EU ETS</b>	The European Union's Emissions Trading Scheme	<b>Mātauranga Māori.</b>	The body of knowledge from Māori ancestors
<b>EVs</b>	Electric Vehicles	<b>MfE</b>	Ministry for the Environment
<b>Free allocation</b>	Refers to industrial allocation under the NZ ETS for emissions-intensive, trade-exposed firms.	<b>Mt CO<sub>2</sub>e</b>	Megatonnes of carbon dioxide equivalent
<b>GDP</b>	Gross Domestic Product	<b>MWLR</b>	Manaaki Whenua – Landcare Research
<b>GST</b>	Goods and Services Tax	<b>NAP</b>	National Adaptation Plan
<b>Hapū</b>	Kinship group, clan, tribe, subtribe	<b>NDC</b>	Nationally Determined Contribution. Under the terms of the Paris Agreement, countries are required to submit NDCs outlining their plans for climate action to reduce greenhouse gas emissions in order to reach the goals of the Paris Agreement and communicate actions they will take to build resilience to the impacts of rising temperatures.
<b>He Ara Waiora</b>	The Treasury's framework (developed by Māori thought leaders, Nga Pukenga) for understanding waiora, a Māori perspective on wellbeing.		
<b>He Tirohanga Mōkōpuna</b>	The Treasury's combined Statement on New Zealand's Long-term Fiscal Position and Long-term Insights Briefing, published on 29 September 2021.		

<b>NDC1</b>	Refers to New Zealand's first Nationally Determined Contribution. It details our international commitment to emissions reduction under the Paris Agreement over the period 2021 to 2030.
<b>NZ ETS</b>	The New Zealand Emissions Trading Scheme. New Zealand's main emissions pricing tool.
<b>NZ ETS Stockpile</b>	The volume of NZUs held by NZ ETS participants that have not yet been surrendered.
<b>NZIER</b>	New Zealand Institute of Economic Research
<b>NZU</b>	New Zealand Unit. An emissions credit used in the NZ ETS.
<b>OECD</b>	Organisation for Economic Cooperation and Development
<b>Offshore mitigation</b>	Emissions reductions and removals that New Zealand supports in other countries.
<b>Paris Agreement</b>	An international treaty on climate change. Its overarching goal is 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".
<b>RBNZ</b>	Reserve Bank of New Zealand
<b>RCP</b>	Representative Concentration Pathway. These are representative pathways utilised to support IPCC reporting that reflect different levels of greenhouse gas concentration.
<b>Surrender of NZUs</b>	The process of returning NZUs to the Government, required in line with compliance obligations under the NZ ETS.
<b>Surrender obligation</b>	The volume of NZUs a participant with compliance obligations under the NZ ETS is required to surrender each year
<b>Tangata whenua</b>	People born of the land, local people, hosts
<b>Taonga</b>	Treasure

<b>TAWA</b>	Tax and Transfer Microsimulation Model
<b>TCFD</b>	Task Force on Climate-related Financial Disclosures
<b>Te ao Māori</b>	The Māori worldview
<b>Te Tai Ōhanga</b>	Reo Māori name for the Treasury. Ōhanga is a word for the economy and financial matters, including connections for wellbeing and prosperity. Te Tai is the term for tide and tidal matters, and denotes a space and a domain. It infers a connection and a guardianship with others, and so reflects the nature of economic and financial matters, which ebb and flow and yet are constant and core to our stewardship and leadership role.
<b>Te Taiao</b>	The natural environment
<b>Te Tiriti ō Waitangi</b>	The Treaty of Waitangi
<b>The Rauora Framework</b>	Part of the NAP which outlines a cohesive set of Māori cultural values and principles from which to approach climate action.
<b>Tikanga</b>	The customary system of values and practices that have developed over time and are deeply embedded in the social context.
<b>UK ETS</b>	The United Kingdom's Emissions Trading Scheme
<b>Urupā</b>	Burial ground, cemetery, graveyard
<b>Waiora</b>	Health, soundness
<b>Wairua</b>	Spirit
<b>Waka Kotahi</b>	Reo Māori name for the NZ Transport Agency. 'Waka' means 'vessel' and 'kotahi' means 'one' so the Māori name conveys the concept of 'travelling together as one' and embraces integration, affordability, safety, responsiveness and sustainability.
<b>Whānau</b>	Family
<b>Whenua</b>	Land



