New Zealand's Journey toward a Low-Emission Future: Today's Climate Change Landscape

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Executive summary

In the coming decades, New Zealand will face important choices shaped by both the risks and opportunities created by climate change. This paper provides an overview of the current climate change landscape from which New Zealand is starting the next stage of its journey toward a global low-emission future. The key findings are:

(i) Climate change science, emission trends and mitigation scenarios The latest reports from the Intergovernmental Panel on Climate Change (IPCC) reinforce the case for significant reductions to global greenhouse gas (GHG) emissions. Under business-as-usual growth in emissions, the global mean surface temperature in 2100 could increase by 3.7°C to 4.8°C compared to pre-industrial levels. A least-cost pathway to limit temperature increases to not more than 2°C above pre-industrial levels would involve reductions of 40–70 percent below 2010 levels by 2050 on the way toward a zero-net-emission global economy. A key objective should be limiting cumulative emissions, and delaying action significantly increases the costs of mitigation.

(ii) International negotiations The climate change negotiations are struggling to deliver a comprehensive agreement that will achieve this pathway. However,

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This background paper was prepared by Catherine Leining, a Policy Fellow at Motu, for participants in Motu's Low-Emission Future Dialogue. This group of stakeholders and technical experts from government, the private sector, academia and NGOs is meeting regularly over 2014–15 to discuss New Zealand's possible pathways toward a global low-emission future. The Dialogue aims to build understanding among participants, identify common ground, and use progressive in-depth discussions to generate and develop innovative solutions, not to generate consensus. The Dialogue builds on Motu's Climate Dialogue, which ran in 2007, and Motu's Agricultural Emissions Dialogue, which ran for 10 meetings through 2011–12.

substantial mitigation activity is underway through national, bilateral, regional and private-sector initiatives. Whether implemented through a central agreement, a regime complex or economic drivers, more stringent global constraints on GHG emissions are likely in the future.

(iii) New Zealand's emission profile Unique among industrialised countries, New Zealand's emission profile is dominated by biological emissions from agriculture (46 percent) and energy (42 percent). From 1990 to 2012, New Zealand's gross emissions (excluding forestry) rose 25 percent and its net emissions (including forestry) rose 111 percent. Although New Zealand is a small emitter in absolute terms, accounting for less than 0.2 percent of global emissions, our per capita emissions were fifth highest among Organisation for Economic Co-operation and Development (OECD) countries in 2011.

(iv) New Zealand's emission reduction targets New Zealand met its target for the first commitment period of the Kyoto Protocol (limiting net emissions on average over 2008–12 to gross 1990 emissions) with a surplus equivalent to 90.1 million tonnes of CO_2eq (carbon dioxide equivalent). This was due largely to Kyoto accounting of forest sinks and purchases of overseas Kyoto units. The following targets are in place for the future:

(a) Under the United Nations Framework Convention on Climate Change (UNFCCC), New Zealand has a non-binding unconditional target to reduce its net GHG emissions to 5 percent below 1990 gross emission levels by 2020. It maintains a conditional 2020 target pledge of a 10–20 percent reduction below 1990 levels.

(b) The government set a 2050 target to reduce net GHG emissions to 50 percent of gross 1990 emissions. This is not binding under domestic legislation.

(v) New Zealand's emission projections Under current policy settings, New Zealand's net emissions are projected to increase 129 percent by 2020 and 159 percent by 2030 relative to 1990 levels. Gross emissions are projected to increase 29 percent and 38 percent, respectively. It is not clear how the New Zealand government plans to meet the 2020 target, particularly given harvesting expectations and New Zealand's standing outside the Kyoto framework.

(vi) New Zealand's mitigation policy New Zealand's mitigation policy was designed to expose producers and consumers to the international price of emissions and enable them to contribute to global mitigation under the Kyoto framework. It was not designed to impose hard limits on domestic emissions or achieve specific sectoral outcomes. As international emission prices have collapsed, so too have incentives for domestic mitigation in New Zealand. New Zealand has now removed itself from the Kyoto framework, and will need to adapt its domestic policy settings accordingly.

(vii) Other domestic mitigation action New Zealand's businesses, research institutions and non-governmental organisations are engaged in a range of activities supporting climate change mitigation. Most activities fall into three categories: shifting the New Zealand economy toward green growth, mitigation research, and advocacy. A 2012 opinion poll showed a strong majority of public support for more action on climate change, but the perception of climate change as an urgent or immediate problem declined between 2008 and 2012.

If we assume that in the coming decades most countries will support constraints on global GHG emissions to prevent dangerous human impacts on the climate system, then we can also assume that for New Zealand to maintain or grow its political and economic advantages in a low-emission world, it will need to contribute to global mitigation efforts by both reducing its domestic emissions and supporting mitigation by other countries.

The seriousness of the potential environmental, economic and social impacts of climate change demands a shift from incremental change to transformational change in efforts to reduce emissions. The catalyst for that shift currently is missing in New Zealand. Continuing to lock our policy, infrastructure, economic activity and behaviour into high-emission pathways could leave us with stranded assets and slow the uptake of the innovations that would make us more successful in the longer term.

Perhaps if we look at the current climate change landscape with fresh eyes, we can see beyond the barriers to the opportunities for New Zealand. How might we take action to reduce our emissions, not because we have to but because we want to? How might domestic mitigation align with our development and resource management objectives and improve our quality of life? How might we enable rapid innovation across sectors and across the supply chain? How might we stimulate economic growth by increasing public and private investment in mitigation and capitalising on emerging markets in low-emission products and services? How might we engage with producers, consumers and shareholders to drive lasting behaviour change? How might we shift from incremental thinking to transformational thinking about climate change, and outgrow the perception that New Zealand is too small to make a difference?

New Zealand has a proud history of bold projects and new ideas. The challenge before us is how we can harness creativity, connectivity and flexibility to chart an exciting and hopeful pathway toward an attractive low-emission future for New Zealand.

1. Introduction

In his book *New Zealand Unleashed* (2007), Steve Carden describes three traits that fuel a country's adaptability to change:

> *First, lots of new ideas need to be generated – I'll call that creativity. Creativity fuels innovation. It needs to be nurtured and encouraged. Second, the ideas of others need to be absorbed. Being a sponge for these ideas can help New Zealand retain the vibrancy needed to adapt. Third, an adaptive society needs to be willing to change. By having a high tolerance for change, New Zealand can make the hard decisions necessary to keep adapting.*

How we apply these three traits of creativity, connectivity and flexibility as a society will determine how successfully New Zealand responds to the dual challenges of climate change: thriving within increasing global constraints on greenhouse gas (GHG) emissions and adapting to the physical impacts of climate change that cannot be avoided.

The past two decades of international effort have not yet shifted the world from a trajectory of increasing GHG emissions. While countries have agreed to a global goal to limit temperature increases to not more than 2°C above pre-industrial levels, global action to limit emissions accordingly has not followed suit. Achieving that global goal with a probability of 66 percent would require limiting cumulative carbon dioxide (CO_2) emissions since the pre-industrial period to about one trillion tonnes of carbon (less when non-CO_2 GHGs are taken into account) (IPCC 2013). As of 2011, we had already spent about half of that amount. If we continue to emit under business as usual, we will have exhausted the remainder of that amount by mid-century (Harvey et al. 2013). Once the cumulative limit has been reached, we will face choices between living with zero net annual emissions, accepting severe climate change impacts that could exceed our adaptive capacity, or relying on hypothetical large-scale geoengineering solutions that could have unpredictable and undesirable consequences.

While precise estimates vary, multiple studies suggest that the costs of inaction to reduce emissions would outweigh the costs of mitigation to achieve the global temperature goal (Stern 2007; Nordhaus 2013). However, managing the variable distribution of mitigation costs and benefits geographically, across sectors and over time is proving very challenging from political, economic and social perspectives. While there is any number of global pathways toward stabilisation of atmospheric concentrations at less dangerous levels, studies indicate that an earlier shift in investment toward low-emission alternatives would help to avoid lock-in to emissions-intensive infrastructure and associated capital that could block the uptake of new technologies, produce costly stranded assets and push the 2°C goal out of reach (Harvey et al. 2013). This shift in investment by governments and businesses is not yet happening at the needed scale and pace, and consumers are not driving significant change.

This poses problems for the global economy as well as the climate system, and is leading to calls for greater corporate disclosure of carbon risks to investors. The Carbon Tracker Initiative (2012) reports that the total carbon potential of the Earth's known fossil fuel reserves is equivalent to nearly five times the remaining cumulative carbon budget for the next 40 years if we want to observe the 2°C limit. This has serious implications for investors

> *Currently financial markets have an unlimited capacity to treat fossil fuel reserves as assets. As governments move to control carbon emissions, this market failure is creating systemic risks for institutional investors, notably the threat of fossil fuel assets becoming stranded as the shift to a low-carbon economy accelerates.*
>
> *…If the 2°C target is rigorously applied, then up to 80 percent of declared reserves owned by the world's largest listed coal, oil and gas companies and their investors would be subject to impairment as these assets become stranded.*

If we hope to move toward zero-net-emission economies by the middle to end of this century, then globally we will need to incentivise rapid changes in fuels, technologies, practices and lifestyles in ways that will support ongoing human development needs. Regardless of what balance we strike ultimately between mitigation and adaptation, significant changes to how we live today appear inevitable.

New Zealand faces the prospect of a global low-emission future with an economy currently driven by activities that are emissions intensive, vulnerable to climate impacts and dependent on international markets. This could have significant implications for New Zealand's future development, including through impacts on our export markets, domestic and foreign investment, and valuation of assets. We also have some powerful attributes, including a rich natural resource base, a strong social fabric and proven ingenuity. The New Zealand Emissions Trading Scheme (NZ ETS) provides useful policy architecture but is not being applied to deliver long-term transformation and economic resilience. In the coming decades, New Zealand will face important choices shaped by both the risks and opportunities created by climate change.

If New Zealand's approach to mitigation can operate with creativity, connectivity and flexibility under any number of possible futures, as suggested in a broader context by Steve Carden (2007), New Zealand will be better prepared to thrive.

2. The climate change landscape

The current climate change landscape from which New Zealand is beginning the next stage of its journey toward a low-emission future can be defined by the following features:

(i) Climate change science, emission trends and mitigation scenarios.

(ii) International climate change negotiations.

(iii) New Zealand's emissions profile.

(iv) New Zealand's emission reduction targets.

(v) New Zealand's emission projections.

(vi) New Zealand's mitigation policy response.

(vii) Other domestic mitigation action.

2.1. Climate change science, emission trends and mitigation scenarios

The Intergovernmental Panel on Climate Change (IPCC) produces periodic reviews of scientific, technical and socio-economic information on climate change.[1] The IPCC's *Fifth Assessment Report* (AR5) was released in stages between September 2013 and April 2014.

IPCC Working Group I (WGI) produced a report on the physical science basis of climate change (IPCC 2013). Some of the key findings are:

(i) Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.

(ii) Total radiative forcing is positive, and has led to an uptake of energy by the climate system. The largest contribution to total radiative forcing is caused by the increase in the atmospheric concentration of CO_2 since 1750.

(iii) Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. This evidence for human influence has grown since AR4.[2] It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.

(iv) Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.

The IPCC (2013) reports that, based on ice-core data, atmospheric concentrations of CO_2, methane (CH_4) and nitrous oxide (N_2O) are higher now than over the past 800,000 years under the influence of emissions from human activity. The globally averaged combined land and ocean surface temperature has increased by 0.85 [0.65–1.06]°C over the period 1880 to 2012.[3] The report assesses four Representative Concentration Pathways (RCPs) for the future.[4] Only one of these, RCP2.6, would align with the temperature goal through a "peak and decline" scenario that would require stringent mitigation policies, and we are not tracking toward that scenario (Collins et al. 2013). For an illustration of the relationship between cumulative emissions and temperature increases, see Annex 1, Figure A1.1.

1 The IPCC was created as a scientific body operating under the United Nations, and has 195 member countries. Its aim is to present a rigorous and balanced assessment of current knowledge without being policy prescriptive, and its work is supported by thousands of scientists from across the world. It does not conduct its own research. See http://www.ipcc.ch/organization/organization.shtml.

2 The IPCC's *Fourth Assessment Report* (AR4) was published in 2007.

3 In the WGI contribution to the AR5, uncertainty is quantified using 90 percent uncertainty intervals unless otherwise stated. The 90 percent uncertainty interval, reported in square brackets, is expected to have a 90 percent likelihood of covering the value that is being estimated. Uncertainty intervals are not necessarily symmetric about the corresponding best estimate. A best estimate of that value is also given where available.

4 Representative Concentration Pathways are four time-dependent scenarios for GHG concentrations and radiative forcing outcomes adopted by the IPCC as standards for modelling. They vary according to assumptions for rates of forcing and emissions. See http://www.skepticalscience.com/rcp.php and http://link.springer.com/article/10.1007/s10584-011-0148-z for more information.

The report reinforces the importance of cumulative emissions of long-lived GHGs as the determinant of long-term climate change impacts. This highlights the urgency of more significant action to shift the global emissions trajectory; we cannot rely solely on large annual reductions later in the century if we want to achieve the global temperature goal. The report also affirms the ongoing warming of the whole climate system due to increasing emissions from human activities, despite an observed slowing of the warming trend in global surface temperature over the past 15 years (1998–2012). Given the process for developing the IPCC assessment reports, the IPCC's findings are generally considered conservative.

IPCC Working Group II produced a report on climate change impacts, adaptation and vulnerability (IPCC 2014a). While noting that some climate change impacts can be positive in some sectors and regions, the report highlights both the overwhelming seriousness and regional variability of negative climate change impacts projected over the coming century and the potentially high (and complex) costs of adaptation. For example, the report cites the World Bank's estimated adaptation costs in the order of US$70–100 billion per year for developing countries by 2050. Regarding the linkages between mitigation and adaptation, the report's 'Summary for Policymakers' notes:

> *Prospects for climate-resilient pathways for sustainable development are related fundamentally to what the world accomplishes with climate-change mitigation (high confidence). Since mitigation reduces the rate as well as the magnitude of warming, it also increases the time available for adaptation to a particular level of climate change, potentially by several decades. Delaying mitigation actions may reduce options for climate-resilient pathways in the future.*

The chapter on Australasia focuses on regional climate change impacts in Australia and New Zealand (Reisinger and Kitching 2014). The report notes regional variation across New Zealand regarding projected changes in temperature and precipitation and associated impacts, as well as risks to New Zealand's coastal infrastructure from projected sea-level rise. The New Zealand Climate Change Centre has produced a useful summary of New Zealand findings (Hollis 2014) from the IPCC's *Fifth Assessment Report*. The summary notes:

- *New Zealand has warmed by about 0.9°C since 1900.*
- *New Zealand's temperature is expected to rise by another 0.8°C or so above the 1986–2005 average if the world rapidly implements stringent measures to limit greenhouse gas emissions.*
- *By contrast, New Zealand's temperature is expected to keep on rising throughout this century – by about 3.5°C above the 1986–2005 average – in a high carbon world.*

New Zealand's approach to adaptation will need to manage the effects of climate change on our economic activity as well as human health and the resilience of both urban and rural communities.

IPCC Working Group III produced a report on mitigation of climate change (IPCC 2014b). The report addresses multiple aspects of mitigation, including environmental, economic, social, institutional and equity considerations. With regard to recent global emission trends and projections, the IPCC reports that global GHG emissions reached 49Gt CO_2eq (carbon dioxide equivalent) in 2010, an 80 percent increase above levels in 1970.[5] Global emissions grew 2.2 percent per year from 2000 to 2010, the fastest rate of growth over the past three decades. The most significant contributors are CO_2 emissions from fossil fuels and industrial processes. Improvements in energy intensity are being outstripped by population and economic growth. For more information on global emission trends by gas, sector and region over the period 1970–2010, see Annex 1, Figures A1.2, A1.3 and A1.4.

Under business-as-usual growth in emissions, the global mean surface temperature in 2100 could increase by 3.7°C to 4.8°C compared to pre-industrial levels (note that the range is 2.5°C to 7.8°C when including climate uncertainty). According to the IPCC (2014b),

> *Baseline scenarios (scenarios without explicit additional efforts to constrain emissions) exceed 450 parts per million (ppm) CO_2eq by 2030 and reach CO_2eq concentration levels between 750 and more than 1300 ppm CO_2eq by 2100. This is similar to the range in atmospheric concentration levels between the RCP 6.0 and RCP 8.5 pathways in 2100. For comparison, the CO_2eq concentration in 2011 is estimated to be 430 ppm (uncertainty range 340–520 ppm).*[6]

Under scenarios that produce a likely chance of limiting the temperature increase below 2°C, emissions would need to decline to levels 40–70 percent below 2010 levels by 2050 and would need to be near or below zero in 2100. Countries' 2020 emission reduction pledges made in Cancun in 2010 likely would not be consistent with meeting the 2°C goal, but likely would be consistent with limiting temperature increases below 3°C.

Under cost-effective scenarios, the macroeconomic costs of mitigation needed to reach a concentration goal of 450 ppm CO_2eq by 2100 are projected to "correspond to an annualized reduction of consumption growth by 0.04 to 0.14 (median: 0.06) percentage points over the century relative to annualized consumption growth in the baseline that is between 1.6 percent and 3 percent per year" (IPCC 2014b). Changes in annual investment flows over the next two decades to meet the temperature limit are illustrated in Annex 1, Figure A1.5.

The IPCC's findings are not intended to be policy prescriptive. However, other high-profile international reports, drawing on consistent analysis, have advocated more ambitious mitigation commitments given the urgent need to reduce global emissions and the availability of solutions that could keep the 2°C goal within reach. Examples include Potsdam Institute (2012), IEA (2013) and UNEP (2013).

The lack of progress in driving ambitious mitigation at the international level reflects broader unwillingness to change, not just by the producers who directly emit GHGs, but also by the consumers whose demand drives production and by the voters who elect governments. Although the international policy framework currently accounts for emissions at the point of production, consumption-related emissions also deserve careful consideration. Some of the emissions progress by industrialised countries since 1990 can be attributed to outsourcing production to developing countries; the Global Carbon Project (2014) found that the net emission transfer from developing

5 This includes net emissions from the land use, land-use change and forestry (LULUCF) sector. Note that the IPCC is applying 100-year global warming potential (GWP) values from the *Second Assessment Report*. Values from the *Fourth Assessment Report* are being applied in post-2012 climate change agreements. The report notes the limitations of the metrics currently applied in assessment of different GHGs.

6 For reference, the atmospheric concentration of CO_2 has increased from the pre-industrial level of about 280 ppm to more than 400 ppm today. See http://www.esrl.noaa.gov/gmd/ccgg/trends/weekly.html.

to developed countries through international trade increased 11 percent per year on average between 1990 and 2012. Changing consumption behaviour by individuals and organisations to reduce emissions has proven difficult, even in the face of financial or other gains (Dietz et al. 2013). Successful mitigation solutions will need to target multiple dimensions of the problem.

2.2. International climate change negotiations

To date, negotiations under the 1992 United Nations Framework Convention on Climate Change (UNFCCC) have not managed to place the world on an agreed pathway toward the global temperature goal. The first commitment period (CP1) of the 1997 Kyoto Protocol placed a cap on emissions from industrialised (Annex B) countries (excluding the United States) with the goal of reducing those emissions to 5.2 percent below 1990 levels over the period 2008 to 2012. In meeting their national commitments within the cap, Annex B countries could count removals from forest sinks, Kyoto units acquired from other industrialised countries through emissions trading and Joint Implementation projects, and Certified Emission Reductions (CERs) from Clean Development Mechanism (CDM) projects in developing countries. Annex B Parties currently are finalising the emissions accounting for CP1. As a whole, Annex B Parties remaining in the Protocol will likely have exceeded this target due largely to the overallocation of units to countries with transitional economies (referred to as "hot air" units available for trading due to economic decline rather than mitigation) and heavy use of CERs, combined with the Global Financial Crisis. (Note that Canada also withdrew from CP1.)

Negotiations for post-2012 and post-2020 agreements have been fractious and ponderous. So far, they have failed to make significant progress commensurate with the urgency of reducing emissions. Although Parties agreed to the 2°C temperature limit in Cancun in 2010, the 2020 emission reduction targets and actions pledged by industrialised and developing countries would reduce projected global emissions of 59Gt CO_2eq per year by only 3–7Gt CO_2eq per year in 2020. This would leave a significant gap of 8–12Gt CO_2eq per year relative to levels consistent with a least-cost 2°C pathway (UNEP 2013).

While Parties do not question the overall need to reduce global emissions, they remain sharply divided over who should reduce emissions, how much, by when, and who should pay. Industrialised countries tend to advocate changes to enshrined and increasingly outdated distinctions between developed and developing countries, while many developing countries point to the historical emissions burden from industrialised countries and their own urgent development needs. All countries fear harming their economic growth and competitiveness by committing to stringent reductions while others choose an easier ride. Calls to increase ambition have not stimulated acceptable top-down or bottom-up solutions.

The changing contributions of industrialised and developing countries to cumulative global emissions were highlighted by UNEP (2013):

> *Relative contributions to global emissions from developing and developed countries changed little from 1990 to 1999. However, the balance changed significantly between 2000 and 2010 – the developed country share decreased from 51.8 percent*

to 40.9 percent, whereas developing country emissions increased from 48.2 percent to 59.1 percent. Today developing and developed countries are responsible for roughly equal shares of cumulative greenhouse gas emissions for the period 1850–2010.

Across the negotiation meetings in Durban in 2011 and Doha in 2012, a subset of industrialised countries (predominantly European Union member states, joined by Australia, Norway, Switzerland, Ukraine and a few others) agreed to a second commitment period (CP2) of the Kyoto Protocol (2013–20) alongside agreement to "develop a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties" by 2015 for the period beyond 2020. Other Parties outside of CP2 (including New Zealand) pledged 2020 mitigation targets and actions under the UNFCCC that are not legally binding.

Work on the new comprehensive agreement progressed in Warsaw in 2013, but so slowly that it was characterised in the *Earth Negotiations Bulletin* as the "Halfway Stop on the Road to Nowhere" (IISD 2013). The negotiations are also addressing a range of other topics, including adaptation, capacity building, technology transfer, adaptation, and financing for developing countries. Decisions in the process are made by consensus, with about 196 Parties at the table and a tradition of resisting partial agreements that could undermine negotiating power across the total package of decisions.

Parties currently hold conflicting views on the form of the new comprehensive agreement.[7] Early momentum is building toward the development of an agreement with bottom-up, nationally determined contributions by all countries measured and reported under top-down rules. By early 2015, Parties will be expected to submit pledges for their post-2020 contributions.

Flannery (2014) and Bodansky and Diringer (2014) provide interesting analyses of options for a comprehensive international agreement in 2015. Keohane and Victor (2013) suggest that given the public-good nature of the problem and the contentious distributional impacts of solutions, pursuing an international "regime complex" rather than a comprehensive integrated regime might enable groupings of like-minded parties to pursue projects with mutual gains and undertake more ambitious mitigation in ways that are more flexible and adaptable.

Based on the negotiation track record, it appears unlikely that ground-breaking ambition will emerge from within the UNFCCC process and trickle down. Instead, domestic policies and measures, bilateral and regional collaboration (including through multilateral financial institutions), private-sector initiatives, changes to trade policies and consumer demand may become the real drivers of international ambition to reduce emissions. Emerging examples include the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, the US–China Climate Change Working Group, and the World Business Council for Sustainable Development's Vision 2050 and Action 2020 programmes.

7 For examples, see http://unfccc.int/bodies/awg/items/7398.php.

2.3. New Zealand's emissions profile

According to *New Zealand's Greenhouse Gas Inventory* (MfE 2014a), over the period from 1990 to 2012 New Zealand's gross GHG emissions (excluding forestry) increased 25.4 percent, from 60.6Mt CO_2eq to 76.0Mt CO_2eq. New Zealand's net GHG emissions (including forestry measured under UNFCCC rules[8]) increased 111.4 percent, from 23.4Mt CO_2eq to 49.4Mt CO_2eq. New Zealand's international bunker fuels (aviation and marine), which are reported separately, increased 50.5 percent, from 2.4Mt CO_2eq to 3.6Mt CO_2eq. For figures illustrating New Zealand's emission trends over 1990–2012, refer to Annex 2, Figures A2.1, A2.2, A2.3 and A2.4.

The data set contained in the World Resources Institute's Climate Analysis Indicators Tool (WRI 2014) enables comparison of New Zealand's emissions with those of other countries. The most recent year for which global data are available is 2010; data for industrialised countries are available for 2011. As shown in Annex 2, Figure A2.5, New Zealand's emissions intensity per capita and per unit of GDP has declined over the period 1990–2011, while absolute emissions have increased. Other bases for comparing New Zealand's emissions performance with other countries are summarised below:

- In 2010, New Zealand contributed less than 0.2 percent of global GHG emissions (both with and without forestry). Excluding forestry, New Zealand's per capita emissions were 17.6t CO_2eq per person, with a global ranking of 23rd highest. The global average was 6.5t CO_2eq per person.
- In 2011, New Zealand's per capita emissions excluding forestry were 16.5t CO_2eq per person, with a ranking of fifth highest among industrialised (Annex I) countries (after Australia, Luxembourg, USA and Canada). This was 7.7 percent lower than in 1990.
- In 2011, New Zealand's total emissions per unit of GDP excluding forestry were 658.6t CO_2eq per million US$ GDP. This was 28.7 percent lower than in 1990. In 2011, New Zealand ranked seventh highest among Annex I countries (after Ukraine, Russian Federation, Estonia, Bulgaria, Australia and Belarus).
- In 2011, New Zealand had the highest agricultural emissions per capita (7.8t CO_2eq per person) and per unit of GDP (310.9t CO_2eq per million US$ GDP) of industrialised countries. Those values have declined 15 percent and 35 percent, respectively, since 1990.
- In 2011, with regard to its energy emissions, New Zealand landed in the middle of the pack of industrialised countries, with energy emissions of 7.0t CO_2eq per person and 280t CO_2eq per million US$ GDP. While New Zealand's energy emissions per capita have not declined significantly from 1990 to 2011, its energy emissions per unit of GDP have declined nearly 23 percent.

New Zealand's emissions profile is unique among industrialised countries because

8 Under UNFCCC rules, net emissions from LULUCF account for all land uses, whereas under the Kyoto Protocol rules chosen by New Zealand for CP1, net emissions from LULUCF are counted only for eligible afforestation, reforestation and deforestation activities.

of the relatively high proportion of biological emissions from agriculture and the relatively low proportion of electricity emissions, reflecting New Zealand's high renewable energy generation (MfE 2014a). Biological emissions accounted for 46.1 percent of gross emissions in 2012, and increased 14.9 percent over the period since 1990. Energy emissions accounted for 42.2 percent of gross emissions in 2012, and increased 36.3 percent over the period. Of energy emissions in 2012, transport accounted for 38.7 percent and public electricity and heat production accounted for 19.6 percent. New Zealand's forestry sector is a net sink that helps to offset emissions from other sectors, but the size of this sink declined by 28.6 percent over the period. The following excerpts summarise drivers for key trends in *New Zealand's Greenhouse Gas Inventory* (MfE 2014a) :

- *The Agriculture sector contributed the largest proportion of total emissions in 1990… The proportion of emissions from the Agriculture sector has generally been decreasing between 1990 and 2008. Emissions from agriculture have increased from 2009 to 2012 due to favourable growing weather and a greater demand for New Zealand agricultural produce in the dairy sector and a favourable milk price. This led to an increase in the dairy cattle population and the amount of nitrogen applied as fertiliser to agricultural soils resulting in an increase of* CH_4 *and* N_2O *emissions from the sector.*

- *The Energy sector experienced the greatest increase over the period 1990–2008… Energy emissions have increased approximately two-and-a-half times as much as those from the Agriculture sector. The Energy sector had the most influence on the trend in total emissions between 1990 and 2008 becoming the largest contributing sector to total emissions in 2008… In 2009–11 emissions from the Energy sector showed a decrease resulting from the effects of the global recession, recent earthquakes and the closure of coal mines following accidents, as well as greater investment in renewable energy sources in New Zealand. A slight increase of emissions from the sector in 2012 (2.9 per cent) was mostly due to low hydro inflows and a subsequent reduction in the share of electricity production generated from renewable sources in the national energy grid.*

- *The fluctuations in net emissions from LULUCF [land use, land-use change and forestry] across the time series…are influenced by the age class profile of New Zealand's production forests particularly in regard to harvesting and deforestation rates. Harvesting rates are driven by a number of factors particularly tree age and log prices. Deforestation rates are driven largely by the relative profitability of forestry compared with alternative land uses. The decrease in net removals between 2004 and 2007 was largely due to the increase in the planted forest deforestation that occurred leading up to 2008, before the introduction of the NZ ETS.*[9] *The decrease in net removals since 2008 is due to the increase in harvesting that has been occurring in New Zealand's production forests.*

9 The New Zealand Emissions Trading Scheme included the forestry sector as of 1 January 2008.

2.4. New Zealand's emission reduction targets

For Kyoto CP1, New Zealand committed to a global responsibility target to reduce its net emissions over the period 2008–12 to five times the level of gross emissions in 1990. In April 2014, the government released the report on its final net position for the period. The government recorded a surplus of 90.8 million Kyoto units (one unit is equivalent to one metric tonne of CO_2eq). A breakdown of the calculation is provided in Annex 2, Figure A2.7. This surplus has been largely driven by forest carbon uptake calculated under Kyoto rules and the surrender of Kyoto units to the government by participants in the NZ ETS. The book value of this surplus was listed as NZ$27 million at a carbon price of NZ$0.30 per tonne CO_2eq as of March 2014 (MfE 2014b).

However, the true value of this surplus is not clear. New Zealand is outside of Kyoto CP2 and it is not yet known how such units will be recognised officially under the UNFCCC. Importantly, the Kyoto net position is a snapshot in time and it does not account for the future emission liabilities assumed by the government between 2008 and 2012. For example, it does not reflect the government's liability for future harvesting or deforestation on afforested land whose owners have not opted to assume both credits and liabilities under the NZ ETS. (In simpler terms, at some point in the future the government will have to "pay back" some of the forestry units that it claimed in CP1 when afforested land gets harvested or converted, and that unit liability does not accrue to landowners.) It also does not reflect the government's future liability under its target for freely allocated New Zealand Units (NZUs) issued under the NZ ETS during 2008–12 and banked by participants to cover future emissions. In this context, the government is carrying both a surplus and liabilities into the future.

For the period 2013–20, New Zealand has made emission reduction pledges under the UNFCCC that are not legally binding. New Zealand has an unconditional "responsibility target" to reduce its net GHG emissions to 5 percent below 1990 gross emission levels by 2020. This corresponds to an average annual reduction over the period of 3.2 percent relative to 1990 (the expression equivalent to a Kyoto quantified emission reduction or limitation commitment). New Zealand has also retained its conditional responsibility target of a 10–20 percent reduction below 1990 levels by 2020 as originally tabled in the negotiations.[10] The government will apply Kyoto rules adapted as needed to reflect New Zealand's position outside of CP2.

Outside of the UNFCCC framework, the government also has a 2050 target to reduce net GHG emissions to 50 percent of gross emission levels in 1990. This is not binding under domestic legislation.

According to *New Zealand's First Biennial Report under the United Nations Framework Convention on Climate Change* (MfE 2013a), the government intends to meet its unconditional 2020 target through a combination of domestic emission reductions,

10 The conditions are: the global agreement sets the world on a pathway to limit temperature rise to not more than 2°C; developed countries make comparable efforts to those of New Zealand; advanced and major emitting developing countries take action fully commensurate with their respective capabilities; there is an effective set of rules for land use, land-use change and forestry (LULUCF); and there is full recourse to a broad and efficient international carbon market (UNFCCC Secretariat 2011).

forestry activities, participation in international carbon markets and application of the Kyoto unit surplus from CP1. From its position outside of Kyoto CP2, it is not clear how the government will be able to participate in international carbon markets or carry over its surplus Kyoto units.

2.5. New Zealand's emission projections

The government has prepared updated GHG projections reflecting the expected impact of the policies and measures that are currently in place. The primary mitigation policy response is the NZ ETS, and in its modelling the government is unable to separate its impact from that of other policies and measures. When modelling the impacts of the NZ ETS, the government assumed that an effective emission price of NZ$5.00 per tonne CO_2eq would apply through 2030 in the energy sector and NZ$12.00 per tonne CO_2eq in the forestry sector.[11] The government reports that with measures, New Zealand's net emissions are projected to increase 129 percent by 2020 and 159 percent by 2030 relative to 1990 levels. Gross emissions are projected to increase 29 percent and 38 percent, respectively. A key driver is forestry harvesting, which is expected to shift the forestry sector from a net sink to a net source of emissions by around 2020. This is illustrated in Annex 2, Figure A2.1. Current measures are estimated to reduce net emissions by about 12 percent below a without-measures scenario for 2020, and gross emissions by less than 1 percent. The relatively small projected impact of existing measures is illustrated in Annex 2, Figure A2.6.

The government's account of its mitigation policies and emission projections in its *Sixth National Communication* (MfE 2013b) and *First Biennial Report* (MfE 2013a) does not clearly demonstrate how it plans to achieve New Zealand's emission reduction targets for 2020 and 2050. In fact, there appears to be a significant disconnect between the government's climate change targets and its current policy settings.

11 This assumes continuation of the one-for-two surrender provision in the energy sector (and presumably for the industrial process sector). The discrepancy between full emission pricing of NZ$10 in the energy sector and NZ$12 in the forestry sector is an artefact of different modelling assumptions in sectoral studies (Sam Holmes, Ministry for the Environment, personal communication to Catherine Leining, 8 April 2014).

2.6. New Zealand's mitigation policy response

New Zealand's approach to climate change mitigation policy has been iterative over time. Importantly, it has never been designed to place a hard limit on domestic emissions. Instead, it has been designed to provide domestic market incentives and facilitative support to change investment and other behaviour, to stimulate research (particularly on mitigation of agriculture emissions), and to enable participation by New Zealanders in global mitigation activity through the Kyoto Protocol's market-based mechanisms. It has also included some relevant regulatory measures (e.g. energy efficiency standards) and sectoral strategies (e.g. New Zealand Energy Strategy, New Zealand Energy Efficiency and Conservation Strategy, New Zealand Transport Strategy) not linked specifically to emissions targets.

In 2002, when New Zealand ratified the Kyoto Protocol, the Labour-led government announced a climate change policy package that included a carbon tax on stationary energy, transport and industrial process emissions (capped at NZ$25 per tonne); Negotiated Greenhouse Agreements that provided tax exemptions for eligible large emitters in return for agreement to a mitigation pathway; and a domestic project crediting mechanism called Projects to Reduce Emissions. The government exempted biological emissions from agriculture from emissions pricing, and entered into jointly funded research with the sector. The government assumed both credits and liabilities for forestry up to a deforestation cap.

After the 2005 election, which left the Labour-led government with insufficient support to proceed with the carbon tax, it initiated a review of climate change policies and shifted policy direction toward an economy-wide emissions trading scheme combined with sectoral strategies. The NZ ETS was established through amendment of the Climate Change Response Act 2002 shortly before the 2008 election. It was the first ETS in the world to cover all sectors and GHGs. Sectors were to enter the scheme in stages through 2013. Output-based free allocation within a fixed cap was provided to eligible emissions-intensive trade-exposed producers with phase-out to begin in 2019. Fixed pools of free allocation were given to owners of pre-1990 forest land and to the fishing sector. Free allocation to the agriculture sector was to be limited to a fixed cap and decided at a later date. The scheme had buy-and-sell linkages to the international Kyoto market with no quantitative limits in either direction.

After the 2008 election, the new National-led government reviewed the NZ ETS and chose to retain it with modifications designed to soften its impact on the economy. Notably, the government added a price cap of NZ$25 per tonne CO_2eq; reduced the unit surrender obligation from one unit per tonne to one unit per two tonnes for the stationary energy, transport and industrial process sectors; removed the cap on free allocation to eligible industrial producers; and deferred unit obligations for the agriculture sector from 2013 to 2015.

The NZ ETS underwent a statutory review in 2011, and this formed the basis for the 2012 amendments to the scheme. The amendments extended the transitional pricing provisions (the price cap and one-for-two surrender obligation) and deferred the phase-out of industrial free allocation and the entry of the agriculture sector indefinitely. They enabled "forest offsetting" so that owners of pre-1990 forest could avoid deforestation liabilities by replanting elsewhere. They established the government's power to auction units. They also decoupled issuance of NZUs from the government's holdings of Kyoto units, which allowed the scheme to operate more independently of the government's obligations under the Kyoto Protocol.

The NZ ETS was not designed to generate specific domestic emission reductions within New Zealand. Instead, it enabled the government to devolve the cost of its international emission reduction obligations from taxpayers to emitters and consumers, transforming that cost into a price signal that would influence emitting behaviour. By setting no quantitative limits on emission unit issuance, imports or exports, the government left it up to the market to discover where least-cost emission reductions could be found and decide whether New Zealand's mitigation investment was best directed domestically or overseas.

A key intended role of the NZ ETS was to send a credible and rising long-term emission price signal to influence commercial investment decisions in new power generation and other long-lived infrastructure, as well as land use. While the price itself was uncertain, directional certainty was considered important to avoid locking New Zealand into an emissions-intensive development pathway that could prove costly under more stringent future global emission constraints, exposing New Zealand's future economy to a high international price of emissions and/or high costs from stranded assets.

From this standpoint, as long as New Zealand producers and consumers were making decisions that took the international price of emissions into account and their emissions were captured within the Kyoto framework, it did not matter if New Zealand's domestic emissions increased or decreased. With no quantitative constraints on trading, New Zealand could contribute to global mitigation and meet its international obligations at least cost while its economy continued to grow efficiently under the influence of an emissions price. Ultimately, the climate would benefit if production shifted to those countries with the most emissions-efficient production, driving their national emissions up while global emissions went down overall for a given amount of production.

However, stabilisation of atmospheric concentrations at more desirable levels does ultimately require a global constraint on overall emissions. Even if production shifts to the most efficient countries, emission-generating production cannot increase indefinitely if we want to stay within a cumulative GHG budget that limits temperature increases below 2°C.

Over the period from 2010 to 2013, the price signal from the NZ ETS declined significantly, as shown by trends in the price of NZUs (see Annex 2, Figure A2.8). This reflected unit oversupply relative to low ambition in the international Kyoto market to which the domestic market was fully linked. While the price signal did change behaviour in the forestry sector early on, discouraging deforestation and incentivising afforestation, this effect has increasingly been reversed as the price has dropped. The low price of emissions (e.g. about NZ$3.00 for NZUs and less than NZ$0.50 for CERs and ERUs (Emission Reduction Units) in mid-2014 (OMF 2014)) creates little incentive relative to other drivers to change energy production and consumption behaviours. Across sectors, the domestic market has lost confidence in a rising price of emissions over time, and policy uncertainty is clouding the long-term value of mitigation investment.

The government's decision not to proceed with a second commitment period under the Kyoto Protocol will affect the future design and operation of the NZ ETS. The scheme's initial design was nested within the Kyoto framework, which provided the overarching constraint on emissions, set the emission price and ensured liquidity. As of 2013, New Zealand was no longer subject to an international cap on emissions. After the 2015 true-up for CP1, NZ ETS participants will no longer be able to import Kyoto units (with the possible exception of primary CERs if the government lifts its current restriction on Letters of Approval that would authorise New Zealand firms to participate directly in CDM projects). Nor will NZ ETS participants be able to export Kyoto units, so there will be a smaller pool of prospective buyers.

For the period post-2015, the government will need to decide whether to provide its own constraint on unit supply and/or prices in the domestic market, and how to ensure liquidity. While the government did establish a limit on auctioning under the 2012 amendments, this is still not a hard cap as it will not constrain the total issuance of NZUs (and therefore will not limit domestic emissions). No information has been provided to date on how the government will conduct auctioning. This uncertainty regarding future domestic emission constraints will impact on commercial investment and NZ ETS compliance decisions.

Alongside the NZ ETS, the government set several sectoral targets.[12] While the NZ ETS has the potential to contribute to those targets, it was not configured to deliver specific sectoral outcomes. The NZ ETS is a blunt price instrument, and to date the price has not been controlled by the government. The sectoral outcomes of the NZ ETS will depend on how the economy responds to an emission price alongside other drivers. If the government wants to deliver on specific sectoral targets, it will need to apply complementary measures and/or reconfigure the NZ ETS.

The statutory role of local and regional governments in climate change mitigation has been constrained by the Resource Management Act. One rationale was that having an overarching climate change policy framework (including emissions pricing) set by central government would help to support national priorities and avoid the proliferation of a variable patchwork of local and regional climate change mitigation policies. However, local and regional governments do have a critical role to play in climate change mitigation, particularly given their influence over infrastructure, housing, transport, land-use planning, economic development and community welfare. They also have an important stake in adaptation and resilience. For example, both Wellington City Council and Auckland Council have developed ambitious emission reduction targets and climate change action plans addressing both mitigation and adaptation. Their ability to deliver on their emission reduction targets is hampered by their lack of control over national stationary energy, transport and emissions pricing policies and funding priorities. However, these cities still offer important potential for learning and leadership with regard to transforming climate change challenges into practical development opportunities.

12 For example, the government has a target under the New Zealand Energy Strategy that by 2025, 90 percent of New Zealand's electricity will be generated from renewable sources.

2.7. Other domestic mitigation action

New Zealand's businesses, research institutions and non-governmental organisations are involved in a range of activities supporting climate change mitigation. Some of these are in partnership with government, while others have been independent. Climate mitigation activities outside of government can be loosely grouped into three categories:

- **Shifting the New Zealand economy toward green growth** This includes major programmes by business organisations (examples include the Sustainable Business Council, Sustainable Business Network and Pure Advantage) to add value to New Zealand's economy and develop new economic opportunities through more sustainable business practices. Government and industry are working together on the future of smart electricity networks under the Smart Grid Forum. Individual companies have made commitments to produce a GHG inventory, reduce their carbon footprint or achieve carbon-neutral certification.

- **Climate change mitigation research programmes** Research programmes on different aspects of mitigation (scientific, technological, economic and social) are being undertaken across industry and academia, often with government support.
- **Climate change advocacy** A wide array of non-governmental organisations (NGOs) representing civil society are conducting advocacy campaigns for changes to government climate change policy and actions by businesses and households.

Public views on the importance and urgency of climate change have fluctuated over time. Horizon Research (2012) conducted a polling study called *New Zealanders' Views on Climate Change Issues*. They reported that the number of New Zealanders regarding climate change as an urgent or immediate problem declined from 75.4 percent in 2008 to 52.4 percent in 2012. The number not regarding climate change as a problem increased from 13 percent to 19 percent over the same period. However, in 2012 over 60 percent of New Zealanders believed that the prime minister, Parliament, government officials, businesses and citizens should be taking more action on global warming. This expressed level of public interest in increased action on climate change, both domestically and internationally, has not yet translated into widespread political will or individual action to make significant changes to New Zealand's emissions trajectory, its contribution to global mitigation and its position in the international negotiations.

3. Conclusion

The scientific case for reducing cumulative global emissions has been reinforced by the latest series of reports from the IPCC. While the international climate change negotiations are struggling to set global emission reduction pathways for industrialised and developing countries, participants do agree on the need to limit temperature increases and the overarching necessity of reducing global emissions. It appears increasingly certain that the future holds more stringent global constraints on GHG emissions, which will change the way we live.

New Zealand's current policy settings were not designed to impose hard limits on domestic emissions. As international emission prices have collapsed, so too have incentives for domestic mitigation in New Zealand. In the absence of policy certainty regarding domestic emission constraints and/or exposure to rising emission prices, New Zealand firms lack clear regulatory drivers or market-based incentives to make investment decisions that support a low-emission development pathway for New Zealand. At the same time, New Zealand has the potential to create new domestic opportunities for economic development and to export its production and expertise to other countries in ways that more closely align human needs with stabilising global emissions.

Strategically, it is important that the government and stakeholders consider New

Zealand's options for an attractive low-emission future and the role of different policies and actions inside and outside of government in making those options a reality – or at least leaving those options open. With greater clarity on New Zealand's opportunities and strategic objectives, it will be easier to decide what level and certainty of emission pricing would be desirable, how to encourage effective mitigation investment, how New Zealand should link to international carbon markets and international mitigation initiatives, how to manage the distributional impacts of those decisions, and how best to achieve specific sectoral outcomes.

New Zealanders will make many important choices in the coming decades about the pathway we take toward a global low-emission future. Ralph Waldo Emerson wrote, "The only person you are destined to become is the person you decide to be." As New Zealanders face the challenges of climate change, who will we decide to be?

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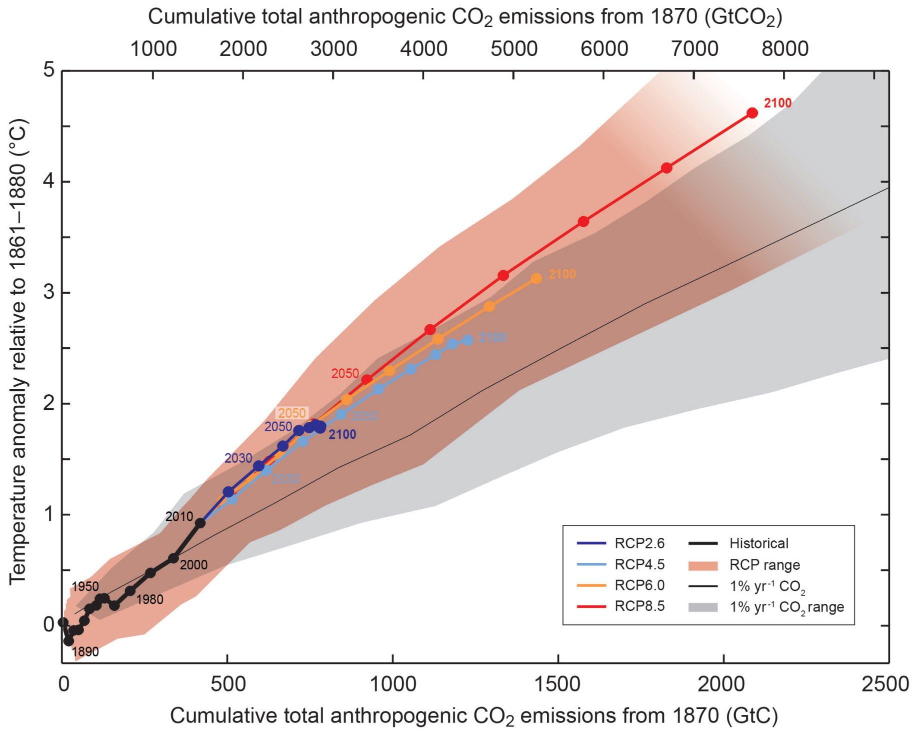
Annex 1: Key figures on emission trends from the IPCC's *Fifth Assessment Report*

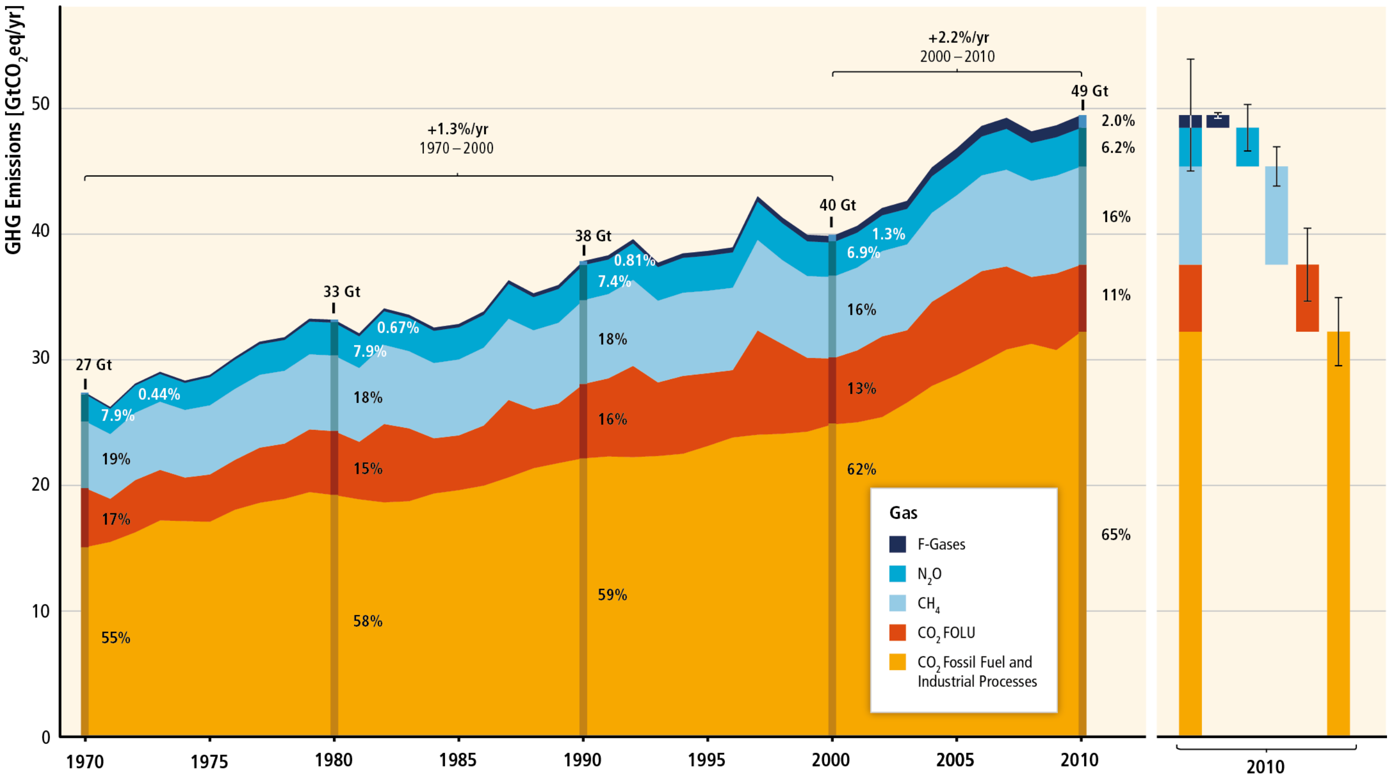
Figure A1.1: Cumulative emissions and temperature impacts under four representative concentration pathways



Global mean surface temperature increases as a function of cumulative total global CO_2 emissions from various lines of evidence. Multi-model results from a hierarchy of climate-carbon cycle models for each representation concentration pathway (RCP) until 2100 are shown with coloured lines and decadal means (dots). Some decadal means are labelled for clarity (e.g., 2050 indicating the decade 2040–2049). Model results over the historical period (1860 to 2010) are indicated in black. The coloured plume illustrates the multi-model spread over the four RCP scenarios and fades with the decreasing number of available models in RCP8.5. The multi-model mean and range simulated by CMIP5 models, forced by a CO_2 increase of 1% per year (1% yr CO_2 simulations), is given by the thin black line and grey area. For a specific amount of cumulative CO_2 emissions, the 1% per year CO_2 simulations exhibit lower warming than those driven by RCPs, which include additional non-CO_2 forcings. Temperature values are given relative to the 1861–1880 base period, emissions relative to 1870. Decadal averages are connected by straight lines. (Abridged from IPCC (2013).)

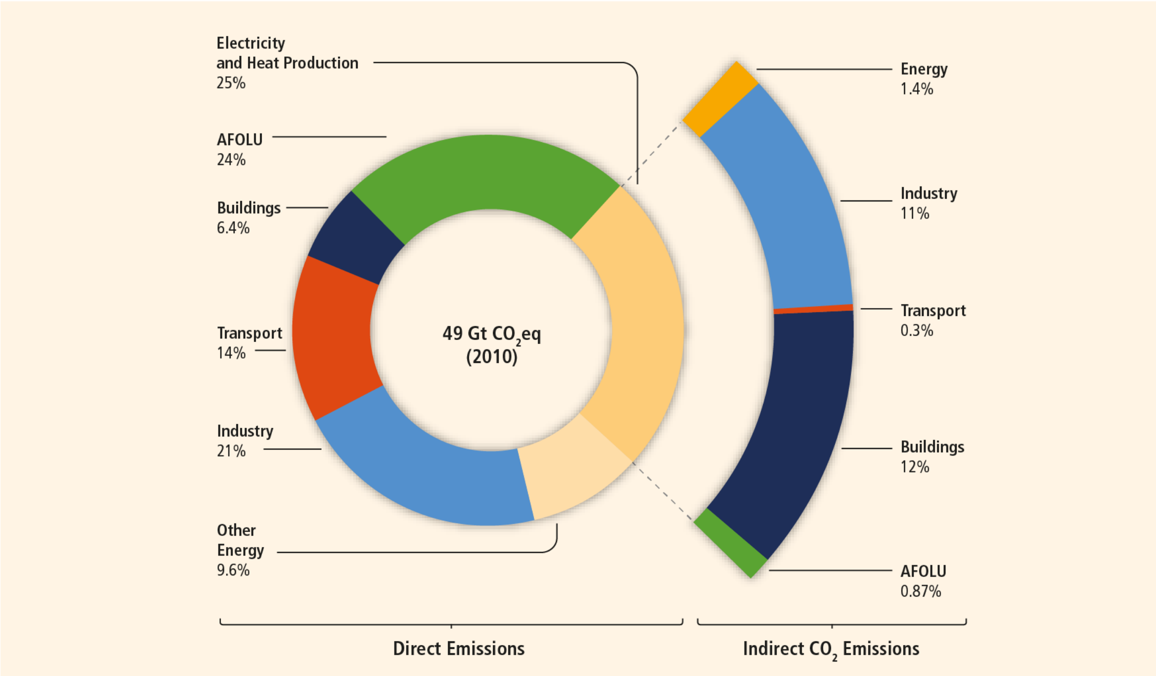
Source: IPCC (2013)

Figure A1.2: Anthropogenic greenhouse gas emissions by gas from 1970 to 2010



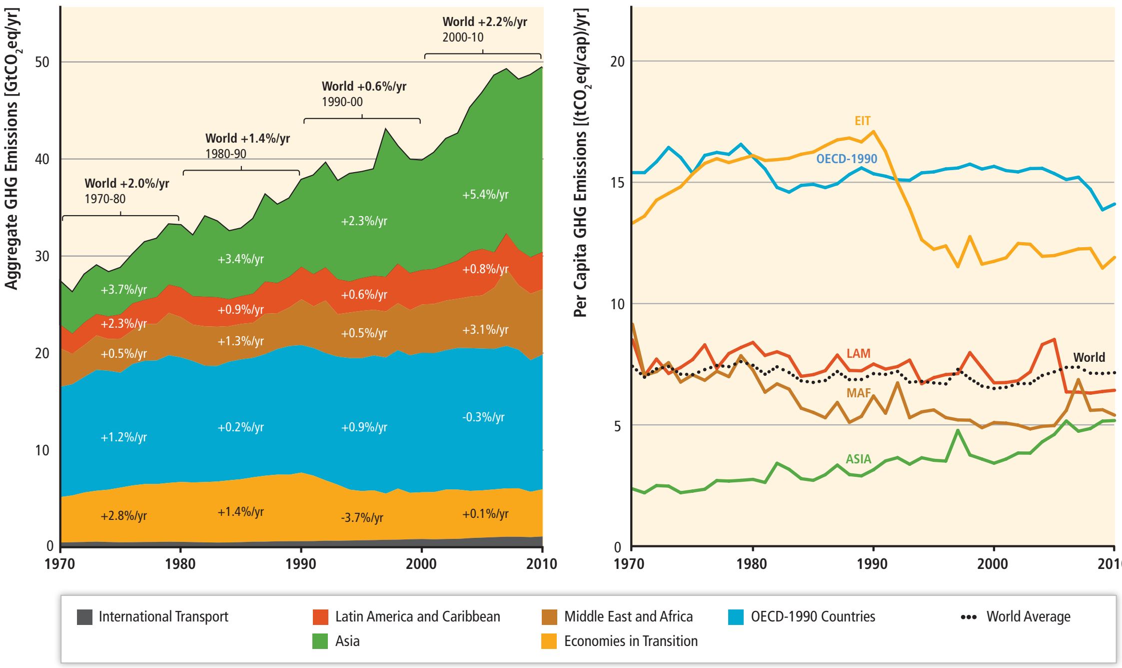
Total annual anthropogenic GHG emissions ($GtCO_2eq/yr$) by groups of gases 1970 – 2010: CO_2 from fossil fuel combustion and industrial processes; CO_2 from Forestry and Other Land Use (FOLU); methane (CH_4); nitrous oxide (N_2O); fluorinated gases covered under the Kyoto Protocol (F-gases). At the right side of the figure GHG emissions in 2010 are shown again broken down into these components with the associated uncertainties (90 percent confidence interval) indicated by the error bars. Total anthropogenic GHG emissions uncertainties are derived from the individual gas estimates. Global CO_2 emissions from fossil fuel combustion are known within 8 percent uncertainty (90 percent confidence interval). CO_2 emissions from FOLU have very large uncertainties attached in the order of ±50 percent. Uncertainty for global emissions of CH_4, N_2O and the F-gases has been estimated as 20 percent, 60 percent and 20 percent, respectively. 2010 was the most recent year for which emission statistics on all gases as well as assessment of uncertainties were essentially complete at the time of data cut-off for the 2013 report. Emissions are converted into CO_2-equivalents based on GWP100 (100-year Global Warming Potentials) from the IPCC *Second Assessment Report*. The emission data from FOLU represents land-based CO_2 emissions from forest fires, peat fires and peat decay that approximate to net CO_2 flux from the FOLU. Average annual growth rate over different periods is highlighted with the brackets. (Abridged from IPCC (2014b).)
Source: IPCC (2014b).

Figure A1.3: Anthropogenic greenhouse gas emissions by sector in 2010



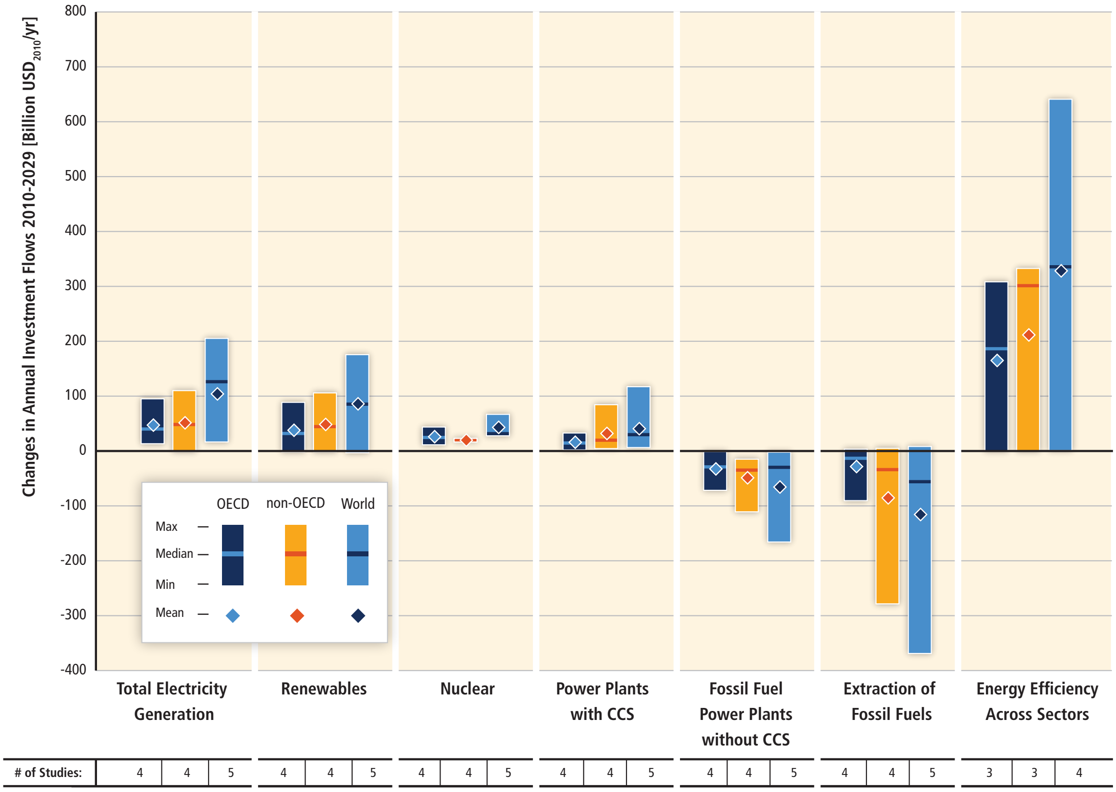
Total anthropogenic GHG emissions ($GtCO_2eq/yr$) by economic sectors. Inner circle shows direct GHG emission shares (in percent of total anthropogenic GHG emissions) of five economic sectors in 2010. Pull-out shows how indirect CO_2 emission shares (in percent of total anthropogenic GHG emissions) from electricity and heat production are attributed to sectors of final energy use. 'Other Energy' refers to all GHG emission sources in the energy sector other than electricity and heat production. The emissions data from Agriculture, Forestry and Other Land Use (AFOLU) includes land-based CO_2 emissions from forest fires, peat fires and peat decay that approximate to net CO_2 flux from the Forestry and Other Land Use (FOLU) sub-sector. Emissions are converted into CO_2-equivalents based on GWP100 from the IPCC Second Assessment Report. (Abridged from IPCC (2014b).)
Source: IPCC (2014b).

Figure A1.4: Anthropogenic greenhouse gas emissions by region from 1970 to 2010



Left panel: GHG emissions per region (territorial) over 1970–2010, including fossil, agriculture and land-use/land-use change sectors, aggregated using 100-year GWP values. Right panel: The same data presented as per capita GHG emissions. (Abridged from Blanco et al. (2014).)
Source: Blanco et al. (2014).

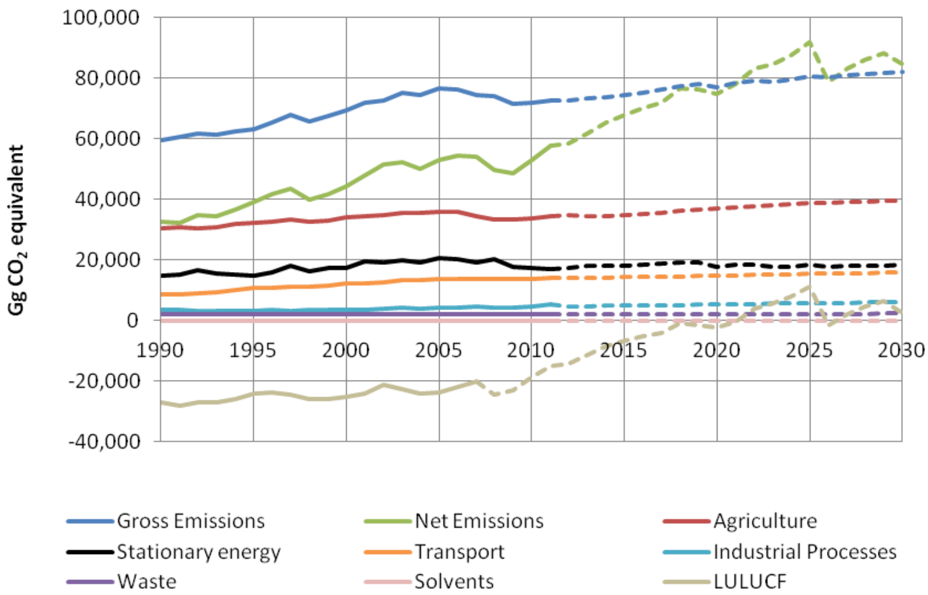
Figure A1.5: Changes in annual investment flows 2010–29



Change in annual investment flows from the average baseline level over the next two decades (2010–2029) for mitigation scenarios that stabilise concentrations within the range of approximately 430–530 ppm CO_2eq by 2100. Investment changes are based on a limited number of model studies and model comparisons. Total electricity generation (leftmost column) is the sum of renewables, nuclear, power plants with carbon capture and storage (CCS) and fossil fuel power plants without CCS. The vertical bars indicate the range between minimum and maximum estimate; the horizontal bar indicates the median. Proximity to this median value does not imply higher likelihood because of the different degree of aggregation of model results, the low number of studies available and different assumptions in the different studies considered. The numbers in the bottom row show the total number of studies in the literature used for the assessment. This underscores that investment needs are still an evolving area of research that relatively few studies have examined. (Abridged from IPCC (2014b).)
Source: IPCC (2014b).

Annex 2: New Zealand's emission and carbon price trends

Figure A2.1: New Zealand's actual and projected emissions 1990–2030 under the UNFCCC



Total gross emissions exclude the LULUCF (forestry) sector. LULUCF projections are based on a mid-point emissions scenario.
Source: MfE (2013a).

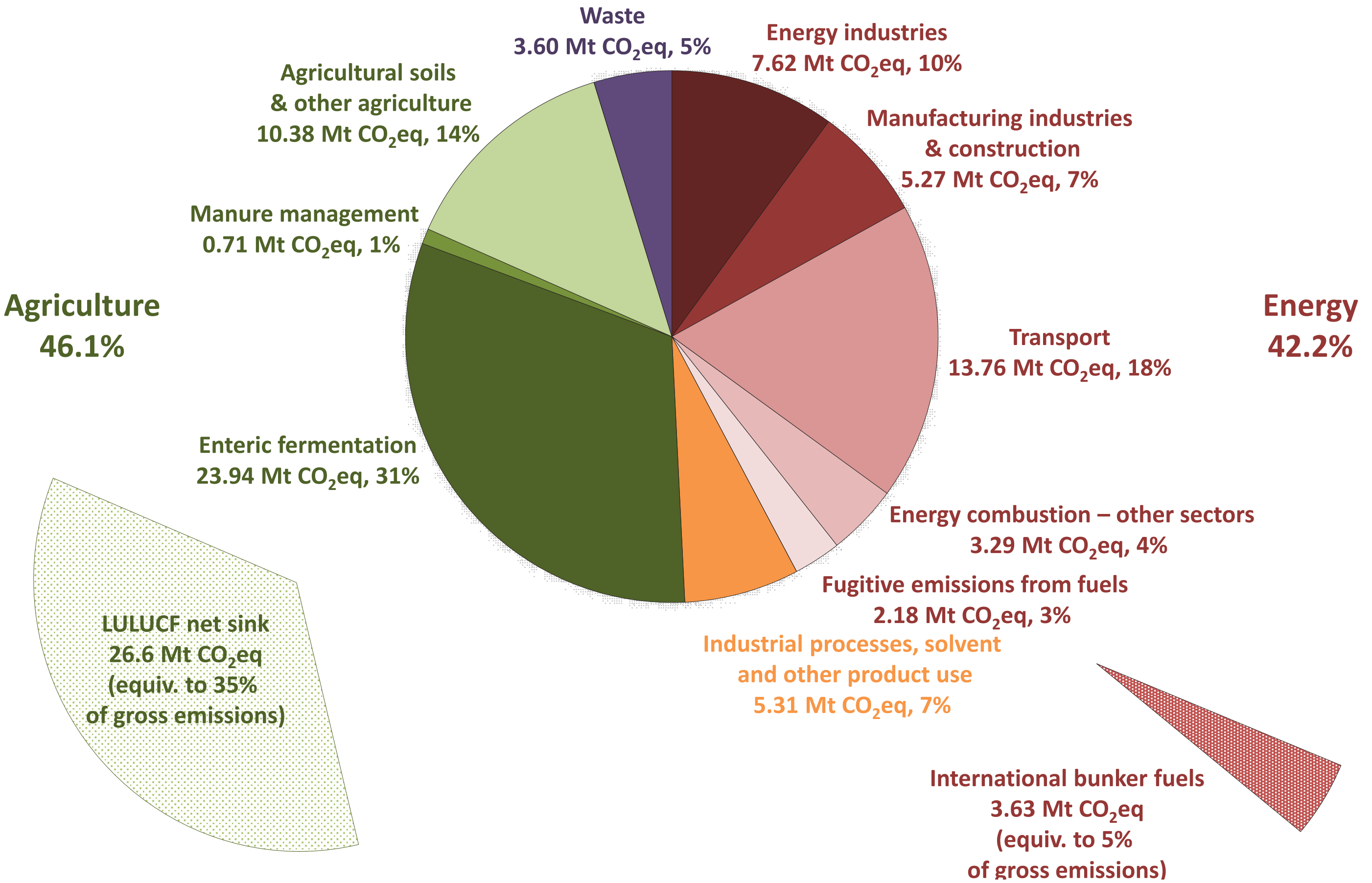
Figure A2.2: New Zealand's emissions by sector in 1990 and 2012

Table ES 4.1.1 New Zealand's emissions by sector in 1990 and 2012

Sector	Gg CO_2 equivalent 1990	Gg CO_2 equivalent 2012	Change from 1990 (Gg CO_2 equivalent)	Change from 1990 (%)
Energy	23,560.4	32,121.3	+8,560.9	+36.3
Industrial processes	3,303.6	5,310.9	+2,014.7	+61.8
Solvent and other product use	41.5	34.1	–7.4	–17.9
Agriculture	30,471.0	35,020.1	+4,549.2	+14.9
Waste	3,303.5	3,595.7	+289.2	+8.8
Total (excluding LULUCF)	**60,641.4**	**76,048.0**	**+15,406.5**	**+25.4**
LULUCF	–37,250.4	–26,598.3	+10,652.0	+28.6
Net total (including LULUCF)	**23,391.1**	**49,449.7**	**+26,058.6**	**+111.4**

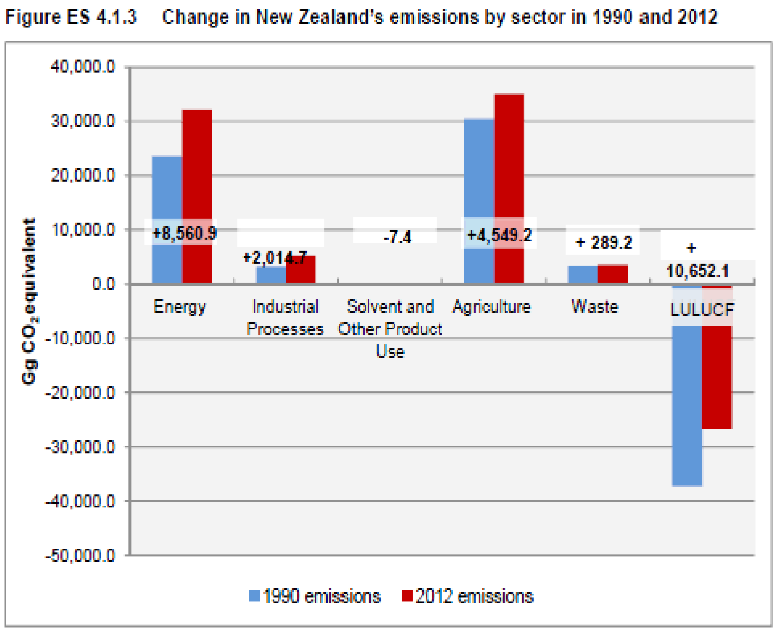
Net removals from the LULUCF sector are as reported under the Climate Change Convention. Columns may not total due to rounding. In this table Solvent and other product use line is included in Industrial Processes and should not be figured in the total emission value.
Source: MfE (2014a).

Figure A2.3: New Zealand's emissions by sector in 2012



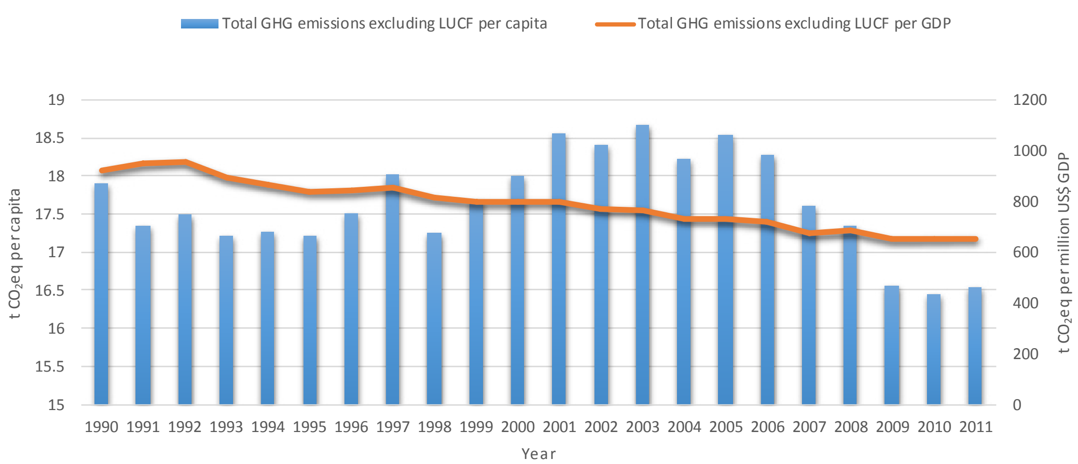
Source: Adapted from MfE (2014a).

Figure A2.4: Change in New Zealand's emissions by sector in 1990 and 2012



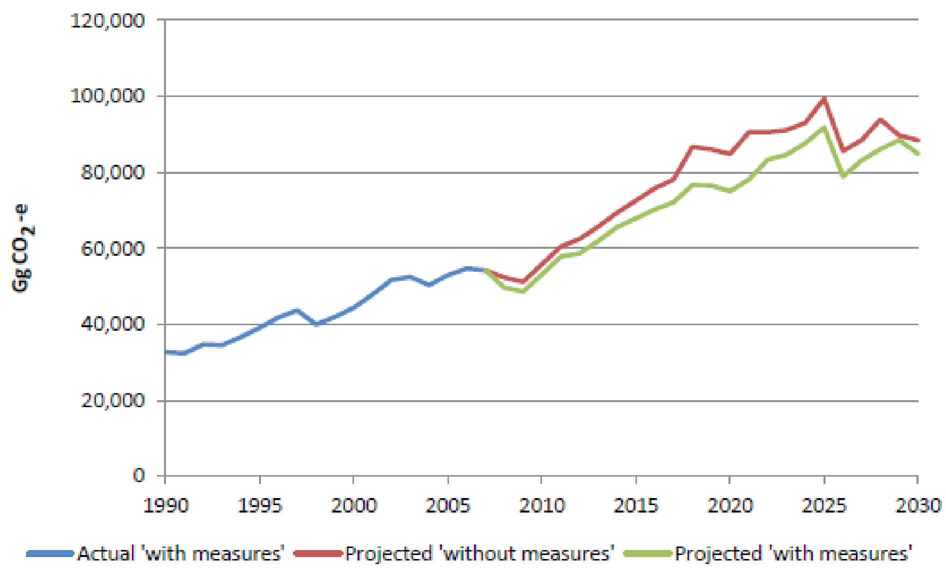
Source: MfE (2014a).

Figure A2.5: New Zealand's emissions trends per capita and per GDP: 1990–2011



Source: Data from WRI (2014).

Figure A2.6: Actual and projected net emissions, with measures versus without measures, 1990–2030



Projections start at 2008 because forestry data from 2008–2012 will not be confirmed until 2014.
Source: MfE (2013a).

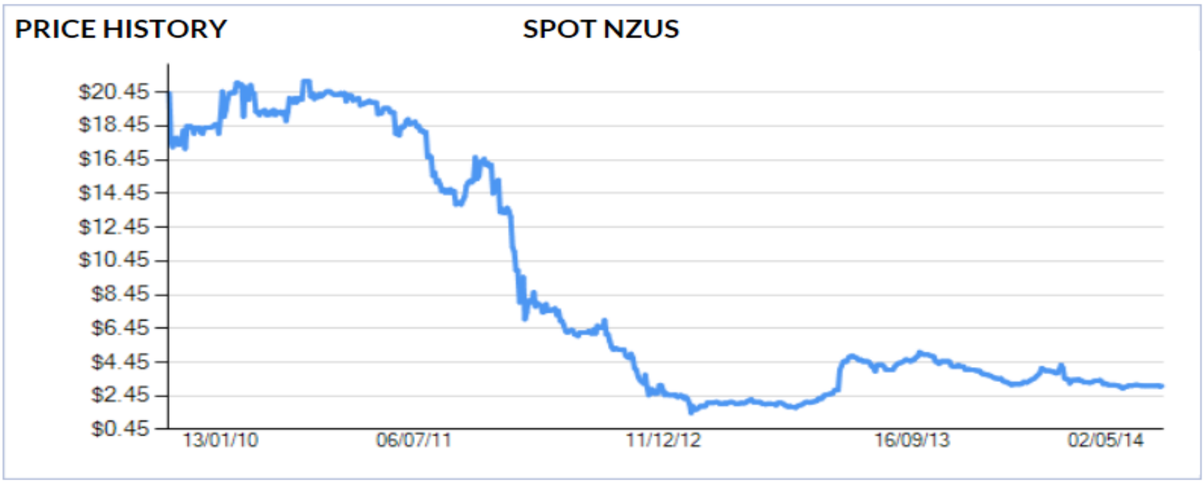
Figure A2.7: New Zealand's net position under the Kyoto Protocol as at April 2014

	APRIL 2014		APRIL 2013
New Zealand's emissions		Mt CO_2-e[1]	
Total emissions	+372.8	+9.3	+363.5
Forestry sequestration Removal Units (RMUs)	-71.6	+5.7	-77.2
Net emissions	301.2	+14.9	286.3
Kyoto units in the Government Account		Millions of units	
Initial Assigned Amount Units (AAUs)	309.6		309.6
Purchases by the Government	+0.1	0.0	+0.1
Transfers to Projects to Reduce Emissions (PRE)	-4.9	-1.7	-3.2
Transfers to Permanent Forest Sink Initiative	-1.4	-0.7	-0.7
New Zealand Units converted to AAUs	-1.2	0.0	-1.2
AAUs projected to remaining PRE projects	0.0	+1.7	-1.7
Kyoto units surrendered via NZ ETS[2]	+90.0	+77.0	+13.0
Current Kyoto unit balance	392.0	76.3	315.9
New Zealand's net position	90.8	61.2	29.6

1. $MtCO_2$-e = million tonnes of carbon dioxide equivalent.
2. NZ ETS = New Zealand Emissions Trading Scheme.

Source: MfE (2014b).

Figure A2.8: Spot price of New Zealand Units from 2010 to 2014



Source: OMF (2014).