Ministry for the Environment
Manatū Mō Te Taiao

New Zealand's Fourth National Communication

under the United Nations Framework Convention on Climate Change

Including the **Report on the Global Climate Observing System**

and the **Report on Demonstrable Progress under the Kyoto Protocol**

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Foreword

New Zealand is committed to tackling climate change.

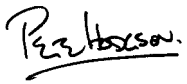
In global terms our national greenhouse emissions are modest, but New Zealand is a country that derives a significant amount of our wealth from primary production, trade and the natural environment. As a result, our economy is vulnerable to the impacts of climate change.

If we want to maintain a stable climate here in New Zealand and ensure a future that preserves equity and opportunities for *all* nations, there must be an international response to climate change. New Zealand is committed to being part of this global solution.

In December 2002, New Zealand joined with most other developed countries and ratified the Kyoto Protocol. In February 2005, the Kyoto Protocol entered into force. This event represents a milestone in the global effort to address climate change. It opened a new chapter in the international dialogue on climate change, and engaged the world to pursue and enhance efforts to reduce greenhouse gas emissions.

New Zealand has chosen to take a multi-faceted approach towards addressing the challenges of climate change and has made significant progress in its response to climate change issues since the *Third National Communication* was published in January 2002. In October 2002, the Government announced a climate change policy package and proceeded with implementation. In November 2005, a comprehensive review of this policy package identified the need for further policy development and new direction. This *Fourth National Communication* reflects the fact that New Zealand's climate change policy is in a state of transition as we shape a long-term strategy for managing this critical issue.

New Zealand remains committed to exploring innovative, social and technological solutions to reduce greenhouse gas emissions, believing that these tools will in turn create economic opportunities. We also remain committed to ensuring that New Zealand understands and prepares for the impacts of a changing climate. After all, this country and its people depend on the climate for our livelihood.



Hon Pete Hodgson

Acting Minister Responsible for Climate Change Issues

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Executive summary

Introduction

The New Zealand Government is committed to playing its part in the global response to climate change. This *Fourth National Communication* provides a snapshot of New Zealand's progress with implementing the United Nations Framework Convention on Climate Change (UNFCCC). This document covers the period from the submission of the *Third National Communication* in January 2002 through to the end of December 2005. This document also contains New Zealand's *Report on the Global Climate Observing System* and the *Report on Demonstrable Progress under the Kyoto Protocol.*

New Zealand's response to climate change has evolved substantially since the *Third National Communication* was submitted. On 19 December 2002, New Zealand became the 101st nation to ratify the Kyoto Protocol. In 2002, the New Zealand Parliament passed the Climate Change Response Act. This Act established a New Zealand climate change registry and corresponding institutional arrangements in accordance with Kyoto Protocol requirements. Other achievements are detailed throughout this *Fourth National Communication*.

When the Government introduced its climate change policy package in 2002, it anticipated there would be three reviews of the package not later than 2005, 2007 and 2010. The reviews would be necessary to monitor progress with emissions reductions, assess the effectiveness of policies, and confirm that New Zealand was positioned to meet its commitments. The first of these reviews was commissioned by the Government in mid-2005 and completed by November 2005.

The review concluded that some elements of the Government's 2002 climate change policy package should be modified to better position New Zealand to respond to the longer-term challenges of climate change. A key outcome of the policy review was the announcement by the newly elected Government in December 2005 that the previously announced carbon tax would not proceed. In addition, a suite of future work programmes would be required to inform Government decisions in light of the review and contribute to further development of policies and measures. In that announcement, the Government reaffirmed its commitment to the Kyoto Protocol.

At the time of publication of the *Fourth National Communication*, the Government's climate change policy is in a phase of transition as the Government considers the suite of work programmes. **It is important to note that the policies and measures as well as the projections reported in this document reflect the Government's decision not to proceed with the previously announced carbon tax, but do not reflect any impact from the new work programmes being considered by the Government at the time of publication.**

National circumstances

New Zealand consists of two large islands and a number of smaller islands located in the southwest Pacific Ocean between 33° and 55° south latitude. The land area is approximately 27 million hectares, making it similar in size to Japan or the United Kingdom. The land cover is dominated by forest and pastoral land with indigenous forests occupying 6.3 million hectares, planted forest occupying 1.8 million hectares and pastoral land occupying 9 million hectares. Five million hectares of land are protected in parks and reserves. New Zealand's population in 2006 is 4.1 million people.

New Zealand's Government is a parliamentary democracy with an elected House of Representatives. Representation is through a single-house mixed-member proportional system (MMP). The principal functions of Parliament are to enact laws, scrutinise the Government's administration, and approve the Government's allocation of tax income. New Zealand has 86 local authorities that provide government for local and regional interests.

The New Zealand economy has sizeable manufacturing and services sectors complementing a highly efficient export-oriented agricultural sector. Agriculture contributes almost seven percent of New Zealand's gross domestic product. Energy-based industries (including dairy processing, and cement and steel manufacturing), forestry, mining, horticulture and tourism have expanded rapidly over the past two decades. Recent economic growth has been strong, and New Zealand currently has one of the faster growing economies in the Organisation for Economic Co-operation and Development (OECD).

New Zealand's greenhouse gas emissions profile is different from that of many other Parties. Nearly 50 percent of New Zealand's greenhouse gas emissions is from agriculture. This compares to an average of 12 percent in other Annex 1 Parties. Reducing greenhouse gas emissions in agriculture is a challenge, as many agricultural activities have a direct relationship between output and greenhouse gas emissions. New Zealand scientists are undertaking world-leading research to develop technologies and management practices that reduce methane emissions from ruminant livestock; however, identifying technologies and management practices that achieve reductions in a safe manner, meet all regulatory requirements and are taken up by industry remain significant challenges.

New Zealand also has notably low emissions from thermal electricity production compared to other countries. On average from 1990 to 2004, renewable energy from hydroelectric, geothermal, and biomass sources, and combined heat and power generation comprised almost 75 percent of New Zealand's electricity supply. Around 90 percent of renewable generation in New Zealand was hydroelectric with limited storage potential.

New Zealand's hydroelectricity system is therefore susceptible to dry periods. Wind generation capacity in New Zealand started being installed around 1992 and by 2004, 354 gigawatt hours of generation were provided by wind power. The investment intentions of major generators suggest this could increase several fold over the next few years.

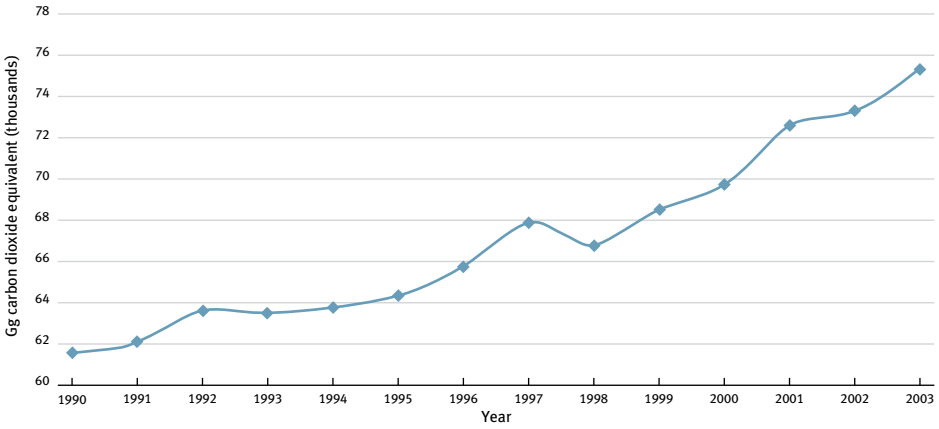
Greenhouse gas inventory

The development and publication of an annual inventory of all human-induced emissions and removals of greenhouse gases not controlled by the Montreal Protocol is part of New Zealand's obligations under the UNFCCC (Articles 4.1 and 12) and the Kyoto Protocol (Article 7). Consistent with the reporting guidelines agreed by the Parties to the UNFCCC, New Zealand has developed an inventory system that records emissions and removal of the gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) from six sectors: energy; industrial processes; solvents; agriculture; land use, land-use change and forestry (LULUCF); and waste. The Climate Change Response Act (2002) names the Ministry for the Environment as New Zealand's inventory agency.

The Ministry for the Environment is responsible for overall development, compilation and submission of the annual greenhouse gas inventory to the UNFCCC. In addition to this overall coordination and quality control role, the Ministry for the Environment produces the estimates of emissions and removals from the LULUCF sector (except planted forests), the waste sector, and the non-carbon dioxide gases from the industrial processes sector (obtained via industry consultants). The Ministry of Economic Development is responsible for the energy sector and carbon dioxide emissions from the industrial processes sector, and the Ministry for Agriculture and Forestry manages the agricultural sector and removals from planted forests in the LULUCF sector.
The inventory estimates are underpinned by research and modelling by researchers at New Zealand's Crown Research Institutes and universities.

In the latest inventory submitted in April 2005 (for the inventory year 2003),[1] New Zealand's total greenhouse gas emissions in 1990 were equivalent to 61,525 Gg CO_2. In 2003, total greenhouse gas emissions were 75,345 Gg CO_2 equivalent. This equates to a rise of 13,820 Gg CO_2 equivalent or 22.5 percent since 1990 (see 4NC Figure ES1). Net removals from the LULUCF sector (including emissions of methane and nitrous oxide) increased from 21,366 Gg CO_2 in 1990 to 22,862 Gg CO_2 in 2003.

4NC Figure ES1: New Zealand's total greenhouse gas emissions 1990 – 2003



Source: Ministry for the Environment (2005b)

New Zealand's emissions profile is dominated by the agriculture sector and the energy sector (the energy sector as defined in the national inventory includes both stationary and mobile combustion (transport)). The agriculture sector emissions totalled 37,203 Gg CO_2 equivalent in 2003 and represented 49.4 percent of all greenhouse gas emissions. Emissions in this sector are now 15.6 percent higher than the 1990 level of 32,194 Gg CO_2 equivalent. The increase is attributable to a 9.6 percent increase in methane emissions from enteric fermentation and 29 percent increase in nitrous oxide emissions from agricultural soils. The energy sector produced 32,321 Gg CO_2 equivalent in 2003 and represented 42.9 percent of New Zealand's total greenhouse gas emissions. Emissions from the energy sector are now 37.0 percent above the 1990 baseline value of 23,594 Gg CO_2 equivalent. The sources contributing most to the increase since 1990 are emissions from road transportation (an increase of 58.4 percent) and public electricity and heat production (an increase of 83.3 percent). The other sectoral components of the inventory are the industrial processes sector (5.3 percent of total greenhouse gas emissions) and the waste sector (2.3 percent of total greenhouse gas emissions).

[1] The *Fourth National Communication* covers the period from the submission of the 2001 *Third National Communication* through December 2005. While New Zealand is preparing a 2006 inventory report containing emissions data for 2004, the 2006 inventory report was not available for incorporation into the *Fourth National Communication*.

The period 1990–2003 has seen changes in the relative amounts of the different greenhouse gases emitted. While methane and carbon dioxide equally contributed to New Zealand's emissions in 1990, carbon dioxide is now the major greenhouse gas in New Zealand's emissions profile. This is the result of increased growth in the energy sector, notably transport, relative to the agriculture sector. However, the agriculture sector continues to dominate New Zealand's emissions profile, producing 49.4 percent of total emissions in 2003.

Policies and measures

The Government considers that in order to minimise the risk of climate change to New Zealand, its Pacific neighbours, and other countries, New Zealand needs to participate in the international effort to mitigate climate change. This requires a credible domestic programme to reduce greenhouse gas emissions and enhance sinks. The Government's 2002 climate change policy package included policies and measures focused on the energy, transport, industry, agriculture, waste and forestry sectors as well as cross-sectoral policies and measures. In response to the 2005 review of the policy package, the Government announced that it would not proceed with the carbon tax and associated Negotiated Greenhouse Agreements, and would implement work programmes in each of the key sectors to develop further policies and measures. The *Fourth National Communication* reports the policies and measures that remained in place as of December 2005, and does not reflect current and planned work on new policies and measures.

Energy policies and measures

The Government has established a whole-of-Government National Energy Efficiency and Conservation Strategy, complemented by sector-specific and energy market policies, to reduce greenhouse gas emissions from the energy sector.

The Energy Efficiency Conservation Authority was established in 2000 as a Crown entity under the Energy Efficiency and Conservation Act. The Authority's function is to encourage, promote and support energy efficiency, energy conservation, and the use of renewable sources of energy. The Energy Efficiency and Conservation Act 2000 provides a guiding, coordinating and aspirational framework for the Authority's activities. The six main goals of this strategy include reducing carbon dioxide emissions; minimising local environmental impacts; improved economic productivity; promotion of industry development; improved economic resilience; and improved health and welfare.

The Government initiated a sustainable energy work programme following release of its Sustainable Development Programme of Action in January 2003. In October 2004, the Government released the document *Sustainable Energy: Creating a Sustainable Energy System* setting out the longer-term challenges for the secure, affordable and sustainable delivery of energy services. At the end of 2005, the Government announced it would develop a National Energy Strategy to provide long-term direction and leadership to put New Zealand firmly on the path to an energy system that supports economic development while being environmentally responsible. The Government also emphasised renewed commitment to promoting energy efficiency and renewable sources of energy. Due to the inter-linkages with climate change policy and other concurrent processes, the development of a National Energy Strategy is a whole-of-Government process.

Transport policies and measures

The New Zealand Transport Strategy defines the Government's vision of an affordable, integrated, safe, responsive and sustainable transport system by 2010. One of its five objectives is to ensure environmental sustainability. This includes encouraging more energy-efficient modes of transport. The National Rail Strategy sets out the Government's rail policy objectives and priorities for action over the next 10 years and outlines the key initiatives to achieve the outcomes. This strategy focuses on growth in two key areas: freight, both bulk and containerised; and urban passenger transport.

Industry policies and measures

When the Government completed the review of the climate change policy package in November 2005, it subsequently decided that a new focus will be required to address industry issues more effectively. As a result, the previously announced carbon tax and associated Negotiated Greenhouse Agreements for eligible industrial emitters will not now be introduced. A work programme will examine alternative measures to the announced carbon tax, including consideration of emissions trading and new, possibly voluntary, arrangements to replace Negotiated Greenhouse Agreements. There are two ongoing voluntary programmes to reduce industrial emissions of fluorinated gases: sulphur hexafluoride, hydrofluorocarbons, and perfluorocarbons.

Agriculture policies and measures

The Government supports the improvement of the agricultural sector's contribution to the national greenhouse gas inventory. This programme recognises the importance of the agricultural sector inventory, the uncertainties surrounding the agricultural industry, the uniqueness of New Zealand's environment and agricultural systems, and the benefit of developing country-specific emission factors in the national inventory.

The Pastoral Greenhouse Gas Research Consortium was established in 2003 and manages and funds research through a partnership between the Government and the agricultural industry. The goals of the jointly agreed agricultural strategy are to:

- identify, establish and develop on-farm technologies to improve production efficiency for ruminants
- identify, establish and develop on-farm technologies for sheep, dairy and beef cattle, and deer which lower methane emissions from New Zealand ruminants and nitrous oxide from grazing animal systems
- exploit commercial opportunities arising from the science and technologies in a global market.

The target is to have safe, cost-effective greenhouse gas abatement technologies which will lower total New Zealand ruminant methane and nitrous oxide emissions by at least 20 percent compared with the "business as usual" emissions level, by the end of the first commitment period (2012).

Waste policies and measures

The Government established a national environmental standard for air quality which requires landfills with a design capacity of over one million tonnes of refuse, and current stock of waste of 200,000 tonnes, to collect and destroy landfill gas. The standard is expected to prevent emissions of around 40,000 tonnes of methane over the first commitment period. The National Waste Minimisation and Management Strategy has also been established to help reduce the volume of waste being produced through better resource use, and design for re-use of products.

Forestry policies and measures

New Zealand's indigenous forests occupy 6.3 million hectares of which 83 percent is owned by the Government. These forests are a considerable reservoir of carbon. Research is underway to provide a greater understanding of the nature of this reservoir.

New Zealand has approximately 1.8 million hectares of planted production forest with radiata pine being the predominant species. In the Government's 2002 climate change policy package, the Government announced that it would retain all sink credits and their associated liabilities in respect of Kyoto production forests (i.e., forest plantings post-1990) for at least the first commitment period of the Kyoto Protocol. The Government would also retain the liability for deforestation of pre-1990 forests up to a cap of 21 Mt CO_2 during the first commitment period. The Government is currently considering a work programme on forestry policy options for managing deforestation and encouraging afforestation and reforestation.

As part of the 2002 climate change policy package, the Government developed a Permanent Forest Sinks Initiative. Under this initiative, the Government proposes to devolve an amount of tradable carbon emission units equal to the amount of carbon sequestered in qualifying forests over the Kyoto Protocol's first commitment period (2008–2012). These forests must maintain a continuous canopy cover, although limited timber harvesting is allowed. Obligations under the contract would be registered against land titles and would run with and bind the land. This initiative is being considered under the Climate Change Response Amendment Bill.

The Government also supports afforestation on severely erosion-prone land on the East Coast of the North Island through the East Coast Forestry Project. Landholders are encouraged to tender for Government grants which help fund the cost of establishing and managing forest on erosion-prone land.

Cross-sectoral policies and measures

The policy for energy-intensive businesses aims to assist energy-intensive small and medium enterprises to reduce greenhouse gas emissions through improved energy efficiency.

The Projects to Reduce Emissions programme supports projects that will reduce New Zealand's emissions during the first commitment period. The programme uses a competitive tender to allocate tradable entitlements to Kyoto emission units to successful projects following an additionality and eligibility assessment. This programme has been New Zealand's main incentive for abatement that is additional to business-as-usual across several sectors of the economy. The project portfolio comprises 41 projects selected through two tender rounds and an early projects process, and 11 million emission units[2] have been allocated. Following the review of climate change policies in November 2005, the Government has sought confirmation that there is a need for further cross-sector incentives, and if so what type of intervention is appropriate. A work programme will address this issue. The Government's consideration of future policy in this area will not affect the implementation of projects already undertaken to date under the Projects to Reduce Emissions programme.

Local government policies and measures

The Government is committed to working in partnership with the local government sector to achieve its mitigation and adaptation climate change objectives. The Government's formalised partnership programme with Local Government New Zealand aims to improve awareness, understanding and acceptance of the effects of climate change within the local government sector. A major part of the local government work is conducted in conjunction with the International Council for Local Environmental Initiatives Australia/New Zealand through the Communities for Climate Protection™ – New Zealand programme. While primarily an enabling framework to assist councils to reduce greenhouse gas emissions, this is also an awareness-raising, capacity-building and monitoring programme.

[2] An emission unit is equivalent to one tonne of carbon dioxide equivalent.

The Resource Management Act has been amended to reflect the focus on nationally based policies to manage greenhouse gas emissions, rather than reliance on regional controls. The Act also now requires specific consideration to be given to renewable energy and the efficiency of the end use of energy. It is important to note that the Government's decision not to proceed with the announced carbon tax in December 2005 could affect the operation of the amended Resource Management Act. This issue will be addressed by Government officials in the new work programmes currently under development.

Bilateral climate change partnerships

New Zealand has established bilateral climate change partnerships with the United States of America and Australia. The partnerships enhance and accelerate collaboration and practical cooperation on climate change issues.

Projections and the total effect of policies and measures

The projections of greenhouse emissions sources and removals included in this *Fourth National Communication* conform to the definition of the "with measures" projection. Emissions and removals are projected for the energy, transport, industrial processes, agriculture, waste, and forestry (i.e., land use, land-use change and forestry, or LULUCF) sectors.

For domestic purposes, New Zealand updated its projected emissions and removals of greenhouse gases for the first commitment period (2008–2012) of the Kyoto Protocol in May 2005 *(Projected Balance of Units During the First Commitment Period of the Kyoto Protocol)*. The emissions calculation was consistent with the methodology used for the national inventory of greenhouse gas emissions and removals submitted to the United Nations Framework Convention on Climate Change Secretariat in April 2005. The May 2005 projected balance of units report remains the official reference for projections until updated in mid-2006.

However, for the purpose of submitting the best available information for the *Fourth National Communication* and the *Report on Demonstrable Progress under the Kyoto Protocol* as of December 2005, officials prepared a **provisional** update of the May 2005 projections to reflect the policy status following the 2005 review. **Therefore, the projections reported in the *Fourth National Communication* reflect the Government's decision not to proceed with the previously announced carbon tax, but do not reflect any impact from the new work programmes being considered by the Government at the time of publication.** The provisional projections reported in this document will be updated in mid-2006.

Given the above caveat, New Zealand's total emissions (excluding net removals from the forestry sector) are projected to rise to 82,431 Gg CO_2 equivalent by 2010 and 91,184 Gg CO_2 equivalent by 2020. These projections equate to an increase from the 1990 emissions of 20,910 Gg CO_2 equivalent (34 percent) in 2010 and 29,664 Gg CO_2 equivalent (48 percent) in 2020.

Emissions from the energy (including transport) and industrial processes sectors are projected to rise to 40,556 Gg CO_2 equivalent in 2010 and 46,071 Gg CO_2 equivalent in 2020, relative to the 1990 level of 26,806 Gg CO_2 equivalent. Emissions projections from the energy sector (excluding transport) are higher than reported in the *Third National Communication* for the 2005-2015 period, reflecting greater expected use of coal in power generation. In 2020, projected emissions are lower than reported in the *Third National Communication*. This reflects technological improvements that are expected to lead to a greater uptake of wind energy and lower use of coal in power generation. Transport sector emissions are projected to continue to grow rapidly reflecting the general growth of the New Zealand economy.

Emissions from the agriculture sector are also projected to increase over the period to 2020, with an increase to 40,476 Gg CO_2 equivalent in 2010 and 43,795 Gg CO_2 equivalent in 2020. These values represent increases of 25.7 percent and 36.0 percent over the 32,194 Gg CO_2 equivalent reported for 1990. The rate of growth in emissions from the agriculture sector is expected to decline due to the limitation on the increase in animal numbers or change in animal species balance, imposed by a finite potential agricultural land area and increasing competition from urbanisation and forest planting. The projection in this *Fourth National Communication* reflects the improvements in the inventory and now accounts for increasing animal productivity.

In the waste sector, methane emissions from wastewater are projected to increase with population over the next two decades; however, methane emissions from landfills are expected to be significantly below 1990 levels in first commitment period of the Kyoto Protocol (2008–2012) and continue to decline towards 2020. The landfill methane emission projections use the same methodologies as the national inventory but allow for population increase and increased recovery of landfill gas. Compared to the *Third National Communication,* this latest projection reflects changes in waste flow composition, reducing waste volumes per person, and increasing recovery rates.

Carbon dioxide removals by planted forests, emissions from forest harvesting and land conversion to forest land are projected using an assumed afforestation rate of 10,000 hectares per year. The projected annual planting rates of 40,000 and 60,000 hectares in the *Third National Communication* have not occurred, with new planting rates having fallen steadily since 2000. Net removals from the forestry sector (including methane and nitrous oxide emissions) are projected to decline from 21,366 Gg CO_2 equivalent removed in 1990 to 9,597 Gg CO_2 equivalent in 2010 and 4,397 Gg CO_2 equivalent in 2020. It is currently assumed that New Zealand's natural forests are a relatively stable carbon reservoir.

Vulnerability assessment, climate change impacts and adaptation measures

A low population density and related long-distance infrastructure, long coastline and varied geomorphology, and an economy reliant on the primary production sector make New Zealand vulnerable to climate hazards. Research and dissemination of findings on the impacts of climate change, vulnerability and adaptation options remain a high priority for New Zealand.

In May 2004, the Ministry for the Environment coordinated and published a national review, *Climate Change Effects and Impacts Assessment*. This document serves as a guidance manual for local government and includes extensive guidance and information on impacts assessments. A second major manual, *Coastal Hazards and Climate Change,* focuses particularly on coastal issues and provides guidance to local government on impacts and adaptation methodologies. Other reports have addressed issues of changes in the risk of flooding and drought.

The broad expected pattern of climate change effects in New Zealand is:

- increased temperatures (with greater increases in the winter season, and in the north of New Zealand)
- decreased frost risk but increased risk of very high temperatures
- stronger west–east rainfall gradient (wetter in the west and drier in the east)
- increased westerly winds
- increased frequency of extreme (heavy) daily rainfalls
- increased sea level.

The Government's approach to adaptation policy consists of a hierarchical set of legislation, guidance material on impacts assessment and the scoping of adaptation options, case studies, and underpinning information material. Current priorities in the climate change area are:

- dissemination of existing knowledge to end-users and stakeholders across central and local government and the private sector to support mainstreaming of adaptation into sector-specific assessment and decision-making processes
- economic assessments of the costs associated with climate change impacts and adaptation and residual costs
- improved climate modelling, particularly of water resources and extreme events including floods and droughts, at a range of scales.

Under the New Zealand approach to the management of natural resources and the risks from natural hazards, most concrete actions to address and minimise effects of climate change fall under the authority of local government (city, district and regional councils).

Planning to reduce the adverse effects of natural hazards is particularly important at the local government level because of the local effects the hazards or resources usually have, which may require locally distinct management and adaptation methods. Legislation including the Resource Management Act 1991, Civil Defence Emergency Management Act 2002 and the Local Government Act 2002 establish and support the responsibilities of local authorities for avoiding, minimising, and mitigating the costs and effects of natural hazards and managing natural resources.

Financial resources and transfer of technology

The Global Environment Facility is the international organisation entrusted with responsibility for operating the financial mechanism of the UNFCCC. New Zealand contributed NZ$12.13 million to the third replenishment of the Global Environment Facility (GEF3), which covers the years 2002 to 2006. In 2001, New Zealand joined with several other countries in a Political Declaration on Financial Support for Developing Countries. New Zealand's share of this voluntary commitment was assessed as NZ$5 million per annum from 2005.

New Zealand is particularly focused on helping to meet the concerns and needs of Pacific Island countries with financial resources and technology transfer to enable developing country Parties to implement the provisions of the UNFCCC, and for adaptation assistance. This is carried out primarily through the work of the New Zealand Agency for International Development (established in 2002) and also by contributing through various Global Climate Observing System-related initiatives in the Pacific region; for example, supporting initiatives to restore and upgrade the regional upper-air networks, produce a Pacific regional climate bulletin, recover historical climate data, and assist with capacity building in Pacific Island hydrological and meteorological services.

At the time of reporting this *Fourth National Communication*, the New Zealand Agency for International Development's environment policy is under preparation. In its current form, the draft policy recognises the significance of climate change for poverty elimination, particularly in the small island developing states of the Pacific region, and it stresses the importance of assisting with adaptation. The environment policy will also guide future engagement and funding allocations.

In the interim, the New Zealand Agency for International Development is assisting Pacific regional agencies in their development of regional policy, strategies, and partnership initiatives concerning climate change. Principal among these is the review and refinement of the Pacific Framework for Climate Change.

The transfer of environmentally sound technologies is largely undertaken by the private sector. The New Zealand Government has a role in facilitating technology development in New Zealand, including through the Technology for New Zealand initiative and other technology-related initiatives such as Research for Industry, and Grants for Private Sector Research and Development.

Research and systematic observations

New Zealand has continued to promote and collaborate in research and systematic observations, as required by Articles 4 and 5 of the UNFCCC. Estimated central Government expenditure on climate change-related research and systematic observations for the 2003/04 financial year is NZ$31.9 million. This represents an increase of NZ$10.9 million over the amount reported in the *Third National Communication*. This expenditure was complemented by an estimated NZ$0.1 million expenditure by regional government, and NZ$1.2 million by the private sector.

New Zealand is making a substantial input to the *Fourth Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC), by supporting one scientist as a member of the IPCC Bureau and providing convening lead authors for two chapters, and lead and contributing authors and review editors for several more chapters. New Zealand Government officials have participated in planning and other meetings related to the Group on Earth Observations and the Global Climate Observing System. The Government contracted the Meteorological Service of New Zealand to provide some assistance to a number of Pacific Island nations with their weather and climate observing systems.

The New Zealand Government operates a balanced portfolio of research that aims to address core national needs, to support areas of national research excellence, and to maintain and develop international linkages that ensure collaboration with international research programmes and the contribution to, and rapid uptake of, emerging new global technologies.

The current portfolio of climate change research has grown out of the work of the National Science Strategy Committee for Climate Change commissioned in 1991. In 2003, the Science Strategy Committee was disestablished and the responsibility for reviewing the strategy was transferred to the Ministry for the Environment. Additional input to strategic research directions comes from the Royal Society of New Zealand's Climate Committee.

The Government's Foundation for Research, Science and Technology is the dominant channel for central Government funding of strategic research and has the main responsibility for funding climate change research from public investment. Domestically, the Ministry for the Environment disseminates research findings on climate change, mitigation options and adaptation processes and methodologies. There is also direct funding of research in some climate change areas by core Government departments to meet operational and policy development needs and some research by local government to help develop community or regional policies. In the agricultural sector, the Government has joined with the private sector to form the Pastoral Greenhouse Gas Research Consortium to jointly fund research into reducing agricultural methane and nitrous oxide emissions.

Internationally, New Zealand exchanges data and information with other countries in line with the policies of the World Meteorological Organization to expand an archive of systematic atmospheric, oceanic and terrestrial observations based on the monitoring activities described in the *First, Second and Third National Communications.*

New Zealand established a climate change partnership with the United States to enhance dialogue and practical cooperation on climate change issues in 2002. A climate change partnership between New Zealand and Australia was announced in 2003. New Zealand is a member of the International Energy Agency and the International Partnership for the Hydrogen Economy and has observer status at the Carbon Sequestration Leadership Forum.

Education, training and public participation

In 2003, the Government agreed to a three-phase public awareness and education programme called "4 Million Careful Owners" to improve New Zealanders' understanding of the issues relating to climate change and initiate changes in behaviours that would assist in the reduction of greenhouse gas emissions. This decision followed extensive research that revealed a strong demand for greater public information and education about climate change and the issues involved. It was also clear from the research that New Zealanders wanted practical advice on what they could do to help reduce the effects of climate change.

The campaign has centred on one core brand, "4 Million Careful Owners," which comprises elements of inclusiveness, community, collective response and pride. The brand was specifically developed to have a life beyond the campaign and to be applicable for a range of environmental public education initiatives in the future. The campaign also features the call to action of "your country needs you," featuring New Zealanders telling their own stories and actions people can take to reduce greenhouse gas emissions.

As reported in the *Third National Communication,* a first round of public consultation on New Zealand's ratification of the Kyoto Protocol and domestic climate change policy options was undertaken in 2001. A second round of public consultation on New Zealand's ratification and more detailed domestic policy options for meeting its Kyoto Protocol emission-reduction target was undertaken in May 2002. Input from the second consultation was used in the formation of the confirmed policy package to address climate change announced in October 2002. As in the first round of consultation, this second round involved the wide distribution of consultation documents followed by nationwide meetings with the public, local government representatives, business and special interest groups, and hui with Māori. New Zealand school children were again involved in the consultation process with consultation kits sent to schools across the country. Following the 2005 review of climate change policy, a further series of consultation meetings was organised in early 2006 to discuss the outcome of the review. At the time of this publication, the Government anticipates further public consultation on climate change policy related to the work programmes currently under consideration.

A wide range of publications has been produced since the *Third National Communication* in 2001. These publications have included general information sheets on how to take action to reduce greenhouse gas emissions, booklets to help inform local government on how they can help prepare communities for climate change, case studies on projects people are undertaking in the community to reduce emissions, and publications explaining specific policy areas. A large number of climate change-related seminars and workshops have been held since the *Third National Communication*. In addition, the Communities for Climate Protection – New Zealand™ programme provides a strategic framework which assists councils and their communities to take action to reduce greenhouse gas emissions.

Chapter 1

Background

Greenhouse gases

Greenhouse gases trap warmth from the sun and make life on Earth possible. Without them, too much heat would escape and the surface of the planet would freeze. However, over the past 50 to 100 years, the concentration of the greenhouse gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) in the atmosphere has been increasing. Since 1750, the concentration of carbon dioxide has increased 31 percent, the concentration of methane has increased 151 percent and the concentration of nitrous oxide has increased 17 percent (Intergovernmental Panel on Climate Change, 2001, 4NC Figure 1). The increased concentration of these gases produces an "enhanced greenhouse effect" that decreases the amount of Earth's heat that is radiated back into space.

Increasing industrialisation over the past century is the major source of the increased concentration of greenhouse gases – carbon dioxide is released by burning fossil fuels such as coal, petrol and gas. They supply around 90 percent of the world's commercial energy needs. The carbon in these fuels, stored in the earth's crust over tens of thousands of years, is being released at a rapid pace. Other greenhouse gases like methane and nitrous oxide come from agricultural practices (cropping and livestock farming), waste disposal and industrial processes. The effects are made worse by the destruction of much of the world's forests, which reduces the amount of carbon dioxide absorbed from the atmosphere.

Climate change

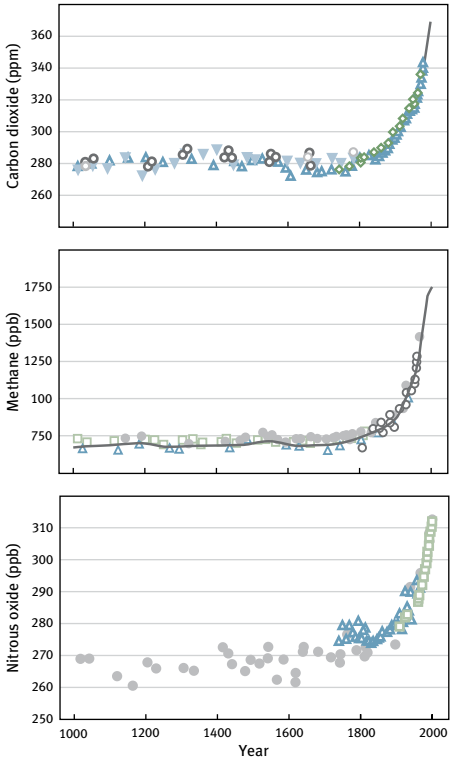
The Earth's climate has undergone many changes over millions of years – from ice ages to tropical heat and back again. Natural changes have generally been gradual, allowing people and other species to adapt or migrate, although some prehistoric climate changes may have led to mass extinction of species. With the enhanced greenhouse effect (commonly referred to as global warming), the process and pace of change have increased.

The effects on the climate due to the "enhanced greenhouse effect" will be different in different parts of the world (Intergovernmental Panel on Climate Change, 2001). However in general, temperatures and sea levels are expected to rise, and the frequency of extreme weather events such as droughts and floods is expected to increase. The changes ahead of us are expected to be larger and to happen more quickly than any recent natural climate variations.

The effects are already measurable; examples include:

- 2004 was the fourth warmest year globally since records began in 1861
- the period from 1995 to 2004 has seen nine of the 10 warmest years on record, with only 1996 not making the "top 10"
- average global temperature has gone up by about 0.7°C since the end of the 19th century
- sea levels increased by about 10 to 20 centimetres between 1900 and 2000
- glaciers are retreating
- Arctic sea ice is thinning and reducing in extent
- 1998 was the world's – and New Zealand's – hottest year since records began.

4NC Figure 1: Human emissions have caused a strong rise in greenhouse gases concentrations over the past 100 years



Note: In all graphs, symbols reference different data sets. The top figure reports variations in atmospheric CO_2 concentrations in Antartic ice cores. The middle and bottom figures report the change in CH_4 and N_2O abundance, respectively, determined from ice cores, firn and whole air samples.

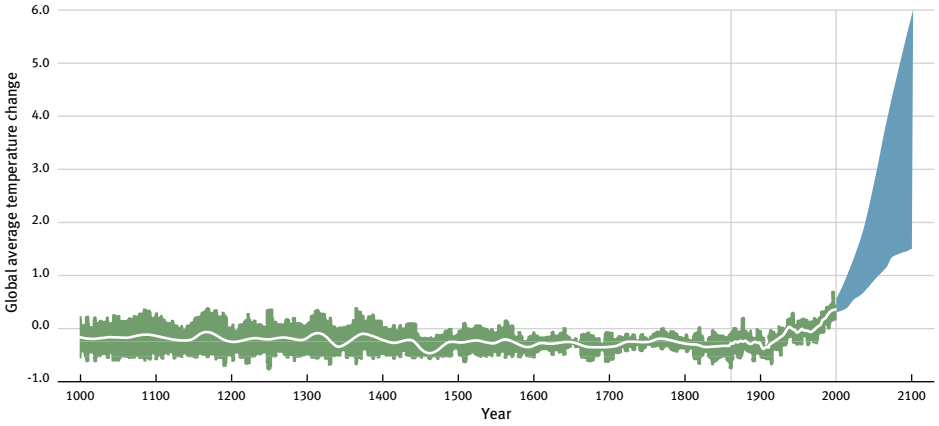
Source: Adapted from Intergovermental Panel on Climate Change (2001)

There has been debate in the past on whether humans were responsible for the observed climate change, or whether it was just a case of natural variability. Recent worldwide observations and complex climate models have produced new and stronger evidence that most of the warming observed over the past 50 years is, in fact, due to human emissions of greenhouse gases. This finding by the Intergovernmental Panel on Climate Change (IPCC) was also supported by the American Academy of Sciences.

As the Earth's temperature continues to rise, the weather is expected to become more extreme. Projections of future global temperature suggest rises range from 1.4°C to 5.8°C over the next 100 years, depending on future greenhouse gas emissions (4NC Figure 2). This will mean higher maximum and minimum temperatures, more hot days and heat waves, and fewer cold spells nearly everywhere. Rainfall patterns are likely to change, and the variability of rainfall is expected to increase.

This will lead to more frequent rain in some mid- and high latitude areas, but possible reductions in others. Large continental land areas will suffer from an increased risk of drought. Apart from gradual changes, extremely heavy rainfall could increase in severity and frequency. Tropical cyclone winds are likely to become more intense with heavier rainfall causing floods and property damage. Sea levels will continue to rise by between 0.1 metre and 1.0 metre by 2100, eroding coastlines and flooding low-lying areas. Sea levels will continue to rise for many more centuries, even after atmospheric temperatures have reached a new stable level.

4NC Figure 2: Historic and projected temperature trends



Note: The projected future temperature rise can be compared with the temperatures over the past 1,000 years or more, deduced from tree rings, corals, ice cores and bore holes. It shows that the changes over the next 100 years are projected to be more rapid than any natural climate variations experienced in the past.

Source: Adapted from Intergovernmental Panel on Climate Change (2001)

In some parts of the world, we can already see changes in response to the increasing temperatures, with shifts in the habitat range for some plants and animals, and earlier flowering of trees. Glaciers are receding worldwide, and seasonal snow and ice cover has decreased in northern high latitudes. The growing season in mid- to high latitudes has increased by up to 11 days over the past 30 years.

Over the next 100 years, the expected rate of change in global average temperatures is likely to be larger than any natural variations in at least the past 10,000 years.

Developing countries will be worst affected by changing climate patterns. Many have land areas that are particularly sensitive to change and prone to floods or drought, and few resources to cope with negative impacts. Coastlines in poorer countries are more vulnerable to flooding – 49 of the 50 countries whose shore protection costs are likely to rise substantially are less developed countries.

Agriculture plays a larger part in the economies of developing countries, which makes them more vulnerable to climate extremes, and poorer nutrition and health care will mean higher loss of life. Many developing countries are also less able to adapt quickly to changes in climate because of a lack of technology, education, infrastructure and money.

International response: The United Nations Framework Convention on Climate Change (UNFCCC)

In 1990, the IPCC concluded that human-induced climate change was a threat to our future. In response, the United Nations General Assembly convened a series of meetings that culminated in the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) at the Earth Summit in Rio de Janeiro in May 1992. The UNFCCC took effect on 21 March 1994 and has been signed and ratified by 188 nations, including New Zealand.

The main objective of the UNFCCC is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (caused by humans) interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

All countries that ratify the UNFCCC are required to address climate change through national or regional programmes to prepare for adaptation to the impacts of climate change, protect and enhance sinks (for example, forests), monitor emissions trends via greenhouse gas inventories and provide financial assistance to developing countries. Developed countries agreed to non-binding targets to reduce greenhouse gas emissions to 1990 levels by 2000.

International response: The Kyoto Protocol

The international community recognised that the UNFCCC alone was not enough to ensure greenhouse gas levels would be reduced to safe levels and that more urgent action was needed. In response, the First Conference of the Parties to the UNFCCC (COP1) launched a new round of talks for stronger and more detailed commitments for Annex I countries (that is, developed countries and countries with economies in transition). After two-and-a-half years of negotiations, the Kyoto Protocol was finalised in Kyoto, Japan on 11 December 1997. New Zealand ratified the Kyoto Protocol on 19 December 2002. The Protocol came into force on 16 February 2005.

The Kyoto Protocol shares the UNFCCC's objectives, principles and institutions, but significantly strengthens it by committing Annex I Parties to individual, legally-binding targets to limit or reduce their greenhouse gas emissions. Only Parties to the Convention that have also become Parties to the Protocol, by ratifying, accepting, approving, or acceding to it, are bound by the Protocol's commitments. Article 3 of the Kyoto Protocol states that the Parties that ratify the Protocol shall individually or jointly ensure that their aggregate anthropogenic greenhouse gas emissions do not exceed their "assigned amounts" with a view to reducing their overall emissions by at least five percent below 1990 levels in the first commitment period (2008–2012).

The "assigned amount" is the maximum amount of emissions (measured as the equivalent in carbon dioxide) that a Party may emit over the commitment period in order to comply with its emissions target. New Zealand's assigned amount is its gross[3] emissions in 1990 multiplied by five (that is, the five years of the commitment period). New Zealand has to take responsibility for any emissions in excess of its assigned amount.

To achieve their targets, Annex I Parties must put in place domestic policies and measures to address emissions. Emissions may also be offset by increasing the amount of greenhouse gases removed from the atmosphere by carbon "sinks" in the land use, land-use change and forestry sector. The Kyoto Protocol also defined three "flexibility mechanisms" to lower the overall costs of achieving its emissions targets – the clean development mechanism, joint implementation, and emissions trading. These mechanisms enable Parties to access cost-effective opportunities to reduce emissions or to remove carbon from the atmosphere in other countries. While the cost of limiting emissions varies considerably from region to region, the benefit for the atmosphere is the same, wherever the action is taken.

Reporting under the UNFCCC and Kyoto Protocol

Under the UNFCCC (and the Kyoto Protocol), New Zealand is required to report a greenhouse gas inventory on an annual basis, and a national communication on a less frequent basis, the frequency being determined by the Conference of the Parties. New Zealand's *Third National Communication* was submitted to the UNFCCC in 2001 and underwent an in-depth review by an international team between May and November 2002, including an in-country visit from 23 to 28 June 2002. The main findings of the team's report (FCCC/IDR.3/NZL), published in March 2003, are contained in Box 1.

This is New Zealand's *Fourth National Communication* and is based on the revised guidelines for national communications from Annex I Parties adopted at the Fifth Conference of the Parties to the UNFCCC (FCCC/CP/1999/7). The *Fourth National Communication* reports on New Zealand's progress towards meeting its commitments under the UNFCCC since the end of 2001, and preparations for the first commitment period under the Kyoto Protocol.

[3] Gross emissions do not include emissions and removals from the land-use, land-use change and forestry sector (LULUCF).

Box 1: In-depth review of New Zealand's *Third National Communication*

The report on the in-depth review of New Zealand's *Third National Communication* noted the following:

- New Zealand broadly met the UNFCCC guidelines for national communications.
- Improvements in reporting had been made compared to the *Second National Communication,* particularly concerning information on greenhouse gas inventories and policies and measures.
- Presentation of information in the national communication could benefit from closer adherence to the UNFCCC guidelines, especially in projections, and policies and measures chapters.
- More analysis could be provided on the factors underlying the historical and future emission trends; such analysis is essential in the context of policies and measures where the monitoring of their effects could be given more attention.
- Although some of the policies may have helped slow the growth in emissions, the effect of these policies was outweighed by the growth in emissions from transport and energy use in industry.
- Other possible reasons for the emissions being higher in 2000 than in 1990 may include insufficient funding of the 1994 policy package, deferment of the consideration and introduction of the carbon charge envisaged in the package, and a reliance on voluntary approaches which did not fully achieve the outcome expected.
- The scale of activities, ambitious timetable and targeted approach the Government had adopted in preparing for the ratification of the Kyoto Protocol was acknowledged with appreciation.
- Also acknowledged was the role of the preferred policy package as a major step forward in the development of an integrated climate change strategy, in which both mitigation and adaptation are taken into account.
- Without the preferred policy package it will be difficult for New Zealand to reach its target under the Kyoto Protocol.
- The role of the National Energy Efficiency and Conservation Strategy was noted. It was also noted that the joint efforts of the Energy Efficiency and Conservation Authority and energy authorities could help to use the potential of non-traditional renewable sources, such as solar and wind energy, which could make a greater contribution to the already high share of renewables in the energy mix.
- New Zealand's efforts to fill key information gaps and uncertainties arising from estimates of carbon in the land-use change and forestry sector were commended, and the importance of this ongoing monitoring for domestic policy purposes and international reporting was noted.

Chapter 2

National circumstances

Geography

New Zealand consists of two large islands (the North Island and the South Island) and a number of smaller islands located in the south-west Pacific Ocean between 33° and 55° south latitude. New Zealand has a combined land area of 27 million hectares, similar in size to Japan or the United Kingdom. New Zealand's Exclusive Economic Zone is vast with the marine area covering 14 times the land area.

New Zealand is 1,600 kilometres long and spans 450 kilometres at its widest point. At 11,500 kilometres, it also has one of the longest and, in some places, most deeply indented coastlines in the world. The country straddles the boundary of the Pacific and Indo-Australian tectonic plates and is well-known for its active volcanoes, geothermal areas, and frequent earthquakes.

Mountains dominate much of the New Zealand landscape; more than three-quarters of the land area is higher than 200 metres above sea level. One obvious consequence of the intense mountain building in New Zealand's past is the deeply dissected landscape carved by numerous steep, fast-flowing rivers.

Population

New Zealand has a population of 4.1 million. The population is expected to reach 5 million by 2041. There are about 15 people per square kilometre in New Zealand; this compares with Japan (340 people per square kilometre) and the United Kingdom (249 people per square kilometre), countries of similar land area.

One-third of the population is resident in the Auckland region and three-quarters of all New Zealanders live in the North Island. The fastest growing cities are Tauranga, Manukau, and Hamilton – all in the North Island. Seventy-eight percent of New Zealanders live in urban centres of 10,000 or more inhabitants, with four centres – Auckland, Hamilton, Wellington, and Christchurch – together being home to just over half the total population.

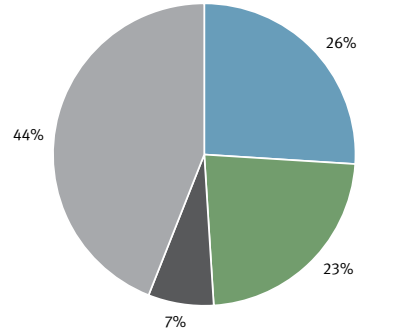
New Zealand has an ageing population. The 65 years-and-over age group grew by over 17 percent from 1994–2004, and now constitutes 12 percent of the total population. By 2051, 26 percent of the population is projected to be over 65. In 1971 the median age in New Zealand was 26, in 2004 it had reached 35 and by 2051 it is projected to be 46 years. The major factors behind this shift in population age structure are decreases in fertility, increases in longevity, and the ageing of a large post-World War II cohort. Increases in New Zealand's population are often attributed to in-migration; in 2004, 22,000 people immigrated to New Zealand.

Land use and land cover

Agriculture dominates land use in New Zealand, accounting for over 45 percent of total land use (4NC Figure 3). While the area under grazing, arable fodder, and fallow land has declined over the 1990s there has been a rapid growth in the area under horticulture. Despite this growth, horticulture accounts for only one percent of the agricultural land area. Most New Zealand agriculture is based on extensive pasture systems with animals grazed outdoors year-round.

There are 66,000 economically sustainable farms in New Zealand. Of this figure, about 44,000 are in the North Island and 22,000 in the South Island. In addition there are up to 120,000 small holdings in New Zealand that are part-time ventures, lifestyle properties or forestry investment blocks.

4NC Figure 3: Land use in New Zealand



Source: Statistics New Zealand (2004)

Indigenous forests occupy 6.256 million hectares, of which 5.187 million hectares are owned by the Crown. The vast bulk of the Crown resource is managed for its conservation values. It comprises 14 national parks and other conservation areas. A further 1.069 million hectares of natural forest are privately owned; half by Māori.

New Zealand also has a commercial planted forest resource, managed as a crop rather than a natural ecosystem. As at 1 April 2003, there were 1.8 million hectares of sustainably managed planted forest in New Zealand. These forests are planted with tree species introduced to New Zealand; the predominant species is *Pinus radiata*.

The early 1990s saw a significant expansion in the area of commercial planted forests due to many factors working in combination, including positive long-term market prospects, the current taxation regime, and the Government's commitment to removing unreasonable impediments to forestry and wood processing.

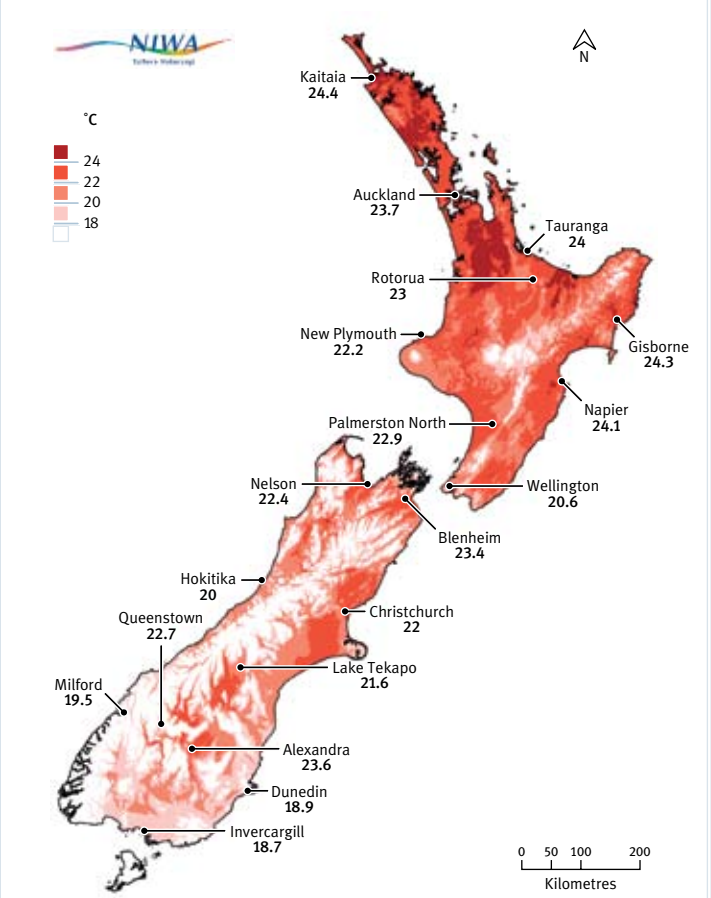
More recently, plantings of commercial forests have declined to historic lows. Prices received for logs have dropped due to a relatively strong New Zealand dollar, substantial increases in shipping costs, and tough international market conditions. Additionally, land prices have risen due to competition from alternative uses such as agriculture (largely dairy) and people buying larger home plots known as lifestyle properties.

Climate

As a long, narrow, mountainous country with the nearest large land mass (Australia) more than 2,000 kilometres away, New Zealand's climate is largely influenced by its location in a latitude zone with prevailing westerly winds, the surrounding ocean and the mountain chains that modify the weather systems as they sweep eastward. All these factors contribute to New Zealand having more variable weather compared to continental countries. Many parts of the country are affected by extremes of wind and rain, which, from time to time, cause considerable damage. 4NC Figure 4 shows sunshine hours, rainfall, and maximum and minimum temperatures across the whole of New Zealand.

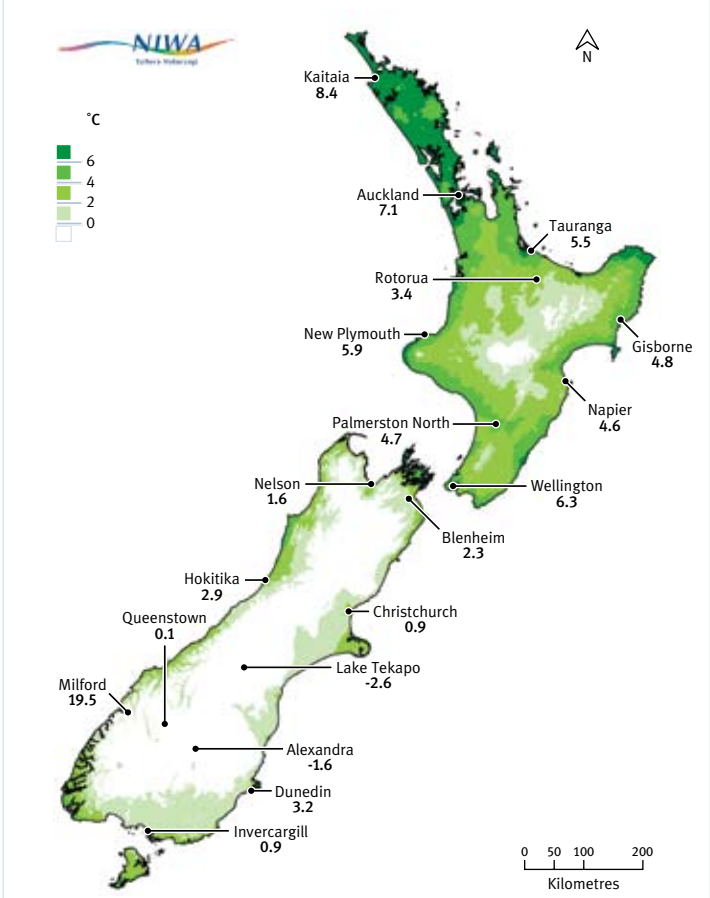
New Zealand climatic conditions

4NC Figure 4.1: Maximum temperature (mid-summer daily average)



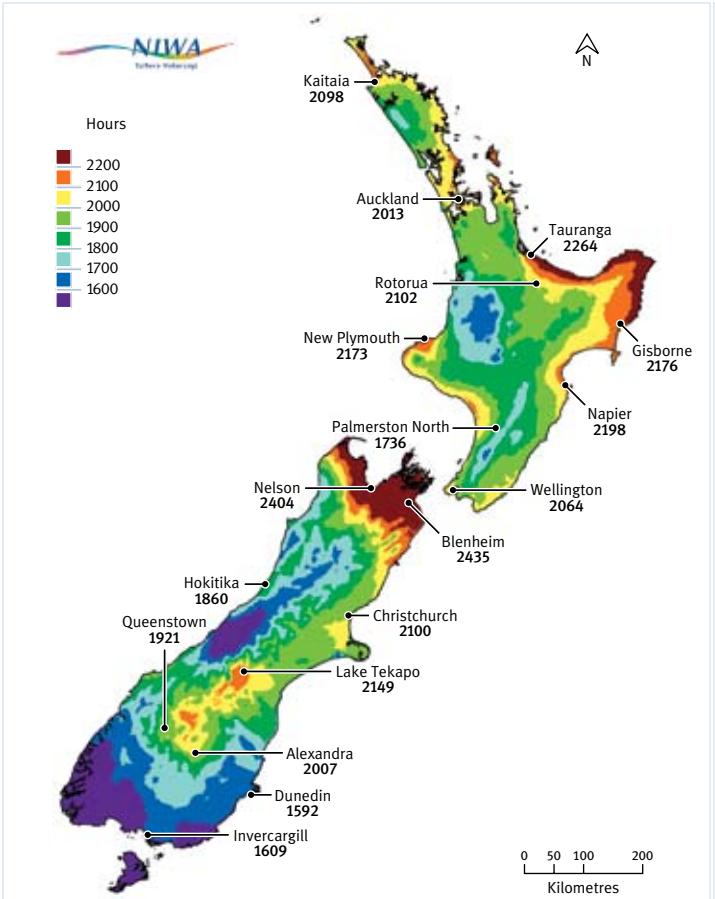
Source: NIWA (2005)

4NC Figure 4.2: Minimum temperature (mid-winter daily average)



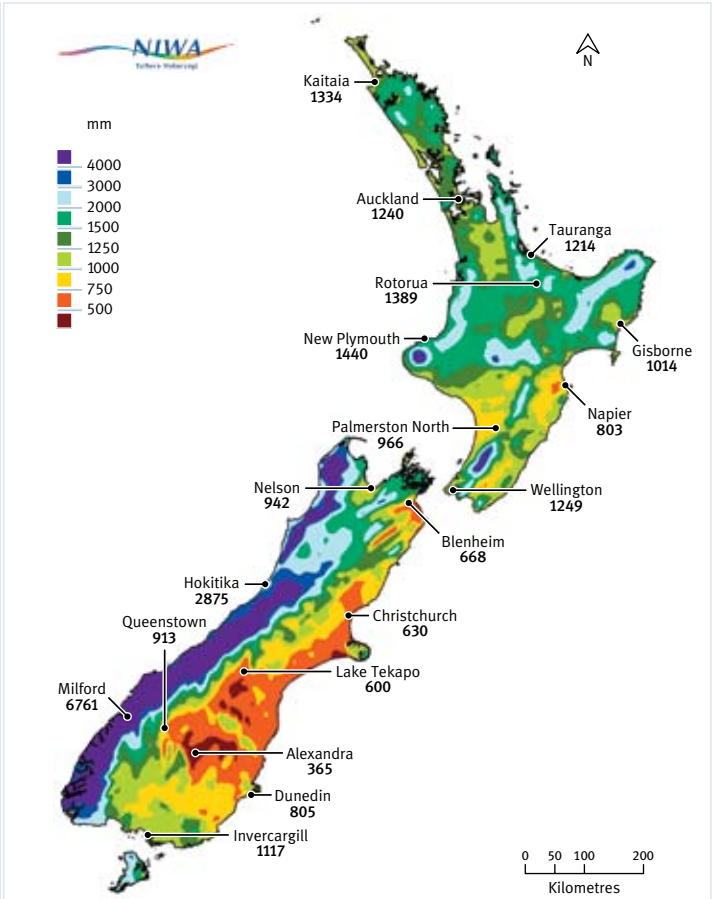
Source: NIWA (2005)

4 NC Figure 4.3: Sunshine hours (annual average)



Source: NIWA (2005)

4NC Figure 4.4: Rainfall (annual average)



Source: NIWA (2005)

Government structure

Central Government

New Zealand is a parliamentary democracy. There is one elected House of Representatives. The principal functions of Parliament are to enact laws, scrutinise the Government's administration, and approve the Government's allocation of tax income. Since 1996 Members of Parliament have been elected using the mixed member proportional representation system. There are currently eight political parties with parliamentary representation.

The executive arm of Government negotiates and takes binding treaty actions on behalf of New Zealand. All multilateral and some bilateral treaties are subject to a Parliamentary treaty examination process prior to binding treaty action, such as ratification or accession. This provides the House an opportunity to consider treaties.

The Government's financial year operates from 1 July to 30 June; the commercial financial year operates from 1 April to 31 March.

Local government

New Zealand has a system of 86 local authorities that, due to devolved decision-making, are largely independent of the central executive Government. Local authorities fall into two main categories, namely regional and territorial authorities. They have their own sources of income independent of central Government, including taxes on land and property, and council-owned enterprises.

The purpose of the Local Government Act 2002 is for local government to promote the social, economic, environmental and cultural well-being of communities and to enable democratic decision-making. A sustainable development approach and community planning are cornerstones of the Local Government Act, with its requirement to consult communities on their desired outcomes and prepare Long Term Council Community Plans. Activities of local government include provision of utility services, recreation assets, transportation services and land management.

Local authorities have primary responsibility for regulating resource use in New Zealand. The mandate for this is governed by a range of legislation, but in particular the Resource Management Act 1991. The Resource Management Act integrated the provisions of more than 75 earlier laws and is founded upon the principle of sustainable management of natural and physical resources. The use of the Resource Management Act in relation to climate change issues is covered in the chapter on policies and measures.

Economic profile

New Zealand has an open market-based economy with sizeable manufacturing and services sectors complementing a highly efficient export-oriented agricultural sector. Together, the agriculture and forestry sectors contribute 6.7 percent of New Zealand's gross domestic product (GDP). Energy-based industries (including dairy processing, and cement and steel manufacturing), forestry, mining, horticulture, and tourism have expanded rapidly over the past two decades.

New Zealand's economic performance improved significantly over the 1990s. From mid-1991, the economy grew strongly, with particularly buoyant output growth between 1993 and 1996. However, the latter half of 1997 and early 1998 saw the economy slip into recession with the joint impact of the Asian economic downturn and a summer drought occurring at the same time as the economy was slowing. The following year saw a recovery in broad-based growth, with the economy growing 4.4 percent in the 1999 calendar year and 3.5 percent in 2000. Economic growth slowed over 2001 as these supporting factors unwound, but rebounded through 2002 on the back of high world commodity prices, a low exchange rate and a robust labour market.

Real GDP over the year ended March 2004 was $NZ137.8 billion ($US84.5 billion). Recent economic growth has been strong, averaging 3.6 percent over 2004 and 4.6 percent over the previous year. This makes New Zealand currently one of the faster growing economies in the Organisation for Economic Cooperation and Development (OECD).

Real GDP per capita in 2004 was $US20,995. Growth in per capita incomes has averaged 2.1 percent over the past five years.

Exports of goods and services comprise over 30 percent of New Zealand's GDP. Australia, North America, the European Union and East Asia each take between 15 percent and 30 percent of New Zealand's exports. New Zealand remains reliant on exports of commodity-based products as a main source of export receipts and relies on imports of raw materials and capital equipment for industry. Key merchandise exports include dairy products, meat, wool, aluminium, iron and steel, and wood products.

New Zealand's economy has diversified over recent years, with the significance of the service sector relative to primary production and manufacturing continuing to grow. Some service sector industries, such as tourism, are likely to continue to expand. However, pastoral agriculture and commodity exports will remain important to the country.

Agriculture

The agriculture sector is New Zealand's largest export earner, earning 53 percent of New Zealand's total merchandise export value in the year to June 2004. When exports of services are included, the dairy industry alone (which is the single largest merchandise export industry) is not far behind tourism in its claim to be New Zealand's largest total export earner. New Zealand is the world's largest single-country exporter of dairy products and sheep meat, has the world's most profitable kiwifruit industry, and is a significant player in other areas such as pip fruit and wool.

From 1984, the Government's commitment to economic liberalisation, including the removal of most agricultural support, has impacted on agriculture by shifting production away from sheep to dairying, deer, and horticulture (fruit, vegetables, and vines), and shifting land use from pastoral land to forestry. As a result, from the early 1990s to the present, dairy cow numbers expanded by over 50 percent, deer numbers expanded by more than 65 percent, the area under horticulture and grape vines rose by over 20 percent, and forestry plantations increased by 40 percent. Over the same period, sheep numbers declined by 28 percent. Total annual nitrogen fertiliser use has increased by a factor of approximately six between 1990 and 2003 with phosphate fertiliser use remaining relatively static.

Agricultural productivity has improved substantially over the past fifteen years as a result of technological change; improved animal husbandry and breeding; effective targeting of investment, cost cutting, and efficiency gains; and scale economies through the expansion of the average size of farms and orchards.

The significant contribution from irrigated agriculture to the economy occurs via a range of land uses that, on average, are more productive than dryland production systems. Modern irrigated farming systems produce a wider range of higher-value crops and products that satisfy the quality and quantity demands of consumers. This is in contrast to the use, in the past, of irrigation primarily as a drought mitigation tool. However, irrigation is going to become a more important tool in the future with a projected increase in the incidence and severity of drought, particularly in eastern regions of New Zealand.

Forestry

New Zealand's timber industry is now based almost entirely on planted forests, which cover 1.8 million hectares, or 6.6 percent of New Zealand's land area. The timber industry has changed progressively over the past four to five decades from reliance on logging of indigenous forests, to the use of planted (exotic) forests first established in the 1920s. It is these planted forests that have enabled New Zealand to put so much of its indigenous forests into permanent reserves.

In 1990, forestry contributed 9.5 percent of merchandise export income. By 1995, that figure had increased to 13.1 percent. Today, as dairying, horticulture, and meat industries enjoy better times, forestry's contribution to export earnings has slipped to 11.3 percent of the total, but it remains the third largest merchandise export earner for this country and an essential and major contributor to earnings. The new planting rate, often a measure of the confidence in the forest industry, has fallen steadily from a peak of over 90,000 hectares in 1994 to around 10,600 hectares in 2004. This has occurred for a number of reasons, including competition for land with other uses such as agriculture, exchange rate movements, and the international market situation for forestry products.

In the early 1990s, when the prospect of a rapid increase in availability of timber from maturing planted forests, termed the "wall of wood," was first raised, the national harvest was just over 11 million cubic metres per annum, of which exports (in roundwood equivalent terms) were 6 million cubic metres. At the time it was considered that the timber supply would double over 10 years, with the harvest then growing to some 30 million cubic metres per annum by the year 2010. In 2000, the annual harvest had indeed nearly doubled as predicted to 19.1 million cubic metres, and by the year ended June 2004 the annual harvest was 20.4 million cubic metres of which 14.5 million cubic metres (in roundwood equivalent terms) were exported. The industry is currently forecast to achieve the predicted 30 million cubic metres per annum by 2012–2014, two years behind the original timing.

New Zealand is a small player in the international forestry market, accounting for 1.1 percent of the world's total supply of industrial wood and 1.3 percent of the world's trade in forest products. In comparison, Canada accounts for 18.8 percent, Sweden 8.2 percent, Russia 2.2 percent, and Chile 1.1 percent of trade.

Support for agriculture and forestry

Government support to agriculture is the lowest in the OECD. Agricultural producer support fell from a peak of over 30 percent of farm receipts in the mid-1980s to two percent in 2001–2003 (as measured by the OECD's producer support estimate) compared to the OECD average of 31 percent. New Zealand's agricultural and forestry producers do not receive price or production subsidies from the Government. Therefore, their incomes are directly influenced by the changes in international prices, exchange rates, market conditions, and other external and domestic factors. Support to agriculture is mainly directed at research, pest and disease control, agri-environmental measures, and climatic disaster relief. The only direct support for forestry is for land stabilisation planting on confined areas of the erosion-prone East Coast of the North Island, and for forestry research which includes research on biosecurity, pest, and disease control.

Energy

New Zealand is largely an importer of oil and oil products. The country's only oil refinery, at Marsden Point, is owned jointly by four oil companies and produces about 68 percent of New Zealand's oil-based fuels. There is also significant direct importing of refined products.

The gas industry is in private ownership. Gas is reticulated in the North Island only. A process of setting in place new governance arrangements for the wholesaling and distribution of gas was started with the establishment of the Gas Industry Company in December 2004. This body is currently developing systems and processes to meet the Government's requirements for the industry.

The electricity industry has gone through a long process of reform with competition in the generation sector first being introduced in 1996. Electricity is sold by generators and bought by retailers and direct (large industrial) users under governance rules that came into force in March 2004. The generation sector is dominated by five major firms, of which three are state-owned enterprises. The national distribution grid is operated by Transpower, also a state-owned enterprise, and there are a number of local distribution networks with a variety of ownership structures. Energy retailers, which were separated from the distribution companies in 1998, are a mix of independent firms and generators. The market is regulated by the Electricity Commission, which also has a mandate to promote efficiency initiatives.

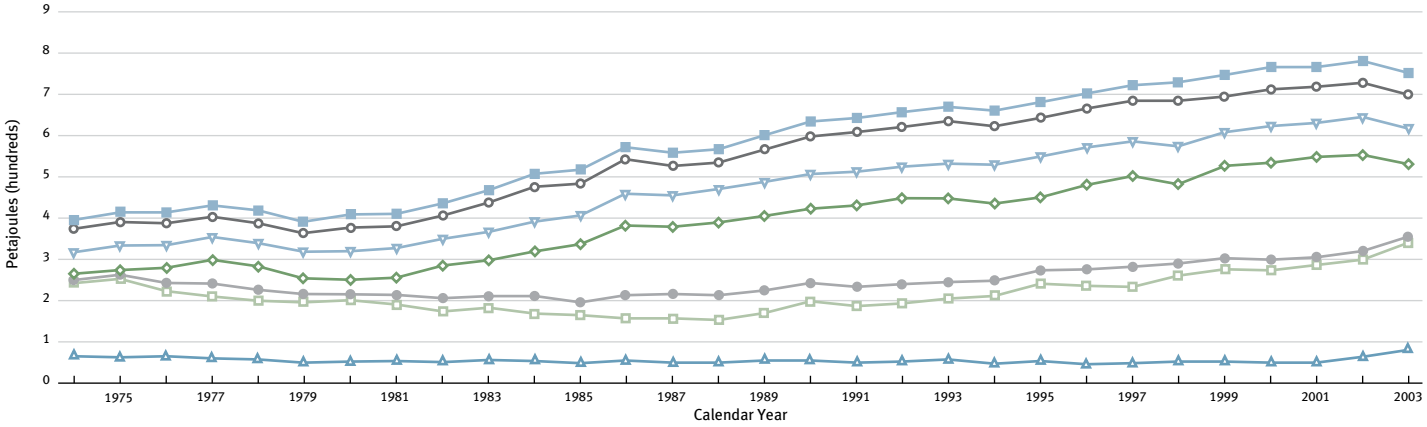
Solid Energy, a state-owned enterprise, produces about 80 percent of New Zealand's coal with the rest being mined by smaller private firms. About 40 percent of New Zealand-produced coal is exported.

There are no subsidies for energy in New Zealand, with the possible exception of publicly-funded research both on renewables and fossil resource assessment and exploration.

Primary energy supply

New Zealand is currently self-sufficient in electricity and gas, and is a net exporter of coal. In 2003, New Zealand's primary self-sufficiency in oil was 24 percent. Imported oil was mainly from Australia, Brunei, Saudi Arabia, United Arab Emirates, Oman, Malaysia, Qatar, and Yemen. Total primary energy supply between 1974 and 2003 is shown in 4NC Figure 5. Energy supply by fuel type in 2003 is shown in 4NC Figure 6.

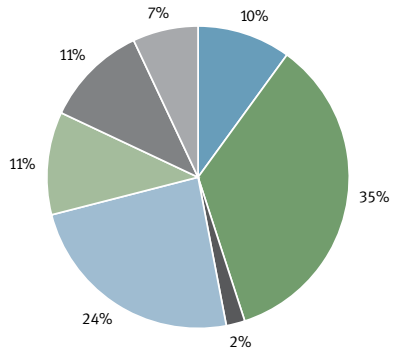
4NC Figure 5: Total primary energy supply by fuel 1974 – 2003



Coal (net)
Gas
Geothermal
Imported oil and oil products
Hydro
Other renewables
Indigenous oil (net)

Source: Ministry of Economic Development (2005)

4NC Figure 6: Total primary energy supply by fuel 2003



Source: Ministry of Economic Development (2005)

Electricity

New Zealand's electricity generation is dominated by renewable sources (4NC Figure 7), with hydroelectric power producing around 60 percent of annual generation (depending on rainfall). Geothermal makes up around 7 percent with smaller contributions from other renewable sources such as biogas, waste heat, wood, and wind. The balance is made up of fossil fuel generation, predominantly gas, but with coal making an increasing contribution.

The electricity industry has four main components:

- Generation – there are five large generating companies (three state-owned enterprises[4] and two private sector companies) and some smaller generation, most of which is associated with major industrial processes ("cogeneration"). At present, New Zealand has adequate generating capacity to meet its electricity requirements. Industry participants have committed to a range of additional generating capacity in coming years to meet growing demand, particularly gas, geothermal, and wind generation. Some new coal generation developments are also being investigated, including re-powering of an existing decommissioned station. New large-scale hydroelectric developments appear to be increasingly unlikely for economic and environmental reasons, although there is still an opportunity for small-scale, niche developments.
- Transmission – Transpower (a state-owned enterprise) owns and operates the national electricity transmission system.
- Distribution – there are around 28 distribution ("lines") companies that own the local distribution networks throughout New Zealand. The ownership of distribution companies is a mix of public listings, shareholder cooperatives, community trusts, and local body ownership, with most lines companies being owned by trusts.
- Retail – retailers compete to meet consumers' electricity needs. They provide a bundled service for most consumers by purchasing electricity at wholesale (spot and contract) prices from the generator companies and transmission/distribution services from distribution companies. There is a high degree of vertical integration between generation and retail in New Zealand, with the main retail companies also being the generators. Retail prices are set in a competitive market but include the cost of various safety and administrative levies on the industry, as well as levies to cover the cost of regulation by the Electricity Commission (which regulates the operation of the industry and markets – see next page) and the Commerce Commission (which regulates transmission and distribution businesses).

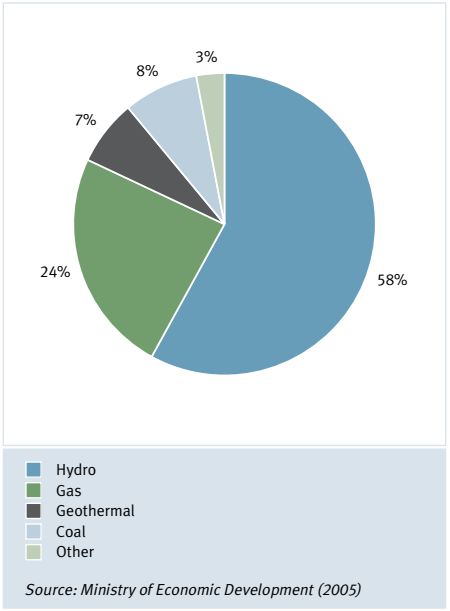
[4] While owned by the Government, state-owned enterprises have the legal authority and operational freedom to make commercial decisions in accordance with their Statement of Corporate Intent. Ministers do not have a role in their day-to-day operating decisions.

In September 2003, following the inability of the electricity industry to establish an integrated self-governance regime, the Government established an Electricity Commission to take responsibility for governance and regulation of the New Zealand electricity industry under the Electricity Act 1992. The Commission regulates the operation of the electricity industry and markets, to ensure electricity is produced and delivered to all consumers in an efficient, fair, reliable and environmentally sustainable manner. The Commission also promotes and facilitates the efficient use of electricity.

The Commission has extensive powers to regulate to achieve its aims, although before introducing new regulations the Commission consults widely with stakeholders and uses influence to seek mutual solutions.

The Parliamentary Commissioner for the Environment is required under the Electricity Amendment Act 2001 to assess the environmental performance of New Zealand's electricity sector. In particular, this assessment is to focus on the performance of the Electricity Commission against its required outcomes.

4NC Figure 7: Electricity generation by fuel type 2003



Source: Ministry of Economic Development (2005)

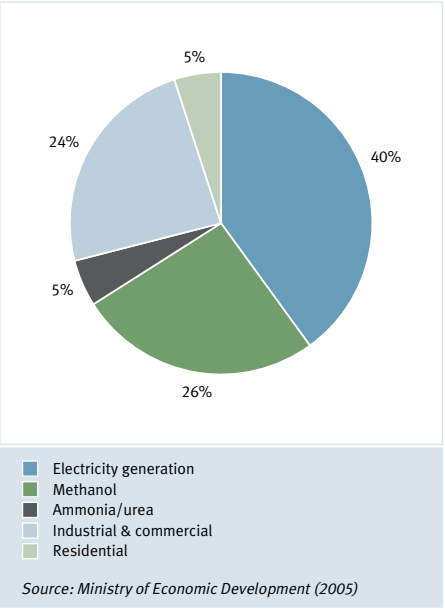
Gas

The gas sector in New Zealand is made up of six main producers, two main transmission lines companies, five distribution networks, and nine gas retailers, providing gas to commercial or residential customers, or to both. There is, however, a large degree of cross-ownership between and within these functions. Prices of gas throughout the supply chain are essentially set by contract.

In October 2004, the Government finalised its desired objectives and outcomes for the industry and amended the Gas Act 1992 in line with these objectives. A co-regulatory body was established to provide recommendations to the Government on how these objectives will be met. The Government has legislated for the establishment of a Crown regulatory body if the industry-led co-regulatory approach does not proceed in a timely manner.

In 2003, gross gas production in New Zealand equated to 190 petajoules. Around 130 petajoules were produced by the Maui field, 60 petajoules less than in 2002. At 2003 production levels, proven and probable New Zealand gas reserves would last a further 11 to 12 years (although it is worth noting that gas production has fallen since 2003). 4NC Figure 8 shows that electricity generation is the most significant use category of gas in New Zealand.

4NC Figure 8: Gas use by sector
September year ending 2004



Source: Ministry of Economic Development (2005)

Oil

Current New Zealand crude oil, condensate, and naphtha production all comes from onshore and offshore fields in the Taranaki region. Indigenous crude oil and condensate production in 2003 was just under 50 petajoules, down from a peak of around 120 petajoules in 1997. This equates to under a quarter of total refinery intake. At current rates of extraction, known recoverable reserves are estimated to last another six to seven years.

Coal

Coal production in 2003 was about 5.2 million tonnes. Around 43 percent of this was exported. An increasing quantity of coal is being imported for electricity generation. The major end uses of coal in the year to September 2004 were electricity generation (50 percent), basic metal manufacturing (21 percent), other industries (17 percent) and commercial use (eight percent). It is estimated that New Zealand has around 8.6 billion tonnes of economically recoverable coal, 80 percent of which is relatively low-grade lignite.

Residential energy use

Currently in New Zealand there are around 1.6 million dwelling units. In 2003 there were around 2,000 houses demolished and 30,000 new houses built. The rate of new buildings is strongly dependent on immigration and household composition changes and is expected to drop slightly in the short term.

About 1.05 million houses were built before 1977 when thermal insulation was made mandatory. From Building Research Association of New Zealand surveys, it is estimated that about 650,000 pre-1977 houses have been retrofitted with ceiling insulation to the 1977 requirements. About 18 percent of existing houses have been retrofitted with hot water cylinder insulation wraps.

The percentage of double glazing supplied to the residential glazing market in New Zealand has risen from 9 percent in 1994 to 23 percent over 10 years. Of the consented residential glazing undertaken in 2004, 69 percent of the South Island market consisted of double glazing.

Transport

The nature of New Zealand's transport system has been influenced by the distribution of the small population over the two main islands. New Zealand's remoteness from many of its trading partners requires extensive use of shipping and, more recently, air transport.

Transport accounts for roughly five percent of GDP; road transport accounts for 3.3 percent. The road transport industry employs three percent of New Zealand's workforce. As with other developed countries, transport in New Zealand is energy intensive with a reliance on fossil fuels.

Road transport

There are around 92,800 kilometres of formed roads in New Zealand.[5] Transit New Zealand is the Government agency responsible for the management, maintenance and further development of the 10,800 kilometres which make up the state highway network. Local councils are responsible for the remaining 16,600 kilometres of urban local roads and 65,400 kilometres of rural local roads.

New Zealand has one of the highest rates of car ownership in the world. For a population of just over four million, there are around 3.6 million registered vehicles on New Zealand's roads, 69 percent of which are passenger motor vehicles. In the 2004 calendar year 234,100 cars entered the fleet from overseas, 154,042 of which were used imports. The average age of used imported vehicles is around eight to nine years. New Zealand roads carry about 37 billion vehicle kilometres of traffic every year.

Rail

The national rail network totals approximately 4,000 kilometres. Urban rail networks exist in Wellington and Auckland and provide approximately 12.3 million passenger trips annually, of which approximately 10 million trips are in Wellington and 2.4 million in Auckland.

The Government was the sole owner and operator of virtually all of New Zealand's rail infrastructure, passenger and freight operations until 1993 when the rail network and operations were sold to Tranz Rail Holdings Limited. (Toll Holdings took over as majority shareholder from 2003 and renamed the company Toll NZ.) The Government retained ownership of the land on which the rail assets were situated and leased the land to the rail operator.

In 2004, the Government re-purchased the national rail network (that is, the rail track). There had been low and declining investment in the rail network during the private ownership, with resulting problems with deferred maintenance, safety and declining service capability.

A National Rail Strategy has now been produced (May 2005) that outlines how the Government will ensure that the rail network is maintained and developed.

Maritime transport

Over 99 percent by volume of New Zealand's exports and imports are carried by sea (85 percent by value for exports and 75 percent by value for imports). The vast majority of this is carried by about 30 overseas shipping companies.

There are 13 commercial ports in New Zealand servicing international and domestic cargo trades and passenger transport. All port companies are majority-owned by local government, although six are partly privatised.

In the 2003/2004 financial year, around 8.6 million tonnes of coastal cargo were carried between New Zealand's commercial ports – 54 percent being containerised cargo.

[5] Figures taken from Transfund New Zealand *Annual Report 2003/04*.

Local operators, using mainly "roll-on roll-off" vessels, link Wellington, Auckland, Nelson, Lyttelton and Timaru and other ports as required. There are also specialist vessels operating around the New Zealand coast: livestock carriers, tugs, cement carriers and also oil tankers servicing New Zealand's oil refinery. Unlike many other countries, coastal cargo is also carried by international ships visiting New Zealand ports in the course of their international voyages.

Most domestic shipping cargo is carried across the Cook Strait between the North and South Islands. Daily ferry services are operated by two competing companies using a total of five vessels (rail and road ferries) transporting passengers and freight with a journey time of around three hours.

There are a small number of passenger ferries operating in the coastal cities – predominately Auckland. They provide commuter and recreational services.

Aviation

New Zealand continues to be a very aviation-oriented nation. Virtually all passenger travel to and from New Zealand is by air. There were 4,261,010 passenger arrivals into New Zealand in the year ended March 2005, an increase of 32 percent since the year ended March 2001.

Of the total arrivals, 56 percent consisted of overseas visitors and 42 percent returning New Zealand residents. This growth has contributed to a tourism industry that is now supporting nearly one in ten New Zealand jobs. Jet and turboprop aircraft are used for international and domestic freight and passenger transport. Light aircraft, including helicopters, are used extensively in agriculture and tourism.

Twenty-one foreign airlines, including three all-cargo airlines, operate flights to New Zealand and 10 serve New Zealand on a code-share basis only. There are three operators providing a scheduled domestic service.

Since 1983, domestic air services have been effectively deregulated, there no longer being any industry-specific economic regulation. In 1986, the overseas investment restrictions on foreign ownership of New Zealand domestic airlines were lifted. The New Zealand Government has also pursued a policy of seeking "open skies" international air services agreements which notably now govern relations with Australia, the United States of America and Singapore. Cabotage rights have been exchanged with a small number of countries, including Australia.

In 2001, the New Zealand Government bought shares in Air New Zealand in order to prevent its financial collapse following the failure of its Australian subsidiary, Ansett. The Government remains the majority shareholder in Air New Zealand with an 80.4 percent stake.

New Zealand's three major international airports and a number of provincial airports have been progressively restructured as limited liability companies. In 1998, the Government's shares in Auckland and Wellington International Airports and a number of provincial airports were sold.

Air New Zealand has embarked on a major programme of fleet re-equipment replacing smaller airliners with new, large, and more environmentally friendly types. For regional international operations, nine A320 aircraft have replaced B737-300 and B767-200ER aircraft; for international long-haul services eight B777-200ER and two B787 aircraft have been ordered to replace B767 aircraft; and for domestic services a fleet of 17 Saab 340A aircraft is being replaced by 17 larger Bombardier Q300 aircraft. Projections out to 2012 show that Air New Zealand's current fleet replacement programme will reduce carbon dioxide emissions corrected for seating capacity and distance flown by approximately 20 percent.

Waste

Wastewater

Wastewater from virtually all towns in New Zealand with a population of over 1,000 people is collected and treated in community wastewater treatment plants. In 2002 there were approximately 317 municipal wastewater treatment plants. In addition there are around 50 Government or privately-owned treatment plants serving smaller populations between 100 and 1,000 people.

While approximately 30 percent of plants, which treat 75 percent of domestic wastewater, are aerobic and therefore produce no methane, there is a significant number of plants that use partially anaerobic processes such as oxidation ponds or septic tanks. Small communities and individual rural dwellings are generally served by simple septic tanks followed by ground soakage trenches.

Very large quantities of high-strength industrial wastewater (approximately 160 million kilograms of chemical oxygen demand, or organic carbon, in 2001) are produced by New Zealand's primary industries. Most of the treatment uses aerobic treatment; if anaerobic treatment is used, all the methane is collected and burned. There is, however, a significant number of anaerobic ponds that do not have methane collection, particularly serving the meat processing industry. Approximately 52 percent of industrial wastewater is treated this way. These are the major sources of industrial wastewater methane.

Landfills

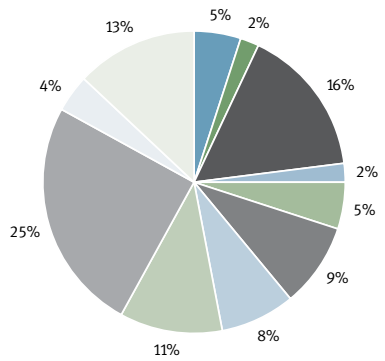
In New Zealand, managing solid wastes has traditionally meant disposing of them in landfills. Based on the results of the 1995 and 2003 National Landfill Census, the number of legally operating landfills, or solid waste disposal sites, fell from 327 in 1995 to 115 sites in 2002, and is forecast to fall to just 43 sites by 2010. Per capita waste generation has fallen from 2.39 kilograms per day in 1995 to 2.081 kilograms per day in 2002. This is the latest actual figure available. A further landfill census will be carried out in 2006.

There have been a number of recent initiatives to improve solid waste management practices in New Zealand. These have included preparing guidelines for consent conditions and the development, operation, closure and management of landfills. As a result of these initiatives, a number of poorly located and substandard landfills have been closed and communities increasingly rely on modern regional disposal facilities, including transfer stations, for disposal of their solid waste.

Industry

The New Zealand economy is dominated by service industries that contribute over half of GDP ($123 billion in 2005) (4NC Figure 9). Primary industries account for less than 10 percent of GDP and secondary industries for about 30 percent.

4NC Figure 9: Industry contribution to GDP 2005

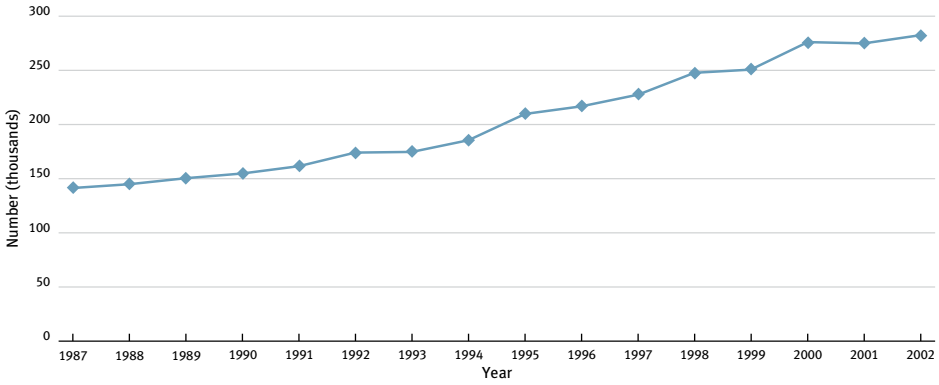


Source: Statistics New Zealand (2005)

In 2004, New Zealand had 324,000 firms employing over 1.6 million people. The number of businesses has more than doubled since 1987 (4NC Figure 10). This growth has been largely confined to the service industries where the number of businesses has grown by 115 percent between 1987 and 2002, mostly in property and business services. By contrast, the number of businesses engaged in primary and secondary industries has remained static (4NC Figure 11).[6]

More than four-fifths (86 percent in 2002) of New Zealand businesses are "micro businesses" that engage five or fewer full-time equivalent (FTE) employees (4NC Figure 12). Most of the growth in the number of businesses between 1987 and 2002 came from these firms. There were approximately 150,000 more "micro businesses" in New Zealand in 2002 than there were in 1987.

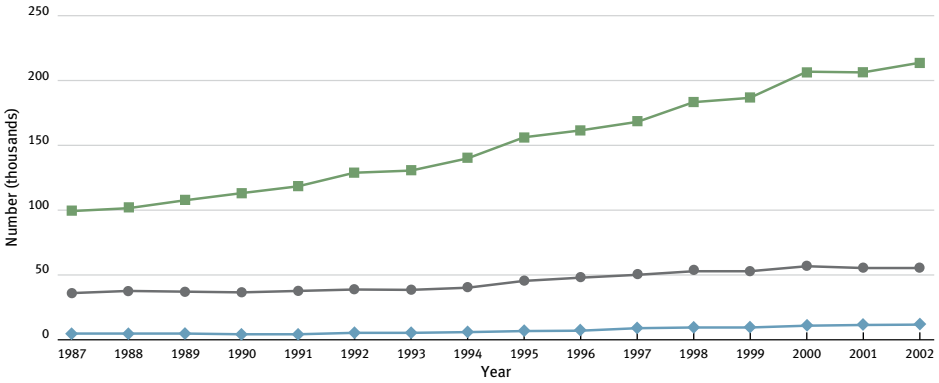
4NC Figure 10: Number of enterprises in New Zealand 1987 – 2002



Source: Statistics New Zealand (2003)

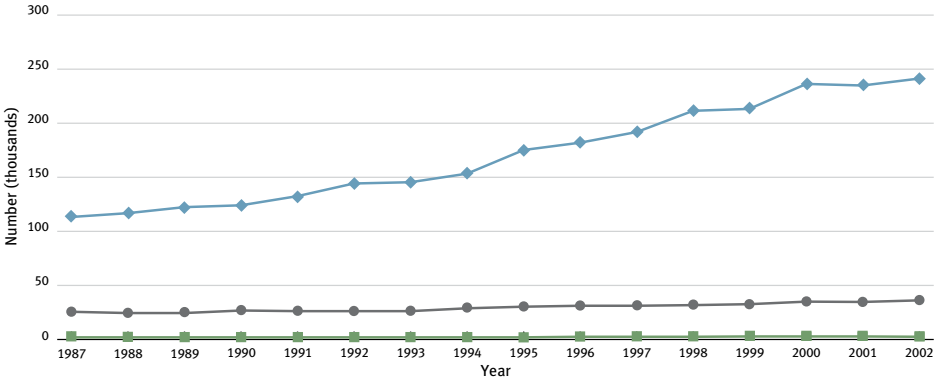
[6] The number of enterprises engaged in primary industries excludes enterprises engaged in farming (approximately 71,000 enterprises in 1998).

4NC Figure 11: Number of enterprises in New Zealand by industry 1987 – 2002



Source: Statistics New Zealand (2003)

4NC Figure 12: Number of enterprises in New Zealand by size 1987 – 2002



Source: Statistics New Zealand (2003)

Chapter 3

Greenhouse gas inventory

Introduction

The information provided in this chapter is fully consistent with the National Inventory Report including the Common Reporting Format tables that New Zealand submitted to the United Nations Framework Convention on Climate Change (UNFCC) on 15 April 2005.

The inventory totals emissions and removals of the gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) from six sectors: energy; industrial processes; solvents; agriculture; land use, land-use change and forestry (LULUCF); and waste. As required in the UNFCCC reporting guidelines, the indirect greenhouse gases carbon monoxide (CO), oxides of nitrogen (NO_x) and non-methane volatile organic compounds (NMVOC) are also included in the inventory as is sulphur dioxide (SO_2).

The Climate Change Response Act 2002 which was enacted to enable New Zealand to meet its international obligations under the UNFCCC and the Kyoto Protocol, effectively establishes the Ministry for the Environment as New Zealand's inventory agency.

The Ministry for the Environment is responsible for overall development, compilation and submission of the annual greenhouse gas inventory submitted to the UNFCCC. In addition to this overall coordination and quality control role, the Ministry for the Environment produces the estimates of emissions and removals from the LULUCF sector (except planted forests), the waste sector, and the non-carbon dioxide gases from the industrial processes sector (obtained via industry consultants). The Ministry of Economic Development is responsible for compiling the energy sector emissions and carbon dioxide emissions from the industrial processes sector, and the Ministry of Agriculture and Forestry compiles emissions from the agriculture sector and removals from planted forests in the LULUCF sector. The inventory estimates are underpinned by the research and modelling by researchers at New Zealand's Crown research institutes and universities.

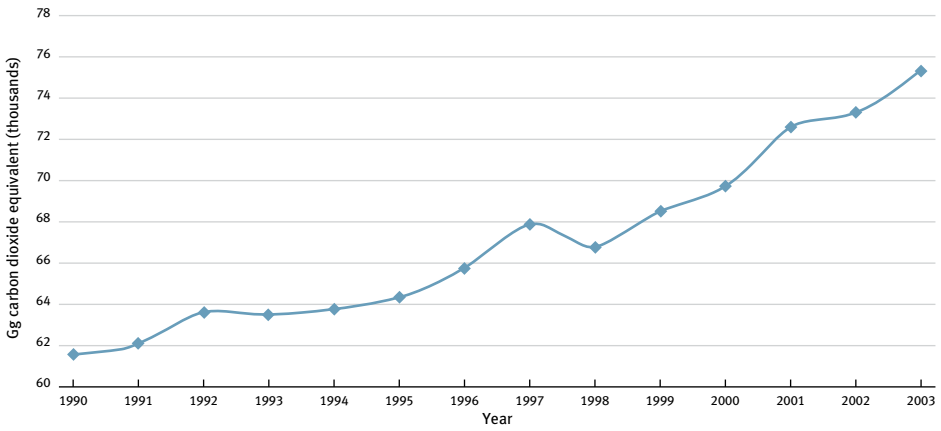
National trends in New Zealand's emissions and removals

The summary by gas and trend tables from the 2003 Common Reporting Format are provided in Annex 1 of this communication.

In 1990, New Zealand's total greenhouse gas emissions were equivalent to 61,525.43 Gg CO_2. In 2003, total greenhouse gas emissions were 75,345.29 Gg CO_2 equivalent[7] equating to a 22.5 percent rise since 1990 (4NC Figure 13). Net removals of carbon dioxide through forest sinks increased from 21,366.19 Gg CO_2 in 1990 to 22,861.60 Gg CO_2 in 2003.

Fluctuations in the trend are largely driven by emissions from electricity generation. This category can show large year-to-year fluctuations because of the use of thermal stations to supplement the hydroelectric generation, which cannot meet the demand for electricity during dry years. Generation in a year with normal rainfall requires lower gas and coal use and a year with less rainfall requires higher gas and coal use. This is a different trend from the steady increase in emissions from coal and gas used in electricity generation found in many other countries.

4NC Figure 13: New Zealand's total greenhouse gas emissions 1990 – 2003



Source: Ministry for the Environment (2005b)

[7] All emissions of non-carbon dioxide greenhouse gases are reported in this chapter as emissions of carbon dioxide equivalent using Global Warming Potentials (GWPs). GWPs represent the relative warming effect, or cumulative radiative forcing, of a unit mass of the gas when compared with the same mass of carbon dioxide over a specific period. The UNFCCC reporting requirements specify that the 100-year GWPs contained in the IPCC Second Assessment Report (IPCC, 1995) are to be used in national inventories.

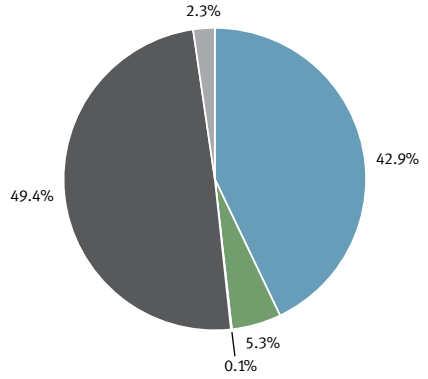
There have also been changes in the relative amounts of the different greenhouse gases emitted. Whereas methane and carbon dioxide contributed equally to New Zealand's emissions in 1990, carbon dioxide is now the major greenhouse gas in New Zealand's emissions profile (4NC Table 1). This is attributed to increased growth in the energy sector compared to the agriculture sector. However, the agriculture sector continues to dominate New Zealand's emissions profile in that 49.4 percent of total emissions in 2003 were produced by the agriculture sector (4NC Figure 14).

4NC Table 1: Emissions of greenhouse gases in 1990 and 2003

Greenhouse Gas Emissions	Gg CO2 equivalent		Change from 1990 (percent)
	1990	2003	
Net CO_2 emissions / removals	3,944.36	11,833.84	200.02
CO_2 emissions (without LULUCF)	25,314.81	34,699.55	37.07
CH_4	25,283.98	26,644.97	5.38
N_2O	10,398.71	13,499.53	29.82
HFCs	0.00	403.96	NA
PFCs	515.60	84.90	-83.53
SF_6	12.33	12.38	0.39
Total emissions without CO_2 from LULUCF	61,525.43	75,345.29	22.5

Source: Ministry for the Environment, 2005b

4NC Figure 14: New Zealand's sectoral emissions in 2003 (all figures Gg CO_2 equivalent)



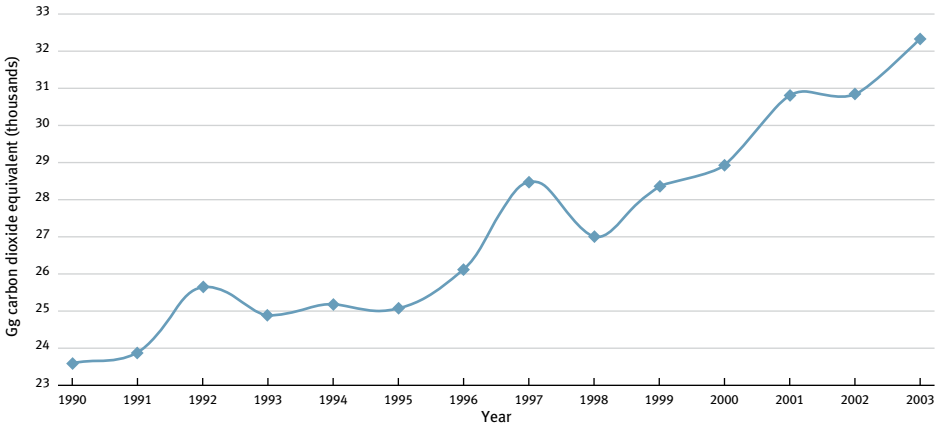
Source: Ministry for the Environment (2005b)

Source and sink category emission estimates and trends

Energy sector

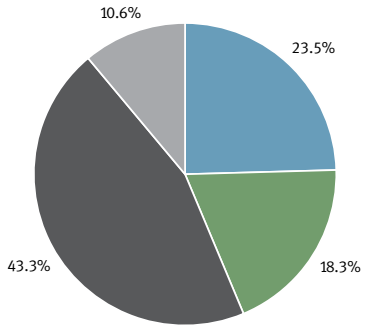
The energy sector produced 32,320.92 Gg CO_2 equivalent in 2003 and represented 42.9 percent of New Zealand's total greenhouse gas emissions. Emissions from the energy sector are now 37.0 percent above the 1990 baseline value of 23,594.11 Gg CO_2 equivalent (4NC Figure 15). The sources contributing most to this increase since 1990 are emissions from road transportation (an increase of 58.4 percent) and public electricity and heat production (an increase of 83.3 percent). Emissions from transport contribute 43.3 percent of the energy sector's greenhouse gas emissions (4NC Figure 16). Greenhouse gas emissions from public electricity and heat generation are 19.8 percent of total energy greenhouse gas emissions. The large increase in emissions from electricity generation is because 2003 was a drier year than usual, resulting in less hydroelectric generation and a greater utilisation of coal-fired generation for 2003. Emissions from the manufacture of solid fuels and other energy industries sub-category have decreased by 80.6 percent from 1990, mainly due to the discontinuation of synthetic petrol production in 1997.

4NC Figure 15: Energy sector emissions 1990 – 2003



Source: Ministry for the Environment (2005b)

4NC Figure 16: Emissions from the energy sector: fuel combustion category as a percentage of total energy emissions in 2003



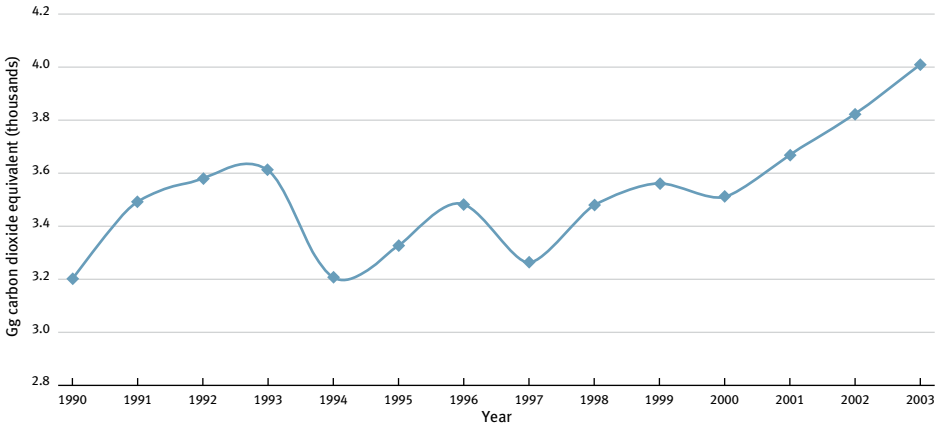
Energy industries	7,604.84 Gg
Manufacturing industries & construction	5,904.41 Gg
Transport	13,985.98 Gg
Other sectors	3,427.43 Gg

Source: Ministry for the Environment (2005b)

Industrial processes sector

New Zealand's industrial processes sector totalled 4,014.19 Gg CO_2 equivalent in 2003 and represented 5.3 percent of total greenhouse gas emissions. Emissions from industrial processes are now 25 percent above the 1990 baseline of 3,211.70 Gg CO_2 equivalent (4NC Figure 17). The sector is dominated by emissions from the metal production category (carbon dioxide and perfluorocarbons) at 58.3 percent of sectoral emissions (4NC Figure 18).

4NC Figure 17: Industrial processes sector emissions 1990 – 2003

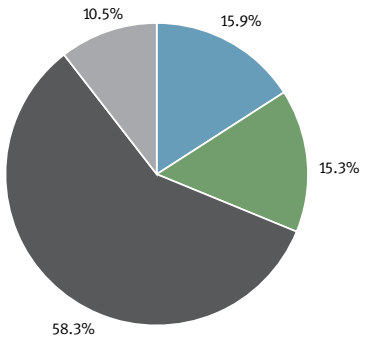


Source: Ministry for the Environment (2005b)

Emissions from the metal production industry comprised 2,339.64 Gg CO_2 equivalent in 2003 and have increased 1.5 percent from the 2,305.79 Gg CO_2 equivalent recorded in 1990. Carbon dioxide emissions account for 96.6 percent of emissions in this category with another 3.4 percent from perfluorocarbons. In 2003, the level of carbon dioxide emissions has increased by 26.4 percent over the 1990 baseline. However, the level of perfluorocarbons has decreased from 515.60 Gg CO_2 equivalent in 1990 to 84.90 Gg CO_2 equivalent in 2003, a decrease of 83.5 percent. The decrease in perfluorocarbon emissions is because the sole aluminium smelter in New Zealand now has a low anode-effect duration by world standards.

There is no manufacturing of hydrofluorocarbons and perfluorocarbons in New Zealand. However, emissions of hydrofluorocarbons totalled 403.96 Gg CO_2 equivalent in 2003 which is an increase of 382 percent from the 1995 level of 83.78 Gg CO_2 equivalent. Emissions of sulphur hexafluoride (SF_6), primarily used in electrical switchgear and transformers, have increased and from 12.33 Gg CO2 equivalent in 1990 to 12.38 Gg CO_2 equivalent in 2003.

4NC Figure 18: Industrial processes sector emissions in 2003 (all figures Gg CO_2 equivalent)



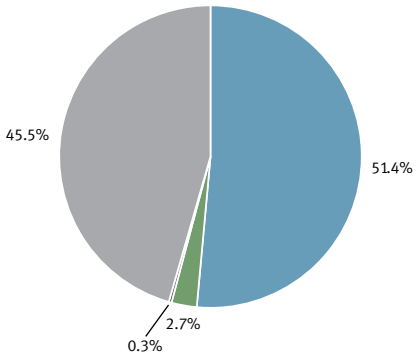
Mineral products	638.83 Gg
Chemical industry	615.18 Gg
Metal production	2,339.64 Gg
Consumption of halocarbons and SF_6	420.54 Gg

Source: Ministry for the Environment (2005b)

Solvent and other product use

Emissions from the solvents and other product use sector in 2003 comprised 31.61 Gg of non-methane volatile organic compounds. This is an increase of 30.4 percent from 24.24 Gg in 1990. The categories dominating the sector are non-methane volatile organic compounds emissions from paint application and other uses (4NC Figure 19).

4NC Figure 19: Emissions of NMVOC from the solvent and other product use sector in 2003 (all figures Gg NMVOC)



Paint application	16.28 Gg
Degreasing and drycleaning	0.85 Gg
Chemical products	0.10 Gg
Other	14.39 Gg

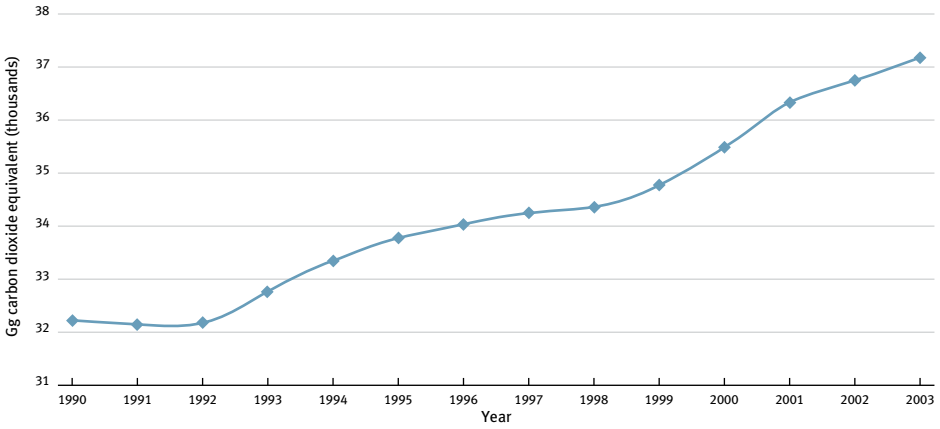
Source: Ministry for the Environment (2005b)

In 2003, nitrous oxide (N_2O) emissions from anaesthesia use totalled 0.16 Gg of nitrous oxide or 48.36 Gg CO_2 equivalent. This is a 16.4 percent increase over the 1990 baseline.

Agriculture sector

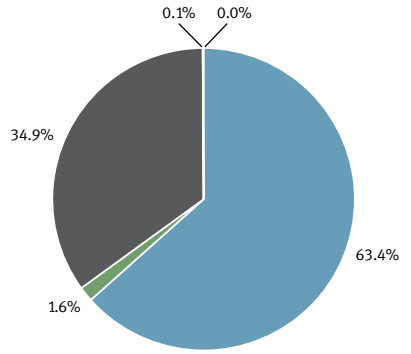
The agriculture sector emissions totalled 37,203.24 Gg CO_2 equivalent and represented 49.4 percent of all greenhouse gas emissions in 2003. Emissions in this sector are now 15.6 percent higher than the 1990 level of 32,193.76 Gg CO_2 equivalent (4NC Figure 20). The increase is attributable to a 9.6 percent increase in methane (CH_4) emissions from enteric fermentation and a 29.4 percent increase in nitrous oxide emissions (N_2O) from the agricultural soils category.

4NC Figure 20: Agricultural sector emissions 1990 – 2003



Source: Ministry for the Environment (2005b)

4NC Figure 21: Emissions the agricultural sector in 2003 (all figures Gg CO_2 equivalent)



Enteric fermentation	23,592.21 Gg
Manure management	610.51 Gg
Agricultural soils	12,968.99 Gg
Prescribed burning of savannas (0.0%)	1.00 Gg
Field burning of agricultural residues (0.1%)	29.93 Gg

Source: Ministry for the Environment (2005b)

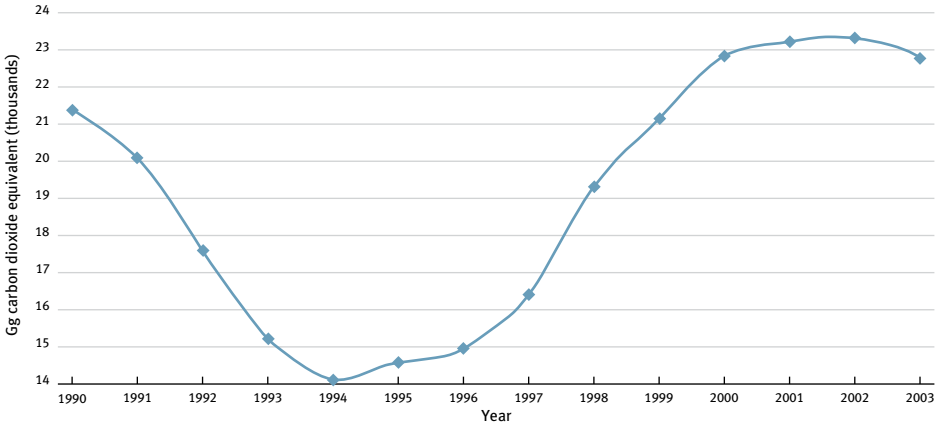
Emissions of methane from enteric fermentation dominate the sector, producing 63.4 percent of carbon dioxide equivalent emissions in the sector (4NC Figure 21) and 31.3 percent of New Zealand's total emissions. Nitrous oxide emissions from agricultural soils are the other major component of the sector, comprising 34.9 percent of agricultural emissions.

Since 1984, there have been changes in the balance of livestock species. There has been a trend of increased dairy production and deer numbers for meat and velvet production due to the prevailing good world prices. This has been counterbalanced by land coming out of sheep production and consequently decreased sheep numbers. Beef numbers have remained relatively static. There have also been productivity increases across all major animal species and classes. At the same time there has been an expansion of the land used for plantation forestry. The land area used for horticulture has not changed significantly since 1990, although the types of produce grown have changed with less grain but more vegetables, fruit and grapes for wine production.

Land use, land-use change and forestry sector

The land use, land-use change and forestry (LULUCF) sector accounted for the removal of approximately 30.3 percent of New Zealand's total greenhouse gas emissions in 2003. Net removals from the LULUCF sector in 2003 (including emissions of methane and nitrous oxide) totalled 22,861.60 Gg CO_2 equivalent and are 7.0 percent above net removals in 1990 (4NC Figure 22).

4NC Figure 22: LULUCF sector net removals from 1990 – 2003



Source: Ministry for the Environment (2005b)

New Zealand has a substantial estate of planted forests, mainly comprising *Pinus radiata,* created specifically for timber-supply purposes, and has well-established data on this estate's extent and characteristics. These forests have removed and stored substantially more carbon dioxide over the period 1990 to 2003 than has been emitted through forest harvesting of both the combined planted and natural forests. The average new planting rate (land reforested or afforested) over the past 30 years has been, on average, 44,900 hectares per year. In the period 1992 to 1998, new planting rates were high (averaging 69,000 hectares per year). During the early 1990s, there had been a period of significant harvesting. Since 1998 the rate of new planting has declined and in 2003, 19,900 hectares of new forest were established. Between 1990 and 2003, it is estimated that 660,000 hectares of new forest had been established as a result of afforestation and reforestation activities.

A current lack of land use and land-use change data consistent with the IPCC land categories, and covering the period 1990 through to 2003, limits complete reporting in this sector. However, in its 2003 inventory, New Zealand improved the completeness of the LULUCF sector reporting by including an initial (Tier 1) estimate for all LULUCF land-use categories from 1997 to 2003. Previously, New Zealand had only included information on net changes in the living biomass from forestry land use and emissions and removals from the planting of forest on grassland.

Research is being conducted on the carbon pools and fluxes in New Zealand's soils and natural forests through the Carbon Monitoring System plots, and specific data for 1990 are being developed as part of the New Zealand Carbon Accounting System. The Carbon Monitoring System and the New Zealand Carbon Accounting System are described in Box 2. These additional data will enable New Zealand to report a complete time-series for all LULUCF categories.

Box 2: The New Zealand Carbon Monitoring and Accounting System

Major ongoing work in the land use, land-use change and forestry (LULUCF) sector includes research and implementing a monitoring system for the carbon stocks and fluxes in soils, shrublands and natural forests. Initiated by the Ministry for the Environment in 1996, this five-year monitoring research project had the following objectives:

- the estimation of carbon storage in soils, shrublands and natural forests in 1990
- the development of a national system to determine soil carbon changes associated with land-use change
- the development of an effective information system to manage the above information.

In 1999, the soil and vegetation carbon monitoring systems developed during the first three years of the project were reviewed by an international panel of forestry and soil experts. This review was held in time for the key recommendations of the review to be undertaken before the development phase was concluded.

The statistical design of the vegetation carbon monitoring system provides for the establishment of 1,400 permanent field plots on an 8-by-8 kilometre grid across natural forest and shrublands for territorial New Zealand.

Using 20-metre by 20-metre plots, measurements are taken of aboveground biomass, such as tree heights and diameters, understorey vegetation, litter, and coarse woody debris. The soil carbon monitoring system analyses soil samples to a depth of 0.3 metres for carbon content. One in every three of the vegetation plots is sampled for soils to reduce the uncertainty in some soil cells.

The soil and vegetation carbon monitoring systems are being implemented. Fieldwork over at least two more years will be required to install the complete network of field plots. Another five-year round of sampling will be required to validate the implementation and begin monitoring of any changes. The current intention is then to repeat these measurements every 10 years.

For the soil carbon monitoring system, 40 soil-paired plots sites are also being established to monitor key changes in soil carbon when land-use changes; that is, scrub to grassland, grassland to Kyoto forest and vice versa.

The New Zealand Carbon Accounting System is being developed. This system will account for human-induced carbon sources and sinks from New Zealand's land use, land-use change and forestry (LULUCF) activities, and (a) is appropriate for annual UNFCCC greenhouse gas emission LULUCF sector reporting; (b) enables accounting and reporting under the Kyoto Protocol; and (c) underpins scenario development and modelling capabilities that support New Zealand's climate change policy development.

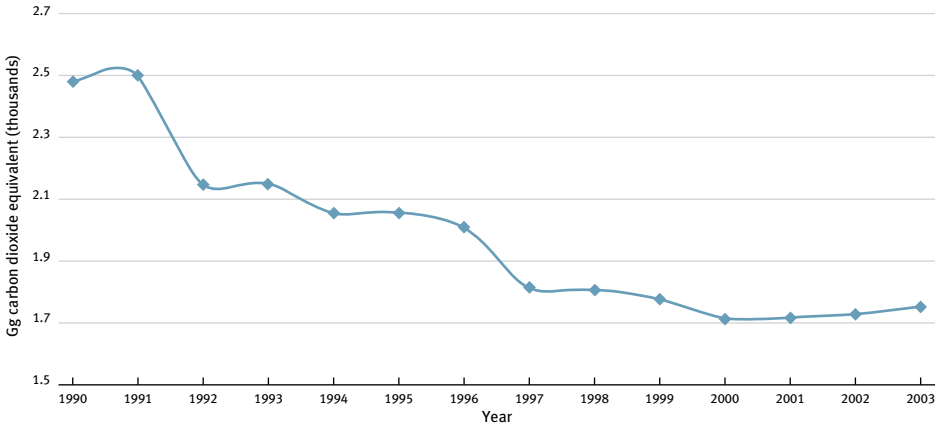
The most developed module of the New Zealand Carbon Accounting System is for natural forests and shrublands based on the carbon monitoring system plots. New Zealand's natural forests cover 6.4 million hectares, and are largely protected, often as national parks. New Zealand has not, until now, needed to establish a national forest inventory to cover its protected forests. This is in sharp contrast to the advanced system used for monitoring and forecasting future wood supply from its 1.8 million hectares of plantation forests.

A monitoring and modelling module is under development for those areas where afforestation and reforestation activities have occurred since 1990 ("Kyoto forests"). This will involve inventory measurements from permanent plots coupled with the use of existing allometric equations or forest volume and carbon models, or both.

Waste sector

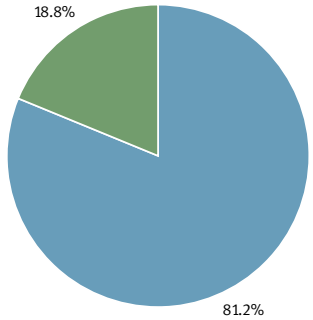
The waste sector emissions totalled 1,754.48 Gg CO_2 equivalent in 2003 and represented 2.3 percent of all greenhouse gas emissions. Emissions in 2003 are now 29.3 percent below the 1990 baseline value of 2,480.06 Gg CO_2 equivalent (4NC Figure 23). The reduction has occurred in the "solid waste disposal on land" category, which has decreased by 34.5 percent as a result of initiatives to improve solid waste management practices in New Zealand.

4NC Figure 23: Waste sector emissions 1990 – 2003



Source: Ministry for the Environment (2005b)

4NC Figure 24: Waste sector emissions in 2003 (all figures Gg CO_2 equivalent)



Solid waste disposal on land	1,425.48 Gg
Wastewater handling	329.00 Gg

Source: Ministry for the Environment (2005b)

Emissions from the waste sector are calculated in three components (4NC Figure 24): solid waste disposal on land, wastewater handling and waste incineration (not shown in the figure as emissions are negligible and not estimated).

Chapter 4

Policies and measures

Introduction and overview of the policy-making process

The Government has considered that in order to minimise the risk of climate change to New Zealand, its Pacific neighbours, and other countries, New Zealand should participate in the international efforts to mitigate climate change. This commitment requires a credible domestic programme to reduce greenhouse gas emissions and enhance sinks.

New Zealand began its response to climate change in 1988 with the establishment of the New Zealand Climate Change Programme, coordinated by the Ministry for the Environment. In May 2000, the Ministerial Group on Climate Change was established to oversee the further development and implementation of New Zealand's climate change response. The Ministerial Group on Climate Change was convened by the Minister responsible for a range of portfolios including Energy; Research, Science and Technology; and Statistics. Other members of the Ministerial Group on Climate Change represented the core Government agencies working on climate change in New Zealand (see opposite).

In 2001, the New Zealand Climate Change Programme shifted to the Department of Prime Minister and Cabinet as the Government developed its preferred policy package. In October 2002, after extensive nationwide consultation, the Government announced its climate change policy package, which included the intention to ratify the Kyoto Protocol (Department of Prime Minister and Cabinet, 2002a). This package included the establishment of a New Zealand Climate Change Office (Department of Prime Minister and Cabinet, 2002c), ultimately placed in the Ministry for the Environment. On 19 December 2002, New Zealand became the 101st nation to ratify the Kyoto Protocol.[8]

In 2002, the New Zealand Parliament passed the Climate Change Response Act, which established a New Zealand climate change registry and corresponding institutional arrangements in accordance with Kyoto Protocol requirements.

In 2004, the Government made subsequent policy decisions which will impact on the design and rules of the registry, including:

- allowing private New Zealand businesses and individuals to hold accounts in the registry and trade in emission units
- allowing entities to bank temporary certified emission reduction units and long-term certified emission reduction units, resulting from forestry projects under the Kyoto Protocol's clean development mechanism (as created by international decisions at the Ninth Conference of the Parties), in the registry.

Following confirmation of international requirements for the development of emission unit registries in December 2004, officials started designing the necessary electronic framework to accommodate New Zealand's climate change registry. The legislative changes needed to implement the above two policy decisions are contained in the Climate Change Response Amendment Bill, currently in the Parliamentary process.

Drawing on the climate change policy package, the Climate Change Office was given the role of coordinating a whole-of-Government approach to addressing climate change with the overarching goal:

...that New Zealand should have made significant greenhouse gas reductions on business as usual and be set towards a permanent downward path for total gross emissions by 2012.

In late 2004 and early 2005, the Ministry for the Environment restructured the Climate Change Office, distributing its functions across the Ministry. Through a steering group of senior officials chaired by Ministry for the Environment, work on climate change is coordinated across Government and advice is provided to Ministers. Agencies involved are:

- Ministry for the Environment
- Ministry of Foreign Affairs and Trade
- The Treasury
- Ministry of Agriculture and Forestry
- Ministry of Economic Development
- Te Puni Kokiri (Ministry of Māori Development)
- Ministry of Transport
- Ministry of Research, Science and Technology
- Energy Efficiency and Conservation Authority
- Department of Prime Minister and Cabinet.

[8] The Kyoto Protocol commits New Zealand to reducing its greenhouse gas emissions to 1990 levels, on average, over the period from 2008 to 2012, or to take responsibility for any emissions above this level.

Following the New Zealand general election in September 2005, a new ministerial position was established: the Minister Responsible for Climate Change Issues. This Minister convenes a Ministerial Reference Group on Climate Change covering the portfolios of Finance, Agriculture, Forestry, Energy, Transport, Environment, and Economic Development. The general election also changed the composition of the Parliament, and future policy development will need to have regard for the interests represented.

Overview of policies and measures

In addition to the 2002 climate change policy package, the Government's policy response to climate change rests on a number of foundation policies described in this communication that are already in place and will continue to apply both during the Kyoto Protocol's first commitment period 2008–2012 and beyond. These include:

- National Energy Efficiency and Conservation Strategy
- New Zealand Waste Strategy
- New Zealand Transport Strategy.

The Government's 2002 climate change policy package included policies and measures focused on the energy, transport, industry, agriculture, waste and forestry sectors as well as cross-sectoral policies and measures. When the Government introduced this climate change policy package, it anticipated there would be three reviews not later than 2005, 2007 and 2010 (Department of Prime Minister and Cabinet, 2002*b*). The reviews would be necessary to monitor progress with emission reductions, assess the effectiveness of policies, and confirm that New Zealand was positioned to meet its commitments. In mid-2005, a full policy review was commissioned by Cabinet. The review was completed in November 2005. The review concluded that some elements of the Government's 2002 climate change policy package should be modified to better position New Zealand to respond to the longer-term challenges of climate change. In December 2005, the Government announced that it would not proceed with the carbon tax and associated Negotiated Greenhouse Agreements, and would implement work programmes in each of the key sectors to develop further policies and measures. In that announcement, the Government reaffirmed its commitment to the Kyoto Protocol.

As a result of the review, Government officials are undertaking further policy work, in consultation with stakeholders, and will report back to Ministers on a range of work programme areas. Because the Government's climate change policy is in a phase of transition as the Government considers the work programmes, new policies and measures under development are not able to be included in the *Fourth National Communication.* Therefore, this chapter reports only those policies and measures that remained in place as of December 2005. A summary of the policies and measures reported in this chapter is presented in Table D1 (see Appendix D).

Energy policies and measures

All policies and measures aimed at reducing greenhouse gas emissions from the energy sector focus primarily on carbon dioxide, which accounts for over 96 percent of the greenhouse gas emissions from the sector. Pursuant to the 2005 review, the Government has established several work programmes that address the further development of policies and measures for the energy sector. Ongoing policies and measures in the energy sector are reported opposite.

Sustainable energy work programme

The Government initiated a sustainable energy work programme following the release in January 2003 of its Sustainable Development Programme of Action, which identified energy as a key area. In October 2004, the Government released the document *Sustainable Energy: Creating a Sustainable Energy System* setting out the longer-term challenges for the secure, affordable and sustainable delivery of energy services.

The programme is a whole-of-Government process led by senior officials from energy-related departments. It involves raising awareness around upcoming challenges in energy, providing a coherent picture of actions the Government is taking to meet those challenges, and providing an assessment of where current Government actions are sufficient and where more needs to be done. It aims to incorporate sustainable development principles in energy policy decision-making and to ensure that New Zealand's energy system is well-positioned to meet present and future challenges, particularly climate change and peak oil.

At the end of 2005 the Government announced it would develop a National Energy Strategy to provide long-term direction and leadership to put New Zealand firmly on the path to an energy system that supports economic development, while being environmentally responsible. The Government also emphasised renewed commitment to promoting energy efficiency and renewable sources of energy. A long-term strategy will help New Zealand to navigate the challenges of security of supply, climate change and rising oil prices by providing:

- A strategic view that accounts for major challenges ahead and connects current policy decisions to long-term policy intentions
- Key priorities and focus for Government and market actions
- Greater regulatory certainty for long-term decision making
- Durable guiding principles for energy decisions leading to consistent actions across the sector and over time
- Policies to address greenhouse gases in the energy sector
- Key areas for applied energy research programmes and uptake
- Improved effectiveness of institutions and regulatory arrangements
- Greater stakeholder involvement and buy-in.

Due to the inter-linkages with climate change policy and other concurrent processes the development of a National Energy Strategy is a whole-of-Government process.

National Energy Efficiency and Conservation Strategy

The Energy Efficiency and Conservation Act 2000 established the Energy Efficiency and Conservation Authority (EECA) as a Crown entity, and mandated the preparation of a National Energy Efficiency and Conservation Strategy by 2001 with a review after five years. The National Energy Efficiency and Conservation Strategy provides a guiding, coordinating and aspirational framework for all of the Authority's activities.

The Energy Efficiency and Conservation Authority's function is to encourage, promote, and support energy efficiency, energy conservation, and the use of renewable sources of energy.

The National Energy Efficiency and Conservation Strategy is driven by six policy goals:

- reduced carbon dioxide emissions
- reduced local environmental impacts
- improved economic productivity
- promotion of industry development
- improved economic resilience
- improved health and welfare.

There are also two high-level national targets:

- a 20 percent improvement in economy-wide energy efficiency by 2012
- increased renewable energy supply, to provide a further 30 petajoules of consumer energy in the year 2012.

The strategy was launched in September 2001. The Government agreed, in March 2006, to replace the strategy within the next 12 to 18 months.

The Authority carries out activities aimed at contributing to these targets in five broad areas: the business sector, the residential sector, the energy supply sector (including renewables), the transport sector, and a range of cross-sectoral measures. Highlights of these are described opposite.

Business sector programmes: "Emprove"

Description of the policy or measure

Launched in 2003, Emprove includes the provision of grants for energy audits, loans to implement energy savings and raising awareness of the opportunities to improve profitability through good energy management.

Objectives of the policy or measure

Emprove aims to help high-energy-use businesses achieve savings in their energy expenditure.

The greenhouse gas or gases affected

The greenhouse gas covered is primarily carbon dioxide through reduced electricity consumption.

Type or types of policy or measure

Emprove is a facilitating action, including the provision of financial resources.

Status of implementation

The programme is under implementation.

Implementing entity or entities

The programme is implemented by the Energy Efficiency and Conservation Authority.

Quantitative estimate of the impacts of the policy or measure

The indications are that Emprove directly contributes over 0.2 petajoules of energy savings per year.

Residential sector programmes: Building regulations

Description of the policy or measure

The residential sector comprises 12 percent of New Zealand's energy consumption and includes private homes, rented homes, apartments, flats and mobile homes. It excludes commercial accommodation and private transport. EECA operates two programmes in this sector: building regulations and EnergyWise home grants. The building regulations programme seeks to make ongoing changes to the Building Code to improve the energy efficiency of residential and commercial dwellings.

Objectives of the policy or measure

The programme targets the capacity of the building regulatory process to deliver energy efficient outcomes in New Zealand's building stock.

The greenhouse gas or gases affected

These measures primarily cover carbon dioxide, through reduced electricity consumption.

Type or types of policy or measure

It is a regulatory measure, improving the existing code.

Status of implementation

The Building Code is being reviewed to respond to the purposes and principles of the Building Act 2004 – which includes a requirement to "facilitate the efficient use of energy and energy conservation and the use of renewable energy in buildings." The new Building Code is expected to come into force around 2009.

Implementing entity or entities

The review is managed by the Department of Building and Housing, with input from the Energy Efficiency and Conservation Authority on energy efficiency and renewable energy issues.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Residential sector programmes: EnergyWise home grants

Description of the policy or measure

The grants scheme focuses on fitting insulation – as well as other energy efficiency measures – for existing homes.

Objectives of the policy or measure

The objective is to improve the energy efficiency of approximately 100,000 pre-1977 homes occupied by low-income families.

The greenhouse gas or gases affected

This scheme primarily covers carbon dioxide from reduced demand for electricity and some fossil fuel.

Type or types of policy or measure

The scheme provides financial assistance.

Status of implementation

The Energy Efficiency and Conservation Authority has administered EnergyWise home grants since 1995. To 30 June 2005, 17,000 homes have been insulated, with $19 million of Government funding.

Implementing entity or entities

The Energy Efficiency and Conservation Authority directly funds service providers, who carry out implementation in the field. Service providers include energy suppliers, energy consumer trusts, lines companies, product suppliers and local councils.

Quantitative estimate of the impacts of the policy or measure

The programme is expected to contribute an additional 0.07 petajoules of energy savings in 2006.

Energy supply and renewables programmes: Renewable energy to the grid

Description of the policy or measure

The aim of this programme is to ensure that more electricity generated for the grid or fed into local distribution networks is sourced from renewable energy. The programme is designed to influence the decisions of existing or potential electricity generators.

Typically the Energy Efficiency and Conservation Authority will provide information, advice and support on renewable energy projects to inform development proposals and facilitate better decision-making by local authorities. This includes providing submissions to local authority's plans, commenting on renewable energy project proposals and supporting the Projects to Reduce Emissions process.

Objectives of the policy or measure

Nationally 10–15 petajoules[9] of additional (from 2001) renewable energy are expected to be added to the grid in 2012.

The greenhouse gas or gases affected

The programme primarily covers carbon dioxide through reduced fossil-fuel electricity generation.

[9] The nature of the Energy Efficiency and Conservation Act's influence in this area means attribution cannot be meaningfully made, so New Zealand's expected additional national supply of renewable energy in 2012 relative to 2001 is used.

Type or types of policy or measure

The programme focuses on provision of information.

Status of implementation

The programme is under implementation.

Implementing entity or entities

The programme is implemented by the Energy Efficiency and Conservation Authority, working with local authorities and those proposing new generation projects.

Quantitative estimate of the impacts of the policy or measure

An estimate suggests the programme has resulted in a net increase in total renewable electricity capacity of approximately 190 megawatts from March 2000 to March 2004.

Energy supply and renewables programmes: Market development of renewable energy

Description of the policy or measure

This programme encourages the uptake of small-scale renewable energy technology through interest-free loans, information provision and education, and supporting market research.

Objectives of the policy or measure

The aim is to increase the sustainability of New Zealand's energy supply by increasing the contribution of renewable energy derived from small-scale energy technologies such as solar water heating and stand-alone power systems.

The greenhouse gas or gases affected

The greenhouse gases covered are primarily carbon dioxide through reduced demand for grid-purchased electricity and fossil fuels.

Type or types of policy or measure

The activities include:

- interest-free loans to purchase solar water heating systems
- promotion of benefits of solar water heating and other renewables
- support for the renewable energy industry, mainly manufacture of solar water heaters (for example, standards, quality assurance, training programmes, demonstration projects)
- support for market research, monitoring and analysis.

Status of implementation

The programme is under implementation.

Implementing entity or entities

The Energy Efficiency and Conservation Authority, working closely with the renewable energy industry, is responsible for implementation.

Quantitative estimate of the impacts of the policy or measure

The focus has been on encouraging solar water heating, with approximately 2,300 new systems installed in 2004 – an increase of 40 percent over sales in 2003.

Nationally, one to two petajoules of additional (from 2001) renewable energy are expected to come from small-scale technologies in 2012.

Energy supply and renewables programmes: Demand response

Description of the policy or measure

This programme involves investigation and facilitation of demand response in the electricity market.

Objectives of the policy or measure

The objective is to significantly improve the responsiveness of medium-sized electricity users to the spot market and their ability to respond to prior signals by shedding or shifting load, or switching to distributed generation options.

The greenhouse gas or gases affected

The programme primarily covers carbon dioxide through reduced fossil fuel electricity generation.

Type or types of policy or measure

The programme identifies and instigates practical measures to facilitate greater demand response within the electricity industry. Specific activities include pilot projects demonstrating demand response practices, and seminars on improved efficiency of electricity usage through load management.

Status of implementation

Currently work focuses on exploiting lessons from existing examples of demand management and trialling creative applications of new technologies and market mechanisms. This is expected to lead to larger-scale deployment of demand-response activities over the medium term.

Implementing entity or entities

The programme is implemented by the Energy Efficiency and Conservation Authority, working closely with the electricity supply industry and the Electricity Commission.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Transport measures

The Energy Efficiency and Conservation Authority operates two programmes in the transport sector: providing support for travel demand management, and a biofuels programme as described in the transport sector. (Note that these programmes are not identified separately under the energy sector category of 4NC Table D1.)

Cross-sectoral programmes: Energy efficiency of products

Description of the policy or measure

There are two sub-programmes: minimum energy performance standards and labelling; and "Energy Star." The first is largely regulatory in nature. It imposes requirements to display energy efficiency labels and ensures that certain types of products meet minimum standards of energy efficiency.

The second, Energy Star, is a voluntary endorsement scheme that, through labelling, will encourage consumers to purchase home appliances, office products and domestic refrigerators based on the Energy Star energy-efficiency specifications.

Objectives of the policy or measure

The aim is to increase the stock of energy efficient products by influencing the purchase process.

The greenhouse gas or gases affected

The programme primarily covers carbon dioxide through more efficient use of energy.

Type or types of policy or measure

The programme includes regulatory standards for energy performance, coupled with mandatory and voluntary labelling to provide information to consumers.

Status of implementation

The Energy Efficiency and Conservation Authority is working with Australian government agencies to develop a joint appliance programme for 2005–07. The joint programme unifies current separate programmes operating in each country and expands the breadth of products subject to investigation and possible energy efficiency regulatory measures.

Existing minimum energy performance standards and labelling cover a number of important product classes including household refrigerators and other appliances. The programme will implement minimum energy performance standards or labelling interventions for 14 product classes by 2008, and a further 19 product classes will be investigated for possible measures in this period.

Implementing entity or entities

The programme is implemented by the Energy Efficiency and Conservation Authority, together with industry and Australian counterparts under the joint National Appliance and Equipment Energy Efficiency Committee.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Transport policies and measures

Institutional arrangements and recent changes

In December 2004, the Government transport sector implemented a structural reorganisation, as identified in the *Transport Sector Review*. This reorganisation has strengthened the ability of the Ministry of Transport and the transport agencies to deliver the objectives of the New Zealand Transport Strategy across all modes of transport without compromising the significant gains already made in the improvement of transport safety. The environmental policy capability of the transport sector has gradually developed since 1996. The reorganisation included the establishment of a dedicated environmental policy group within the Ministry of Transport in late 2004 and significant progress is now being made in this area.

Responsibility for the integrated management of land transport planning and delivery, including funding allocation, has been assigned to the new Crown entity Land Transport New Zealand, formed in 2004 from the former agencies Transfund and Land Transport Safety Authority. Land Transport New Zealand is required by statute to exhibit a sense of social and environmental responsibility which includes avoiding, to the extent reasonable, adverse effects on the environment. Before approving an activity for funding, Land Transport New Zealand must be satisfied that the activity will contribute in an efficient and effective manner to Land Transport New Zealand's objective, including its social and environmental responsibility. Land Transport New Zealand must also be satisfied that the activity has been assessed to the extent practicable against other land transport options and alternatives.

In operating the state highway system, Transit New Zealand (Transit) is also required by statute to avoid, to the extent reasonable, adverse effects on the environment. Every year Transit must prepare a land transport programme for the state highway system and submit this to Land Transport New Zealand for approval. Transit's bid is prioritised alongside applications for funding submitted by local government.

The environmental work programmes that are led by central Government include:

- uptake of cleaner fuels through fuel specification standards, specifically regulating sulphur levels
- introduction of vehicle emission standards and development of policies to reduce the negative air quality impacts of motor vehicles
- fostering the uptake of renewable fuels
- fostering purchase of fuel-efficient vehicles through providing consumer purchasing information and Government purchasing practices
- processes involving local government and focused on the development and implementation of integrated regional planning strategies
- increased funding for walking and cycling infrastructure
- increased funding for public transport.

New Zealand Transport Strategy

As signalled in New Zealand's *Third National Communication*, the Government completed the New Zealand Transport Strategy in 2002. The strategy is the first comprehensive attempt to recognise all modes and users of transport and to respond directly to the broader social, economic, and environmental needs of the country. The strategy's vision is as follows: "By 2010 New Zealand will have an affordable, integrated, safe, and responsive and sustainable transport system." The strategy has five integrated objectives which are equally important:

- assisting economic development
- assisting safety and personal security
- improving access and mobility
- protecting and promoting public health
- ensuring environmental sustainability.

The New Zealand Transport Strategy gives a strategic framework to transport decision-making in New Zealand. The enactment of the Land Transport Management Act 2004 means that transport agencies must reflect the broad focus of the New Zealand Transport Strategy within their policy and operational outputs. Previously agencies had a focus on "safety and efficiency at reasonable cost". The strategy is helping to inform decision making by central Government, guide the work of its agencies, and act as an important point of reference for communities.

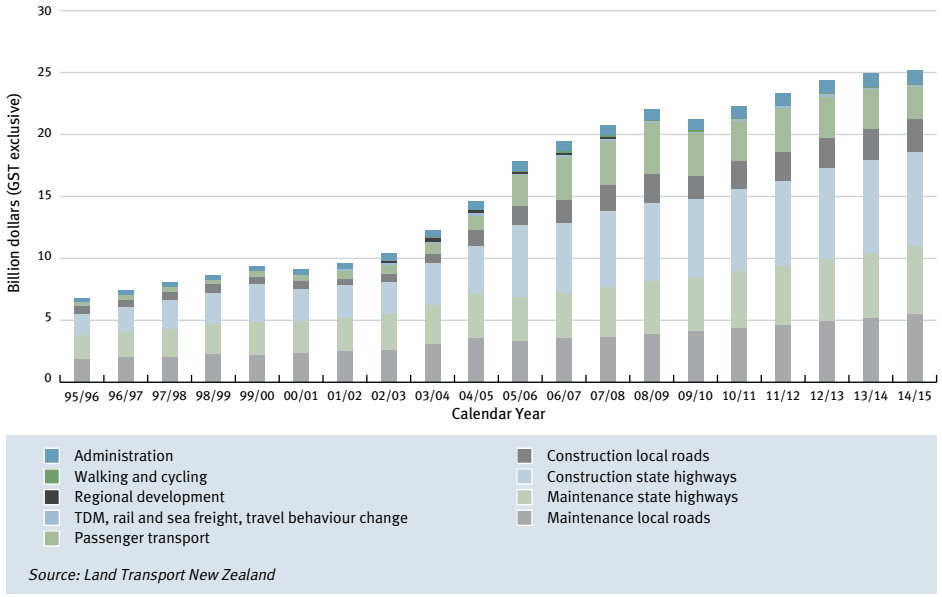
The New Zealand Transport Strategy was completed in 2002 and was given legislative backing by the Land Transport Management Act 2004. In approving any activity as qualifying for national funding the relevant Government agency (Land Transport New Zealand) must specifically take into account how the proposal meets the five objectives of the strategy, including how it "ensures environmental sustainability". Transit New Zealand, which operates and maintains state highways, and local government in its functions, are similarly guided by the multiple objectives.

The Ministry of Transport is the Government department leading and coordinating the implementation of the strategy. Alignment of national and regional transport plans to the New Zealand Transport Strategy objectives under the Land Transport Management Act 2004 is generally the responsibility of implementing agencies such as Land Transport New Zealand. Several major policy documents identify transport as an element in meeting their objectives and the New Zealand Transport Strategy acknowledges these. Key documents are: *Growing an Innovative New Zealand* (Office of the Prime Minister, 2002), the *New Zealand Tourism Strategy* (Ministry of Tourism, 2003) and the *National Energy Efficiency and Conservation Strategy* (Energy Efficiency and Conservation Authority, 2001).

To support the environmental objectives of the New Zealand Transport Strategy, the Government has indicated funding priorities. Through increasing funding for travel demand management, the Government is seeking to improve use of existing transport networks and to educate and inform people about alternative travel choices by emphasising individual and community benefits of smart travel behaviour and environmentally friendly travel modes; for example, travel planning. An increase in patronage funding for public transport has seen growth in public transport use. Patronage funding was introduced in 2000 as a way to boost funding for public transport and to encourage regional councils to focus on initiatives that would get more people using public transport. Since its introduction, public transport patronage has increased by about 27 percent. An attractive public transport system will also increase the likelihood of the success of transport demand management.

4NC Figure 25 shows the substantial increase in funding for public passenger transport, alternatives to road infrastructure, and walking and cycling over the last few years and the future allocations.

4NC Figure 25: National Land Transport Programme – 2005/06 expenditure and forecast allocations



Source: Land Transport New Zealand

National Rail Strategy

The National Rail Strategy was released in May 2005 and will be implemented by the Ministry of Transport. It sets out the Government's rail policy objectives and priorities for action over the next 10 years and outlines key initiatives that are intended to achieve the outcomes sought. The strategy focuses on growth in two key areas: freight, both bulk and containerised; and urban passenger transport. The national rail infrastructure will require significant new investment in some areas to attract new freight flows and increase the number of commuters. Nevertheless, with increasing demand for efficient freight movement in New Zealand's growing economy and increasing congestion in both Auckland and Wellington, there will be natural growth in rail freight and urban rail passengers.

The strategy outlines action in accordance with the Government's vision for an affordable, integrated, safe, responsive and sustainable transport system. This includes shifting commuter and freight traffic on to rail, where appropriate, to ease road traffic congestion.

Programmes: Air quality

Description of the policy or measure

The Government (through the Ministry of Transport and Ministry of Economic Development) has work programmes that have a primary focus on addressing air quality and health issues. These programmes have some co-benefits for reducing greenhouse gases. They cover importation of vehicles, the operation of the existing fleet and fuel quality.

The benefits of these programmes, in terms of greenhouse gas reductions, are, however, not easily quantifiable. In addition to uncertainties around emerging technologies, there are other factors that will more strongly influence fuel consumption; for example, the ability of the consumer to choose more powerful vehicles and the number of kilometres travelled. Public campaigns associated with these programmes will emphasise the need to maintain vehicles and this has direct fuel economy benefits.

The *Third National Communication* suggested that there would be reduced greenhouse gas emissions from a Government-planned programme for in-fleet vehicle testing. In March 2005, the Government announced that the vehicle testing programme, in the form it was initially envisaged, will not go ahead.

It has also been recognised that there was no certainty that reductions in greenhouse gases would result from the programme. Hence, New Zealand's *Fourth National Communication* does not include greenhouse gas reductions from vehicle testing.

Objectives of the policy or measure

The objective is to improve air quality by introducing mandatory fuel standards and improving the quality of the vehicle fleet. Diesel fuel was required to have a maximum level of 50 parts per million of sulphur by January 2006 and the Government has signalled that it will require ultra-low sulphur levels (10–15 parts per million sulphur) in 2009/2010. Lowering the sulphur levels in transport fuels will allow for uptake of emerging vehicle technologies with fuel economy benefits. Imported vehicles built after 1990 must now show that they were built to the standard that applied in the country of manufacture (Road Transport Rule: Vehicle Equipment 2004).

There is the potential for more stringent controls on the vehicle fleet. Work on vehicle emission standards covers both imported vehicles and the existing fleet. New Zealand does not have a domestic vehicle manufacturing industry and it is unusual in that New Zealand's imports are dominated by used vehicles from the domestic Japanese market.

The greenhouse gas or gases affected

With regard to transport emissions, the primary greenhouse gas is carbon dioxide. Relatively small amounts of nitrous oxide are released. Policies focused on reducing air pollutants will affect emissions of oxides of nitrogen and sulphur (NO_x and SO_x).

Type or types of policy or measure

The programme is regulatory.

Status of implementation

The regulations for 50 parts per million sulphur diesel and the Vehicle Equipment, Road Transport Rule are implemented. The Government has sought public comment on a reduction to 10–15 parts per million in 2009. Public consultation is currently occurring on additional controls to reduce the harmful emissions from vehicles entering, and already in, the vehicle fleet.

Implementing entity or entities

The Ministry of Transport is responsible for vehicle standards and the Ministry of Economic Development for fuel standards.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Information about non-GHG benefits of the policy or measure

The focus of the policy is improvement in air quality, including reductions in particulates, oxides of sulphur and nitrogen and hydrocarbons.

How the policy or measure interacts with other policies and measures at the national level

Policies focused on improving the quality of vehicles entering the fleet for air quality reasons have benefits for improving the fuel efficiency of the fleet.

Programme: Renewable transport fuels

Description of the policy or measure

This programme supports fulfilment of New Zealand's Renewable Energy Target, which includes an indicative target for renewable transport fuels of two petajoules a year by 2012. The two petajoules target is equivalent to about one percent of current transport energy use.

Objectives of the policy or measure

The objective is to increase production and availability of bio-ethanol/petrol blends and biodiesel. Neither is currently commercially available.

Bioethanol is produced from whey, a by-product of the dairy industry. Current domestic production of fuel grade ethanol could provide 0.2 to 0.3 percent of petrol consumption.

Biodiesel feedstock in New Zealand is primarily tallow from the meat industry. With currently available feedstock and significant investment in manufacturing plant it is estimated that it would be possible to replace five percent of diesel with biodiesel.

The greenhouse gas or gases affected

The greenhouse gas covered is primarily carbon dioxide.

Type or types of policy or measure

The programme is regulatory.

Status of implementation

The programme is in the planning stage. The Government has confirmed that it will develop and introduce a mandatory biofuels sales target. Comment has been sought from oil companies, biofuels producers and raw material suppliers, motor vehicle industry groups and transport users groups on the value of such a target. In support of a likely future sales target, fuel standards for biofuels are being developed in consultation with the industry.

Implementing entity or entities

The agencies implementing the policy are the Ministry of Transport and the Ministry of Economic Development.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Information about non-GHG benefits of the policy or measure

Use of biodiesel has air quality benefits, but these are not expected to be significant at low-level blends.

How the policy or measure interacts with other policies and measures at the national level

The programme is consistent with sustainable energy policies, including consideration of oil security.

Programme: Information on vehicle fuel-efficiency

Description of the policy or measure

A website is being developed to provide customers with a measure of vehicle fuel economy (litres per 100 kilometres). Given the high proportion of used Japanese vehicles available, this work has required understanding the manufacturing standards for the Japanese domestic market. Associated fuel-efficiency labelling of vehicles at point of sale is being investigated.

Objectives of the policy or measure

The objective is to encourage the purchase of fuel-efficient vehicles by providing appropriate consumer purchasing information, covering both new and second hand vehicles.

The greenhouse gas or gases affected

The greenhouse gas covered is primarily carbon dioxide.

Type or types of policy or measure

It is an information policy.

Status of implementation

The data have been collated. A website is planned for launch in 2006.

Implementing entity or entities

The Ministry of Transport is responsible for implementing the programme.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

How the policy or measure interacts with other policies and measures at the national level

This programme links with programmes encouraging appropriate vehicle purchases by Government departments and agencies.

Programme: Surface transport costs and charges

Description of the policy or measure

A Government-commissioned report, *Investigation into Surface Transport Costs and Charges,* has been prepared. The purpose of this study was to provide estimates of the costs imposed by road users and by rail users, and the payments they make for using each mode, as the basis for future land transport policy. The study provides estimates of all of the costs and charges involved in the total nation-wide road and rail systems, including estimates for the costs of capital, infrastructure (operations, maintenance and depreciation), congestion, accidents, environmental externalities (including impacts on water quantity and quality, local air quality, noise pollution and greenhouse gas effects), taxes, and charges such as road user charges, motor vehicle registration and re-licensing, fares and freight tariffs. No policy decisions have yet been made as a result of the report.

Objectives of the policy or measure

The objective is to assist the Government to make decisions on the relative competitive position of road and rail for freight transport and of rail, bus and the private car for passenger transport.

The greenhouse gas or gases affected

The programme primarily covers carbon dioxide.

Type or types of policy or measure

This is an informational initiative.

Status of implementation

The programme was launched by the Minister of Transport on 31 March 2005.

Implementing entity or entities

This initiative is implemented by the Ministry of Transport.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Information about non-GHG benefits of the policy or measure

The report also covers the cost of harmful emissions affecting air quality.

How the policy or measure interacts with other policies and measures at the national level

The report adds to the information base regarding the transport sector.

Programme: Travel demand management

Description of the policy or measure

Travel demand management programmes are targeted at businesses, local authorities, schools and other institutions.

Objectives of the policy or measure

The programmes aim to encourage people to use forms of transport that use less energy and reduce their present dependency on the single traveller per car.

The greenhouse gas or gases affected

The programme primarily covers carbon dioxide.

Type or types of policy or measure

This is a voluntary programme based on providing assistance through information provision, education and financial support. Government agencies (central and local) work with business and schools to establish appropriate travel behaviour and transport mode. Walking and public transport are supported.

Status of implementation

The programme is being implemented in targeted areas – primarily large urban areas.

Implementing entity or entities

The programme is implemented by the Energy Efficiency and Conservation Authority.

Quantitative estimate of the impacts of the policy or measure

These programmes are expected to contribute 0.04 petajoules of energy savings in 2006 and have the potential to contribute even greater savings in the future.

Information about non-GHG benefits of the policy or measure

Air quality benefits are generated from reduced vehicle use.

How the policy or measure interacts with other policies and measures at the national level

This programme links with local government land transport management plans. These plans include proposed developments for public transport and appropriate infrastructure to support walking, cycling and use of public transport.

Programme: Aviation and maritime transport

The Government has no specific policies aimed at reducing greenhouse gas emissions of air and maritime transport. Ministry of Transport and other officials meet with International Maritime Organisation and International Civil Aviation Organisation representatives from time to time to ensure domestic policy is kept informed of developments in those fora.

Local Government Case Study:

Auckland – A city of 1.4 million people

The **Auckland Regional Land Transport Strategy** (produced by the Auckland Regional Council) proposes the way forward for the region's transport system for the next 10 years – to 2016. It sets regional objectives and policies for transport planners and service-providers in the Auckland region. The legal requirement for the strategy is the Land Transport Act 1998 (Section 175 (2)) and the Local Government (Auckland) Amendment Act 2004. Since November 2003, all regional land transport strategies are required to contribute to an integrated, safe, responsive and sustainable land transport system.

Vision for transport in the Auckland region

A transport system which enhances the Auckland region as a great place to live, work, and play.

The strategy's contribution to "ensuring environmental sustainability"

There are some matters which are outside the control of the Regional Land Transport Strategy. These include the fuel efficiency of vehicles and increased travel as a result of regional growth. An area which can be influenced is managing travel demand.

Travel demand

The strategy recognises that it is not possible to adopt a "predict and provide" approach to transport in Auckland – there are too many cars. While additional services and infrastructure will be required, the region will also increasingly need measures that reduce the demand for travel, particularly by private vehicles.

The strategy includes a Travel Demand Management Strategy (required under the Land Transport Management Act 2003) that seeks to influence the demand for travel – in particular to reduce car trips and to encourage more people to walk, cycle, catch public transport, share car trips, and to work, shop and play locally.

Travel demand management tools can include travel plans for schools and work places, walking and cycling networks and connections, and the supply and pricing of parking.

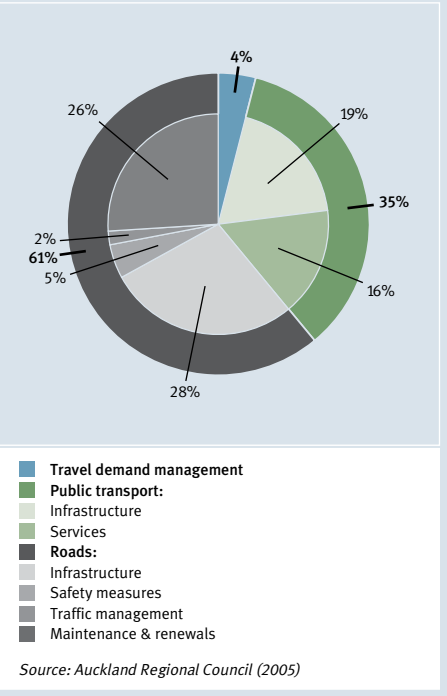
(Note: Charging people to use parts of the road network – road pricing – is a current central Government work programme which involves separate evaluation and public consultation.)

A consultation document identified a preferred option which gave prominence to travel demand management supported by a substantial increase in public transport spending. This focus was confirmed in the final strategy.

Costs

The strategy allocates $11.03 billion over 10 years. This includes $6.81 billion to cover new roading infrastructure, maintenance/ renewals, traffic management and safety to allow improvements to the region's strategic road network. The balance of the money would be allocated to passenger transport ($3.8 billion) and travel demand management measures ($420 million).

4NC Figure 26: Budget allocation for the Auckland Regional Land Transport Strategy



Source: Auckland Regional Council (2005)

Expected outcomes for environmental sustainability

Relevant outcomes from implementing the preferred strategic option include:

People will have a greater choice of travel modes and it will be easier to change between them with the introduction of integrated ticketing.

By 2016, walking or cycling is expected to make up 15.5 percent of all trips.

The reliability of public transport services will be much higher.

In peak periods, 11 percent of trips is expected to be by public transport, compared with 7 percent now.

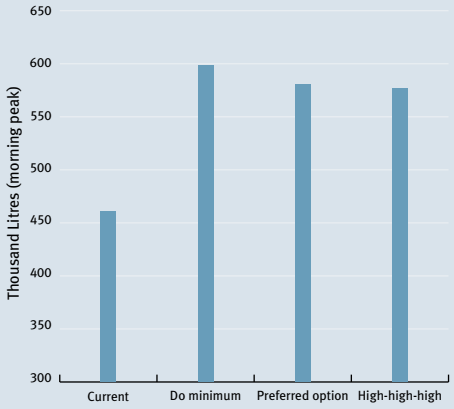
Forty-nine percent of motorised trips into the Central Business District will be by public transport, compared to 32 percent now.

How will progress be measured?

1. Fossil fuel used

As a result of the significant increase in population and economic activity, energy used to travel as measured by fuel use is expected to increase by 26 percent by 2016. But, this is a lesser increase that the "do minimum" option.

4NC Figure 27: Projected transport fossil fuel use per annum at 2016 in Auckland



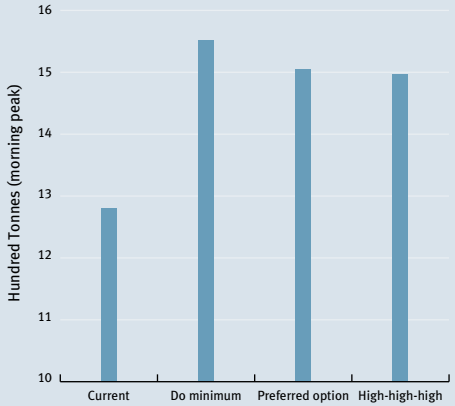
Note: The "high-high-high" option refers to high funding levels in all three areas (travel demand management, public transport and roading improvements) in contrast to the "preferred option," which had medium funding levels for travel demand management, high funding levels for public transport and medium funding levels for roads (with completion of 63% of identified improvements).

Source: Auckland Regional Council (2005)

2. Carbon dioxide emissions from transport

Carbon dioxide emissions generated by the transport system are expected to increase by 21 percent by 2016.

4NC Figure 28: Projected tonnes of transport carbon dioxide emissions (morning peak) in 2016 in Auckland



Note: The morning peak traffic (7–9am) is used as a comparative measure because this is what the Auckland Transport Model is based on.

Source: Auckland Regional Council (2005)

Industry policies and measures

When the Government completed the review of the climate change policy package in November 2005, it subsequently decided that a new focus will be required to address industry issues more effectively. As a result, the previously announced carbon tax and associated Negotiated Greenhouse Agreements for eligible industrial emitters will not now be introduced. A work programme will examine alternative measures to the announced carbon tax, including consideration of emissions trading and new, possibly voluntary, arrangements to replace Negotiated Greenhouse Agreements.

New Zealand's current climate change policies for industry are focused on the Projects to Reduce Emissions programme, measures to assist energy-intensive businesses, and the National Energy Efficiency and Conservation Strategy. All of these policies are described in other sections of this chapter.

A very small fraction (less than 0.5 percent) of New Zealand's greenhouse gas emissions is attributable to fluorinated gases. In New Zealand these are known as synthetic gases and include sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). Measures to address the emissions of these gases are addressed opposite.

Programme: Sulphur hexafluoride

Description of the policy or measure

Recognising the small contribution sulphur hexafluoride makes to New Zealand's overall greenhouse gas emissions profile, the Government has agreed a Memorandum of Understanding with relevant industry participants to manage sulphur hexafluoride emissions. The Memorandum of Understanding is not legally binding on either the Crown or the industry participants.

Objectives of the policy or measure

The Government has exempted users of sulphur hexafluoride from any application of its climate change policies. In return the industry representatives who have signed the memorandum agree to move towards best practice in terms of their management of sulphur hexafluoride emissions.

Users have been classed into two categories: major and minor users. Major users are defined as users holding quantities of sulphur hexafluoride within equipment exceeding 500 kilograms. Minor users hold quantities less than 500 kilograms. The Memorandum of Understanding established targets for major users to keep leakage rates at a maximum of two percent per annum relative to total equipment nameplate weight of sulphur hexafluoride held by the participant. Participants can achieve their target reductions using an offset of emissions elsewhere.

This target is qualified by another commitment from major users – to establish monitoring and reporting regimes within 18 months of signing the Memorandum of Understanding consistent with the Tier 3a methodology set out in the *IPCC Good Practice Guidelines*. Once the monitoring and reporting regime is in place, major users will report their emissions of sulphur hexafluoride on a July–June annual basis, with performance relative to targets measured against this reporting.

Minor users have no targets or commitments under the Memorandum of Understanding.

The greenhouse gas or gases affected

This programme targets sulphur hexafluoride.

Type or types of policy or measure

The Memorandum of Understanding is a non-binding, voluntary agreement between the Government and industry to manage sulphur hexafluoride emissions.

Status of implementation

The Memorandum of Understanding was signed on 27 July 2004 giving the major users until 27 January 2006 to implement their monitoring and reporting regimes.

Implementing entity or entities

The Memorandum of Understanding was signed by the Convenor of the Ministerial Group on Climate Change[10] on behalf of the Government, and state-owned generators and transmission companies including: Transpower, Vector, Meridian Energy, Mighty River Power, Genesis Power, Contact Energy, and Comalco.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Programme: No-loss campaign

Description of the policy or measure

The programme is aimed at improving the awareness of refrigeration and air conditioning engineers about the greenhouse gas risks associated with fluorocarbon refrigerants. The mechanism is education about a code of practice followed by an examination and issuance of a "No-Loss" card to those who are successful.

Objectives of the policy or measure

The objective of this programme is to improve the management of fluorocarbon refrigerants.

The greenhouse gas or gases affected

The programme covers hydrofluorocarbons and perfluorocarbons.

Type or types of policy or measure

This is a voluntary educational programme.

Status of implementation

The programme is under implementation.

Implementing entity or entities

The programme is being implemented by refrigeration industry bodies.

Quantitative estimate of the impacts of individual policies and measures or collections of policies or measures

This information is not available.

Agriculture policies and measures

Non-carbon dioxide emissions – methane and nitrous oxide from pastoral agriculture – account for just under half of New Zealand's total greenhouse gas emissions.

Finding proven, practical and cost-effective farm practices and technologies to reduce agricultural emissions remains a challenge. The Government has decided, therefore, that it will bear the cost of the agricultural sector's non-carbon dioxide emissions, provided that the agricultural sector contributes to research into ways to reduce greenhouse gas emissions from agricultural activities.

Programme: Support for improvement of the agricultural sector national greenhouse gas inventory

Description of the policy or measure

This programme was built around recognition of the importance of the agricultural sector inventory and the uncertainties surrounding it, including the uniqueness of New Zealand's environment and agricultural systems, and need to develop country-specific emission factors.

Objectives of the policy or measure

The objective of the agricultural greenhouse gas inventory research programme was to systematically reduce uncertainties and improve the estimates of agricultural methane and nitrous oxide national inventory estimates, for the purpose of reporting to the United Nations Framework Convention on Climate Change and fulfilling other reporting requirements.

Indicators of success were to be a reduction over time in the national inventory's uncertainty estimates and a more robust national inventory estimate, as judged by international peer review.

The greenhouse gas or gases affected

The programme addressed methane and nitrous oxide.

[10] This position is now held by the Minister Responsible for Climate Change Issues.

Type or types of policy or measure

This was a Government-supported research programme funded for four years to improve the estimates of activity data and emission factors as identified by the *IPCC Good Practice Guidance* manual and required for reporting under the UNFCCC and Kyoto Protocol requirements.

Status of implementation

The programme was implemented 1 July 2001 and completed 30 June 2005.

Implementing entity or entities

The programme was implemented through the Ministry of Agriculture and Forestry with the support of the Ministry for the Environment and two expert science working groups, NZ Net, and Methanet. The working groups comprised an inter-agency network of public and private sector scientists who were specialists in nitrous oxide and ruminant methane research.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Information about the costs of the policy or measure

The Government allocated a total of $2.75 million (GST[11] inclusive) to be spent over four years. The funding profile was $0.5 million, $0.75 million, $1 million and $0.5 million.

Information about non-GHG benefits of the policy or measure

The programme has highlighted the increase in animal performance over time in New Zealand, and has been instrumental in enhancements to the national agricultural statistics collected.

How the policy or measure interacts with other policies and measures at the national level

The policy forms part of the National Greenhouse Gas Inventory Programme and links closely with the national programme of research into agricultural sector mitigation research by the Pastoral Greenhouse Gas Research Consortium.

Programme: Pastoral agriculture research

Description of the policy or measure

A voluntary partnership between the Government and the agricultural sector has been formed, incorporating the establishment of a new agricultural sector body, the Pastoral Greenhouse Gas Research Consortium, a sector research strategy and collaborative funding between the parties.

Objectives of the policy or measure

The objectives of the programme are to identify, establish and develop on-farm technologies for sheep, dairy and beef cattle and deer which lower methane emissions from New Zealand ruminants and nitrous oxide from grazing animal systems.

The Pastoral Greenhouse Gas Research Consortium's target is to have safe, cost-effective greenhouse gas abatement technologies, which will lower total New Zealand ruminant methane and nitrous oxide emissions by at least 20 percent as compared with the "business as usual" emissions level, by the end of the Kyoto Protocol's first commitment period (2012).

The greenhouse gas or gases affected

The programme seeks to influence the level of methane and nitrous oxide emissions from enteric fermentation in ruminants and through deposition of nitrogen through dung and urine onto pasture and into waste management systems.

Type or types of policy or measure

The programme is a voluntary agreement between the Government and the agricultural sector to carry out research into mitigation technologies and practices.

[11] GST is New Zealand's Goods and Services Tax.

Status of implementation

The programme was launched in 2003 and has been in place for two years. The Pastoral Greenhouse Gas Research Consortium reports annually to the Government on the progress made. The consortium refined its research strategy in 2005.

Implementing entity or entities

The programme is implemented through a Memorandum of Understanding between the Government and key agricultural sector bodies, and is implemented by the Pastoral Greenhouse Gas Research Consortium. The Memorandum of Understanding is associated with an industry strategy on the research approach to mitigating greenhouse gases in agriculture. The research outlined in the strategy document is funded through a partnership between Government and the agricultural industry and is managed by the consortium. The dairy, sheep, beef cattle, deer sectors and fertiliser manufacturers are industry partners in consortium and contribute funds to its current and future research programmes and, independently, through their own research programmes. The Government funding contribution is provided to the consortium via the Foundation for Research, Science and Technology.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Information about the costs of the policy or measure

The industry funding contribution is matched dollar for dollar by Government funding through the Foundation for Research, Science and Technology. Currently the Government funding level is $1.6 million per annum. Add-on methane and nitrous oxide research to other private and public sector research programmes significantly increases the total level of investment and impact of this programme.

Information about non-GHG benefits of the policy or measure

The aim of the Pastoral Greenhouse Gas Research Consortium is also to look for technologies that will also enhance agricultural productivity as well as environmental performance. Methane in ruminants is a waste product representing up to 10 percent of energy loss to animals. Harnessing this energy loss into increased productivity is the preferred option for Pastoral Greenhouse Gas Research Consortium research.

Some of the technologies have other environmental and economic benefits. For example, Eco N, a de-nitrification inhibitor product that reduces nitrous oxide emissions, reduces nitrate leaching into groundwater while at the same time increasing forage production.

How the policy or measure interacts with other policies and measures at the national level

A number of policies may have an impact on the extent of the methane and nitrous emissions from agriculture.

Policies that reduce nitrogen inputs and thereby limit nitrous oxide emissions are being considered for key areas around iconic New Zealand's lakes – Lake Taupo and Lake Rotorua – where degradation of water quality has been occurring due to farming and other activities.

Policies that enhance forestry are taking land out of agricultural production and so reduce methane and nitrous oxide emissions while enhancing carbon sinks; for example the East Coast Forestry Project.

In the South Island high country, the tenure of extensively farmed land is being reviewed with the aim of retuning some of the land to the Conservation Estate and out of livestock farming. From 2002 to 2013, livestock numbers are estimated to be reduced by 0.5 million stock units.

Waste policies and measures

Policies to reduce the greenhouse gas emissions associated with the waste sector have been developed by the Ministry for the Environment in partnership with local government. Particularly relevant is the organic waste stream due to its generation of methane when disposed of in landfills.

National Waste Minimisation and Management Strategy

This strategy, launched in March 2002, aims to reduce the volume of organic waste being produced through better resource use, and design for re-use. The following targets have been set:

- by 2005, 60 percent of garden wastes diverted from landfill and by 2010, complete (more than 95 percent) diversion of garden wastes
- by 2015, complete diversion (more than 95 percent) of kitchen wastes from landfills
- by 2007, all sewage sludge disposed to landfill is appropriately treated.

The strategy interacts with the national environmental standard on landfill gas capture and policy and guidance instruments regarding landfill siting, design and management.

Programme: National environmental standard for landfill methane

Description of the policy or measure

The national environmental standard requires landfills with a lifetime design capacity exceeding one million tonnes and a current stock capacity of 200,000 tonnes to collect and destroy landfill gas. The standard is expected to prevent around 40,000 tonnes of methane being emitted over the first commitment period.

Objectives of the policy or measure

The objective is to increase the use of methane recovery systems at larger landfills.

The greenhouse gas or gases affected

The programme covers methane emissions.

Type or types of policy or measure

The programme is regulatory.

Status of implementation

The national environmental standard came into effect in October 2004. Non-complying landfills have three years from that date to fund, design and install a collection system. *The 2002 Landfill Review and Audit* (Ministry for the Environment, 2003) shows that 19 of New Zealand's 116 operating landfills exceed the one million tonne threshold, and 75 percent of these already collect and manage landfill gas or are planning to do so in the near future.

Implementing entity or entities

This standard is implemented by regional and local councils, with support from the Ministry for the Environment.

Quantitative estimate of the impacts of the policy or measure

The standard is estimated to reduce emissions by 2.07 million tonnes CO2 equivalent over the period from 2006 to 2016. This represents 60% of all landfill gas emissions, which equals 2.4% of New Zealand's total methane emissions.

Information about the costs of the policy or measure

There will be small annual monitoring costs for regulatory authorities, including central Government and regional councils.

Some landfill operators will incur gas collection system design and installation costs. All landfill operators will face monitoring and reporting costs. However, the cost to landfill operators will be relatively low as the standard's size threshold of one million tonnes is widely accepted in the industry as being the level at which collection of landfill gas is technically and financially viable.

Information about non-GHG benefits of the policy or measure

The standard will provide a level playing field and certainty for the waste management industry, as well as an incentive to divert organic waste (e.g., food scraps and garden waste) from landfills. It will also assist in the control of landfill odours and in landfill health and safety concerns.

How the policy or measure interacts with other policies and measures at the national level

There is ongoing closure of smaller landfills and the general trend towards larger landfills that attempt to meet internationally defined best practise in terms of environmental effects. There is also interaction with effects from the National Waste Minimisation and Management Strategy, including increasing separation and divergence of green waste from landfills, and from improvements in landfill management, based on recently introduced (but non-mandatory) landfill guidelines.

Programme: Methane and nitrous oxide emissions from industrial, commercial and domestic wastewater

Methane and nitrous oxide emissions from wastewater are a small part of New Zealand's total greenhouse gas emissions. However, several local authorities already extract methane from wastewater treatment plants and use it for generating electricity, heating boilers and heating digesters. In some instances the methane is flared. Some industrial emitters are extracting methane from wastewater treatment systems and using it as an energy source. Others are examining the potential for using methane from this source.

Forestry policies and measures

The Government announced its climate change policies for the forestry sector in the climate change policy package in 2002. From a Kyoto Protocol perspective, policies in relation to planted production forests are the most important. For these forests, under the preferred policy package the Government decided to retain all sink credits and their associated liabilities for at least the first commitment period. These credits arise from forests first planted since 1990 (so-called Kyoto forests). Kyoto forest owners would not face any deforestation or harvesting liabilities at any stage where the Crown had retained the forest sink credits. Should the Government decide to devolve forest sink credits in the future, then associated deforestation and harvesting liabilities would only be devolved in proportion to the credits received by the Kyoto forest owner.

Under the preferred policy package, the Government, rather than forest owners, also assumed the liability created by the Protocol for deforestation of pre-1990 forests, up to 21 million tonnes of carbon dioxide emissions. This is roughly equal to deforestation of 10 percent of forests expected to be harvested during the Protocol's first commitment period. In the event that significant deforestation occurred at levels above expectations, the Government would consider its policy options to manage emissions within the cap, including addressing issues such as how deforestation rights within the cap would be allocated; how to monitor and enforce the deforestation cap; and what actions the Government would take in the event the cap was exceeded.

Pursuant to the 2005 review of the climate change policy package, the Government is currently considering a work programme on forestry policy options for managing deforestation and encouraging afforestation (new tree planting) and reforestation (reversion to indigenous forest or replanting). Ongoing policies and measures in the forestry sector are reported opposite.

Programme: Permanent Forest Sinks Initiative

Description of the policy or measure

Developed in response to the 2002 climate change policy package, this proposed initiative would be a contract (registered against land titles) between the Crown and a landowner. The Crown would agree to devolve an amount of tradable carbon emission units equal to the amount of carbon sequestered in new permanent forest sinks over the Kyoto Protocol's first commitment period. Obligations under the contract would be registered against land titles and would run with and bind the land. These forests must maintain a continuous canopy cover, although limited timber harvesting is allowed.

Objectives of the policy or measure

The objective of the initiative would be to allow landowners the opportunity to access the value, created under the Kyoto Protocol, of carbon from newly established permanent forest sinks. It would also generate many environmental co-benefits, including reducing agricultural emissions (as forests tend to displace agricultural production in New Zealand) and improved resistance to damage from severe adverse weather events.

The greenhouse gas or gases affected

This initiative would principally address carbon dioxide. By displacing agricultural production this initiative will also have some effect on reducing methane and nitrous oxide.

Type or types of policy or measure

The initiative would essentially be a contractual arrangement between landowners and the Crown.

Status of implementation

The House of Representatives would need to pass the Climate Change Response Amendment Bill, which is currently under consideration, to begin the process of operationalising the initiative. Regulations would then need to be developed.

Implementing entity or entities

The programme would be implemented by the Ministry of Agriculture and Forestry.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Information about the costs of the policy or measure

The Government allocated a total of $0.25 million to establish the initiative. Once established the initiative would be fully cost-recovered from participants.

Information about non-GHG benefits of the policy or measure

The initiative would allow landowners to make better economic use of their land, particularly of isolated and erodable land not suitable for agriculture or commercial clear-fell forestry. The initiative would be likely to produce positive environmental outcomes in terms of biodiversity, soil and water conservation, water quality and flood protection, funds for natural forest restoration, diversification of forest timber species, the development of a special-purpose timber supply, and the reduction in agricultural emissions through displacing some marginal pastoral agriculture.

How the policy or measure interacts with other policies and measures at the national level

The initiative has synergies with other Government policies such as the East Coast Forestry Project.

Programme: East Coast Forestry Project

In 1992, the Government established the East Coast Forestry Project.

Description of the policy or measure

Landholders in the affected area are encouraged to tender for Government grants which help fund the cost of establishing and managing forest on eroding and erosion-prone land. This financial assistance offsets the additional costs and risks associated with afforestation on this land. The project allows a range of treatments to be applied to erosion-prone land including commercial forestry, poplar and willow planting, and the setting aside of areas for regeneration of native forests.

Objectives of the policy or measure

The project aims to facilitate the planting of 200,000 hectares of commercially productive forest over the 28 years to 2020 on eroding and erodable land in the East Coast region of the North Island. Following a Ministerial review completed in 2000, the project was modified to target 60,000 hectares of the most at-risk lands and allowing for inclusion of some surrounding lands, totaling about 120,000 hectares.

The greenhouse gas or gases affected

This project would principally address carbon dioxide. Because it will displace agricultural production, it will also have some effect on reducing methane and nitrous oxide.

Type or types of policy or measure

This is a fiscal measure. The Government provides financial incentives to treat eroding and erosion prone land.

Status of implementation

This project is under implementation. Since the project's inception in 1992, 32,000 hectares of forest have been established. This includes about 17,000 hectares of the targeted at-risk land with the balance being adjacent land established to form sustainable land management boundaries. It is anticipated that this planting rate will increase as local government regulation on sustainable land use is developed.

Implementing entity or entities

This project is implemented by the Ministry of Agriculture and Forestry.

Quantitative estimate of the impacts of individual policies and measures or collections of policies or measures

This information is not available.

Programme: Regional council-assisted afforestation

A number of regional councils offer financial support to land owners to afforest for sustainable land management and biodiversity enhancement reasons. Carbon sequestration is a co-benefit. While plantings since 1990 are known to be significant, we have not been able to quantify these, or further describe the programmes, for this report.

Cross-sectoral policies and measures

The Government's 2002 climate change policy package contained cross-sectoral policies and measures for the Kyoto Protocol first commitment period. This package included the introduction of a carbon tax from 2007, together with Negotiated Greenhouse Agreements for eligible firms. As an outcome of the review, the Government announced in December 2005 that it would not proceed with the announced carbon tax and that it would implement a work programme on alternative measures to the announced carbon tax. Two cross-sectoral policies and measures developed under the 2002 climate change policy package are ongoing: a policy for energy-intensive businesses, and the Projects to Reduce Emissions programme.

Programme: Energy-intensive businesses

Description of the policy or measure

The policy for energy-intensive businesses aims to assist energy-intensive small and medium enterprises to reduce greenhouse gas emissions through improved energy efficiency. Energy intensive businesses are defined as those that spend more than eight percent of costs on energy.

Nine industries have been identified as being energy intensive. Technologies will be selected that are capable of delivering significant energy savings and have the potential to be widely used in these industries. Firms that are willing and able to host projects in some or all of these industries will then be selected to demonstrate the application of these technologies.

The target industries are wood processing, food processing, basic metals, non-metallic industries, paper and paper products, glasshouse crops, fishing, irrigated dairying, and irrigated arable crops.

Objectives of the policy or measure

The energy-intensive businesses policy aims to reduce greenhouse gas emissions resulting from energy use by small and medium enterprises on a cost-effective basis.

The greenhouse gas or gases affected

The main greenhouse gas affected is carbon dioxide.

Type or types of policy or measure

The policy is implemented through the following four measures:

- financial grants to assist capital investment in technologies to improve energy efficiency
- demonstrations of energy-efficient technologies to provide support for innovation and technology uptake
- training for company directors to influence a conservation culture in corporate governance
- education for company managers and staff about energy efficiency.

Status of implementation

Implementation will proceed in two stages, depending on funding. The first stage is a pilot programme (under implementation), and the second stage will be a fully-fledged scheme (planned).

A pilot scheme was established on 1 July 2005 to test the effectiveness of the grant scheme and demonstration projects, and to provide information that could support establishment of a fully-fledged scheme. Training and education programmes will begin in 2006.

Implementing entity or entities

The Energy Efficiency and Conservation Authority (EECA) is responsible for implementing the policy. The Ministry for the Environment has an oversight role and is responsible for any subsequent policy change or development.

Quantitative estimate of the impacts of the policy or measure

Small to medium enterprises are estimated to account for around 15 percent (5 million tonnes) of total New Zealand carbon dioxide emissions (35 million tonnes in 2003). EECA estimates that most firms are capable of achieving energy efficiency gains of five to seven percent through relatively simple measures. Further improvements (possibly up to 20 percent) may be made using information from energy audits.

The policy aims to achieve overall efficiency gains of five percent for fossil-fuel use (coal, gas, liquid fuels), seven percent for electricity use, and up to 20 percent in some firms in the target industries. Assuming a direct one-to-one relationship between energy savings and emissions reductions, this would translate into emissions reductions of at least 300,000 tonnes of carbon dioxide per year (about three percent of emissions from industrial and commercial sources).

Information about the costs of the policy or measure

The pilot demonstration and grant scheme will cost $1.1 million to implement in 2005/06 and $1.35 million in 2006/07 and 2007/08, excluding private sector capital investment. The fully-fledged scheme has not yet been fully costed.

Information about non-GHG benefits of the policy or measure

The policy aims to contribute to other Government objectives, including energy efficiency, electricity security, sustainable development, and growth and innovation.

Programme: Projects to Reduce Emissions

Description of the policy or measure

The Projects to Reduce Emissions programme aims to provide an incentive for projects that reduce emissions below "business as usual" during the first commitment period of the Kyoto Protocol. The projects contribute to emissions mitigation, capacity building in renewable energy, and improving energy efficiency.

Projects must also take place in New Zealand and result in a reduction in the total greenhouse gas emissions that will be reported by New Zealand in its greenhouse gas inventory. Foreign firms are able to participate in the tender, either directly or indirectly by way of a relationship with a New Zealand-based company.

Projects implemented under the programme are potentially eligible to be joint implementation projects in accordance with the terms of the Kyoto Protocol. Participants in the programme receive assigned amount units (AAUs) but can elect to receive emission reduction units (ERUs) if the project meets international and domestic criteria for joint implementation projects.

Objectives of the policy or measure

The programme is designed to reduce New Zealand's greenhouse gas emissions by supporting projects that provide emission reductions in the Kyoto Protocol's first commitment period (2008–2012) beyond the reductions that would have occurred without the project (that is, beyond "business as usual").

The greenhouse gas or gases affected

The main greenhouse gases covered by the programme to date have been carbon dioxide and methane. Successful project tenders have included wind farms, hydroelectricity generation, co-generation projects, geothermal electricity generation, bio-energy and landfill gas projects.

Type or types of policy or measure

The Projects to Reduce Emissions programme provides financial assistance in the form of Kyoto Protocol emission units to projects that reduce greenhouse gas emissions in the first commitment period.

Status of implementation

The project portfolio comprises 41 projects selected through two tender rounds and an early projects process. Following the review of climate change policies in November 2005, the Government has sought confirmation that there is a need for further cross-sector incentives, and if so what type of intervention is appropriate. A work programme will address this issue. The Government's consideration of future policy in this area will not affect the implementation of projects already undertaken to date under the Projects to Reduce Emissions programme.

Implementing entity or entities

The Ministry for the Environment is responsible for implementing the policy. Subsequent policy development is being undertaken as a cross-Government initiative.

Quantitative estimate of the impacts of the policy or measure

Nearly 11 million units (with each unit having a value of one tonne of carbon dioxide equivalent) have been allocated under the Projects to Reduce Emissions programme (4NC Table 2). Units will be awarded only if the 41 projects are fully implemented.

4NC Table 2: Units allocated during the Projects to Reduce Emissions rounds

Pre-tender rounds	Number of projects awarded units	Units allocated (millions)
Pre-tender round	2	0.76
Tender round 1 (2003)	13	3.66
Tender round 2 (2004)	26	6.18
Total	**41**	**10.60**

Information about the costs of the policy or measure

There are minor administrative costs to the Crown incurred through measuring eligibility, negotiating contracts, monitoring project development and verifying emission reductions.

Local government policies and measures

In October 2002, the Government formally signalled in its climate change policy package that it wished to work in partnership with the local government sector to achieve its climate change objectives (both mitigation and adaptation).

Programme: Partnership with Local Government New Zealand

Description of the policy or measure

The Ministry for the Environment is working with Local Government New Zealand (LGNZ) to assist local authorities to mitigate and adapt to climate change. The Ministry for the Environment has a contract with LGNZ to deliver a formalized partnership between central and local government to enhance the Ministry for the Environment's outreach to and engagement with local government on climate change issues, thereby increasing the effectiveness of the local government and other relevant climate change work streams. The partnership aims to improve awareness, understanding and acceptance of the effects of climate change within the local government sector, leading to increased long-term, sustainable behaviour change in relation to mitigating and adapting to climate change.

Objectives of the policy or measure

The objectives of the partnership programme are to:

- establish and maintain regular communication channels between central and local government on climate change matters
- ensure local government involvement in peer review of adaptation guidance materials (including testing with local government focus groups)
- support the Communities for Climate Protection New Zealand mitigation programme
- support the "4 Million Careful Owners" climate change public awareness and education programme where it intersects with local government sector public awareness activities (refer Chapter 9, "Education, training and public participation")
- provide other advisory functions as required to assist central Government to communicate with the local government sector more effectively.

The greenhouse gas or gases affected

The partnership is a facility for interaction between central and local government and does not target a specific gas *per se*, although methane emissions from landfill and carbon dioxide emissions from transportation are particularly relevant to the local government operations.

Type or types of policy or measure

The partnership coordinates the two-way flow of information and dialogue on climate change policy and programmes between central and local government. The partnership also assists in alerting the local government sector to wider funding opportunities, such as the climate change funding stream under the 2004 Sustainable Management Fund tender round managed by the Ministry for the Environment.

Status of implementation

The partnership has been in operation since March 2004.

Implementing entity or entities

The Ministry for the Environment and Local Government New Zealand are implementing the programme.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Information about the costs of the policy or measure

The costs to the Ministry for the Environment are $65,000 per year. Information about costs to Local Government New Zealand is not currently available.

How the policy or measure interacts with other policies and measures at the national level

The partnership is the forum via which the central Government communicates with local authorities on climate change policy and programmes of relevance to local government, including the Projects to Reduce Emissions programme, and the Permanent Forest Sinks Initiative.

Programme: Communities for Climate Protection™ – New Zealand

Description of the policy or measure

A major part of the local government work is conducted in conjunction with the International Council for Local Environmental Initiatives Australia/New Zealand (ICLEI-A/NZ) through the Communities for Climate Protection™ – New Zealand (CCP–NZ) greenhouse gas emissions reduction programme.

CCP–NZ is a voluntary framework to assist councils to take action to reduce greenhouse gas emissions in their own operations and in the wider community in which they act. It is part of ICLEI-A/NZ's global Communities for Climate Protection™ campaign.

Objectives of the policy or measure

The CCP–NZ mitigation programme aims to reduce greenhouse gas emissions by:

- improving energy efficiency
- reducing waste
- encouraging sustainable transportation
- enhancing urban design
- promoting sustainable farming practices.

The programme focuses on:

- achieving political momentum in councils to take greenhouse action
- assisting council staff to develop greenhouse gas emission inventories
- setting targets for emission reductions
- developing action plans for achieving these
- putting in place monitoring programmes for emissions reductions
- building on the Energy Efficiency and Conservation Authority's Energy-Wise Councils Partnership programme, an existing programme which focuses on energy efficiency.

The greenhouse gas or gases affected

This programme addresses carbon dioxide and methane.

Type or types of policy or measure

While primarily an enabling framework to assist councils to take action to reduce greenhouse gas emissions, CCP–NZ also works to raise awareness, build capacity and improve monitoring programmes in local government.

Status of implementation

The programme was launched in July 2004. Seventeen local government bodies or councils representing around 50 percent of the New Zealand population have since joined CCP–NZ. Funding to support this programme has been secured via contract up until June 2007.

Implementing entity or entities

The International Council for Local Environmental Initiatives Australia/ New Zealand implements the programme. Contract management rests with the Ministry for the Environment. Oversight for the programme's implementation is provided by the CCP–NZ governance body that includes Local Government New Zealand, the Energy Efficiency Conservation Authority, and the Ministry for the Environment.

Programme: Adaptation

Description of the policy or measure

In October 2002, Cabinet directed officials to provide more detailed information on the impacts of climate change as an underpinning element of the Government's climate change policy package, with a view to facilitating adaptation to these impacts. The Ministry for the Environment accordingly developed two work streams: economic impacts and adaptation; and local government adaptation.

These two work streams are managed by an "adaptation" project group (refer to Chapter 6, "Vulnerability assessment and adaptation").

In relation to the local government adaptation work stream, a "toolbox" of guidance materials has been produced to help councils better integrate consideration of the effects of climate change in their day-to-day decision-making.

Objectives of the policy or measure

The local government adaptation guidance materials aim to provide:

- clarification on expected future climate change effects, both in national terms and with respect to specific regions across New Zealand
- practical tools in the form of decision-making frameworks and checklists to enable councils to better consider and respond to climate change effects via existing planning, asset management, hazard management and regulatory processes
- models in the form of case studies which illustrate how other councils have integrated consideration of climate change effects into their operations.

The greenhouse gas or gases affected

This is not applicable.

Type or types of policy or measure

This is an adaptation programme.

Status of implementation

A toolbox of information materials, impacts reports and guidance materials for local government is now complete. This comprises:

- information booklets to raise awareness of climate change effects at the council and senior manager level, and technical staff and planning level respectively
- technical manuals which provide detailed scientific detail on climate change effects in New Zealand, including climate change impacts on coastal hazards
- a quality planning best-practice guidance note aimed at council planners, which outlines recommended planning approaches and the legislative basis for action
- a range of other research and information on climate change impacts on agriculture, biodiversity, health, and forestry.

In addition, a number of case studies have been completed and are available on the Ministry for the Environment website, and several more are due for e-publication shortly.

The Ministry for the Environment website also hosts an informal best practice section for local government which highlights and promotes model council activities relating to climate change.

Implementing entity or entities

This programme is implemented by the Ministry for the Environment, in conjunction with local government.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Programme: Legislative amendment to the Resource Management Act

Description of the policy or measure

The Resource Management Act 1991 is the main environmental statute governing resource management in New Zealand. The Resource Management Act is founded upon the principle of sustainable management of natural and physical resources and integrated the provisions of more than 75 earlier laws. The Act devolves the responsibility for regulating resource use to local authorities (by using regional and district plans). There have been a number of amendments to the Act since 1991 to reflect evolving priorities and needs in environmental management.

Objectives of the policy or measure

The Resource Management (Energy and Climate Change) Amendment Act 2004 reflects the Government's preference for national coordination of controls on greenhouse gas emissions. It gives greater emphasis to climate change and energy matters in Resource Management Act planning and decision-making and provides for nationally consistent management of greenhouse gas emissions. The Act makes explicit provisions within section 7 of the Resource Management Act for all persons exercising functions and powers under the Act to have particular regard to:

- the effects of climate change
- the efficient end use of energy
- the benefits to be derived from the use and development of renewable energy.

The Government's preference is to manage greenhouse gas emissions at the national level. The Resource Management Amendment Act removes councils' ability to make local decisions about managing greenhouse gas emissions when making rules in plans and considering discharge (of greenhouse gases) to air consent applications, except where necessary to implement a national environmental standard. This amendment provides for nationally consistent decision-making with respect to managing greenhouse gas emissions.

It is important to note that the Government's decision not to proceed with the announced carbon tax in December 2005 could affect the operation of the Resource Management Amendment Act. This issue will be addressed by Government officials in the new work programmes currently under development.

The greenhouse gas or gases affected

This policy affects all greenhouse gases.

Type or types of policy or measure

The Resource Management Amendment Act is a piece of legislation clarifying local government responsibility for responding to the effects of climate change.

Status of implementation

The Amendment Act came into force on 2 March 2004. The Energy Efficiency and Conservation Authority and the Ministry for the Environment have produced guidance and information on the renewable energy and climate change effects elements of the Amendment Act. There is specific guidance for councils on decision-making and planning under the amended Act. As stated above, the operation of the Amendment Act could be affected by the Government's decision not to proceed with the announced carbon tax. Officials are undertaking further work in this area.

Implementing entity or entities

This policy is implemented by local government, Ministry for the Environment, and the Energy Efficiency and Conservation Authority.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

Bilateral climate change partnerships

Description of the policy or measure

New Zealand has established bilateral climate change partnerships with the United States of America and Australia. The partnerships enhance and accelerate collaboration and practical cooperation on climate change issues.

United States–New Zealand

Objectives of the policy or measure

The partnership aims to maximise United States–New Zealand business, research, and policy cooperation on climate change under nine priority areas:

- climate change science
- technology development
- registries
- agricultural emissions abatement
- business engagement
- developing country assistance
- Antarctic research
- public education
- product and process standards.

The greenhouse gas or gases affected

Carbon dioxide, methane and nitrous oxide are the primary greenhouse gases covered by the partnership.

Type or types of policy or measure

The partnership coordinates information, action, and dialogue on climate change between the United States and New Zealand. Particularly relevant is the role the partnership plays in connecting researchers in the two countries working in common areas.

Status of implementation

The partnership was announced in October 2002. The first 26 projects were launched in July 2003. A further six projects were announced in Washington, DC in July 2004.

Implementing entity or entities

The Ministry for the Environment coordinates the partnership together with the United States Department of State. A range of Government agencies, research entities, non-governmental organisations, and service providers participate in the partnership at the project level. In New Zealand, these include:

- National Institute of Water and Atmospheric Research
- Industrial Research
- CRL (Coal Research Limited) Energy
- Landcare Research
- AgResearch
- Institute of Geological and Nuclear Sciences
- Antarctica New Zealand
- New Zealand Meteorological Service
- New Zealand Business Council for Sustainable Development
- Lincoln University
- Massey University
- Victoria University of Wellington
- Ministry for the Environment
- Ministry of Agriculture and Forestry
- Ministry of Economic Development
- New Zealand Agency for International Development
- Energy Efficiency and Conservation Authority.

In the United States, project partners include:

- Department of State
- Department of Energy
- Environmental Protection Agency
- National Oceanographic and Atmospheric Administration
- National Science Foundation
- Consortium for Agricultural Soils Mitigation of Greenhouse Gases.

Quantitative estimate of the impacts of the policy or measure

This information is not available.

How the policy or measure interacts with other policies and measures at the national level

The partnership reinforces New Zealand's strong commitment to abatement research for methane and nitrous oxide emissions from agricultural systems.

Australia–New Zealand

Objectives of the policy or measure

The partnership aims to maximise Australia–New Zealand business, research, and policy cooperation on climate change under five priority areas:

- agricultural emissions abatement
- business and local government engagement
- helping Pacific Island countries
- energy efficiency
- climate change science.

The greenhouse gas or gases affected

Carbon dioxide, methane nitrous oxide and sulphur hexafluoride are the primary greenhouse gases covered by the partnership.

Type or types of policy or measure

The partnership coordinates information, action and dialogue on climate change between Australia and New Zealand. Particularly relevant is the role the partnership plays in raising awareness of the business opportunities and challenges that climate change poses.

Status of implementation

The partnership was announced in a joint Australia–New Zealand Ministerial press conference in Melbourne on 26 July 2003. The first seven projects were launched at the Ninth Conference of the Parties in Milan, Italy, December 2003.

Implementing entity or entities

The Ministry for the Environment coordinates the partnership with the Australian Greenhouse Office. A range of Government agencies, research entities, non-governmental organisations and service providers participate in the partnership at the project level.
In New Zealand these include:

- National Institute of Water and Atmospheric Research
- Institute of Geological and Nuclear Sciences
- AgResearch
- Environmental Defence Society
- Ministry for the Environment
- Ministry of Foreign Affairs and Trade
- Ministry of Agriculture and Forestry
- Ministry of Economic Development
- Energy Efficiency and Conservation Authority.

In Australia, project partners include:

- Australian Greenhouse Office
- Bureau of Meteorology
- Primary Industries Research Victoria
- Australian National University.

Policies and measures no longer in place

As noted earlier in this chapter, the Government's 2002 climate change policy package included the introduction of a carbon tax from 2007. Associated Negotiated Greenhouse Agreements were available for firms that met a competitiveness-at-risk test whereby, in exchange for relief from the proposed carbon tax, firms would agree to move towards world's best practice in emissions intensity. Following a full policy review commissioned by Cabinet in mid-2005, the Government announced in December 2005 that the previously announced carbon tax, and associated Negotiated Greenhouse Agreements, would not proceed. The Government is implementing a work programme to develop alternative measures to the announced carbon tax, including consideration of emissions trading and new, possibly voluntary, arrangements to replace Negotiated Greenhouse Agreements.

Chapter 5

Projections and the total effect of policies and measures

Overview

This chapter reports on projections of New Zealand's greenhouse gas emissions and removals from known anthropogenic (man-made) sources and sinks. The projections of greenhouse emissions sources and sinks are "with measures" and consist of energy, transport, industrial processes, agriculture, waste, and forestry (i.e., land use, land-use change and forestry) projections.

For domestic purposes, New Zealand updated its projected emissions and removals of greenhouse gases for the first commitment period (2008–2012) of the Kyoto Protocol in May 2005 *(Projected Balance of Units During the First Commitment Period of the Kyoto Protocol)*. The emissions calculation was consistent with the methodology used for the national inventory of greenhouse gas emissions and removals submitted to the United Nations Framework Convention on Climate Change Secretariat in April 2005. The May 2005 projected balance of units report remains the official reference for projections until updated in mid-2006.

In mid-2005, a full climate change policy review was commissioned by Cabinet. A key outcome of the policy review was the announcement by the Government in December 2005 that the previously announced carbon tax would not proceed. In addition, a suite of future work programmes would be required to inform Government decisions in light of the review and contribute to further development of policies and measures.

For the purpose of submitting the best available information for the *Fourth National Communication* and the *Report on Demonstrable Progress under the Kyoto Protocol* as of December 2005, officials prepared a ***provisional*** update of the May 2005 projections to reflect the policy status following the 2005 review. **Therefore, the projections reported in the *Fourth National Communication* reflect the Government's decision not to proceed with the previously announced carbon tax, but do not reflect any impact from the new work programmes being considered by the Government at the time of publication.** The provisional projections reported in this document will be updated in mid-2006.

Summary of projections

4NC Table 3 summarises historical and projected New Zealand greenhouse gas emissions and removals by sector and gas for the "with measures" case. Data for the year 2003 and prior are historical values, while the numbers for 2005 and later are projections. The energy, transport, and industrial process sector projections are from the Ministry of Economic Development's Supply and Demand Equilibrium Model (SADEM). Projections for the other sectors were obtained as described in the relevant sections below. Total emissions are also reported in carbon dioxide equivalent values, converted from each gas to a carbon dioxide equivalent on the basis of global warming potentials (GWP).[12]

[12] All emissions of non-CO_2 greenhouse gases are reported in this chapter as emissions of CO_2 equivalent using Global Warming Potentials (GWPs). GWPs represent the relative warming effect or cumulative radiative forcing, of a unit mass of the gas when compared with the same mass of CO_2 over a specific period. The UNFCCC reporting requirements specify that the 100-year GWPs contained in the IPCC Second Assessment Report (IPCC, 1995) are used in national inventories.

4NC Table 3: Historical and "with measures" emissions projections

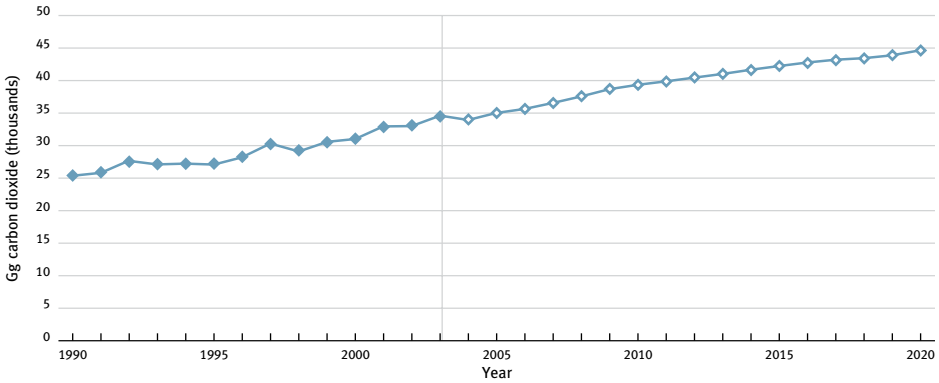
Projection by sector and gas (Gg gas except as noted)	1990	1995	2000	2003	2005	2010	2015	2020
Energy (excluding transport)								
Carbon dioxide	14,019.8	13,285.4	15,562.0	17,441.4	17,164.6	19,271.3	20,539.8	20,614.5
Methane	30.8	29.3	36.7	37.6	42.0	44.2	45.6	46.5
Nitrous oxide	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4
Carbon dioxide equivalent	14,737.5	13,977.6	16,419.5	18,334.9	18,139.6	20,292.5	21,590.4	21,715.0
Transport								
Carbon dioxide	8,632.8	10,855.9	12,281.2	13,788.1	14,203.1	15,695.0	17,552.1	19,514.0
Methane	7.1	6.4	3.6	2.5	2.6	2.7	2.9	3.1
Nitrous oxide	0.2	0.3	0.4	0.5	0.5	0.6	0.6	0.7
Carbon dioxide equivalent	8,856.6	11,094.9	12,486.3	13,986.0	14,412.7	15,937.7	17,799.0	19,796.1
Total energy								
Carbon dioxide	22,652.6	24,141.3	27,843.2	31,229.5	31,367.7	34,966.3	38,091.9	40,128.5
Methane	37.9	35.7	40.4	40.0	44.6	46.9	48.5	49.6
Nitrous oxide	0.5	0.6	0.7	0.8	0.8	0.9	0.9	1.1
Carbon dioxide equivalent	23,594.1	25,072.5	28,905.8	32,320.9	32,552.3	36,230.2	39,389.4	41,511.1
Industrial processes								
Carbon dioxide	2,662.2	3,019.8	3,162.8	3,470.0	3,603.5	3,739.3	3,839.0	3,941.8
Methane	1.0	2.8	5.0	2.0	2.1	2.2	2.3	2.3
Nitrous oxide	-	-	-	-	-	-	-	-
HFC (CO_2 equivalent)	-	147.5	173.3	404.0	419.5	435.3	446.9	458.9
PFC (CO_2 equivalent)	515.6	83.8	59.3	84.9	88.2	91.5	93.9	96.4
SF_6 (CO_2 equivalent)	12.3	15.0	12.0	12.4	12.9	13.3	13.7	14.1
Carbon dioxide equivalent	3,211.7	3,325.2	3,511.7	4,014.2	4,168.6	4,325.7	4,441.0	4,559.9
Solvent and other product use								
Carbon dioxide	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Methane	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nitrous oxide	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Carbon dioxide equivalent	41.5	45.0	47.1	48.4	49.5	52.3	55.3	58.5
Agriculture								
Carbon dioxide	N/A	N/A	N/A	N/A	NA	NA	NA	NA
Methane	1,053.7	1,084.6	1,126.1	1,150.7	1,176.5	1,241.0	1,286.8	1,332.6
Nitrous oxide	32.5	35.5	38.3	42.1	43.3	46.5	48.8	51.0
Carbon dioxide equivalent	32,193.8	33,770.3	35,509.2	37,203.2	38,129.5	40,476.0	42,150.8	43,794.6

4NC Table 3: Historical and "with measures" emissions projections (cont'd)

Projection by sector and gas (Gg gas except as noted)	1990	1995	2000	2003	2005	2010	2015	2020
Forestry (LULUCF)								
Carbon dioxide	-21,370.5	-14,652.0	-22,823.4	-22,865.7	-23,800.0	-9,600.0	-3,400.0	-4,400.0
Methane	0.2	0.3	0.2	0.2	0.2	0.1	0.1	0.1
Nitrous oxide	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carbon dioxide equivalent	-21,366.2	-14,645.9	-22,818.9	-22,861.6	-23,796.8	-9,596.9	-3,396.9	-4,396.9
Waste								
Carbon dioxide	N/A	N/A	N/A	N/A	NA	NA	NA	NA
Methane	111.2	90.8	74.4	75.8	69.3	56.4	53.2	52.3
Nitrous oxide	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Carbon dioxide equivalent	2,480.1	2,058.7	1,717.4	1,754.5	1,617.5	1,347.1	1,280.4	1,260.6
Projection by sector (Gg CO_2 equivalent)								
Energy	23,594.1	25,072.5	28,905.8	32,320.9	32,552.3	36,230.2	39,389.4	41,511.1
Industrial processes	3,211.7	3,325.2	3,511.7	4,014.2	4,168.6	4,325.7	4,441.0	4,559.9
Solvent and other product use	41.5	45.0	47.1	48.4	49.5	52.3	55.3	58.5
Agriculture	32,193.8	33,770.3	35,509.2	37,203.2	38,129.5	40,476.0	42,150.8	43,794.6
Forestry (LULUCF)	-21,366.2	-14,645.9	-22,818.9	-22,861.6	-23,796.8	-9,596.9	-3,396.9	-4,396.9
Waste	2,480.1	2,058.7	1,717.4	1,754.5	1,617.5	1,347.1	1,280.4	1,260.6
Total emissions (excluding net emissions from forestry)	**61,521.2**	**64,271.7**	**69,691.2**	**75,341.2**	**76,517.3**	**82,431.3**	**87,317.0**	**91,184.7**
Total emissions (including net emissions from forestry)	**40,155.0**	**49,625.8**	**46,872.3**	**52,479.6**	**52,720.5**	**72,834.4**	**83,920.1**	**86,787.9**
Projection by gas (Gg gas except as noted)								
Carbon dioxide	25,314.8	27,161.0	31,006.0	34,699.5	34,971.2	38,705.6	41,930.9	44,070.3
Methane	1,204.0	1,214.2	1,246.0	1,268.8	1,292.6	1,346.6	1,390.9	1,436.9
Nitrous oxide	33.5	36.7	39.6	43.5	44.8	48.1	50.4	52.8
HFC (CO_2 equivalent)	-	147.5	173.3	404.0	419.5	435.3	446.9	458.9
PFC (CO_2 equivalent)	515.6	83.8	59.3	84.9	88.2	91.5	93.9	96.4
SF_6 (CO_2 equivalent)	12.3	15.0	12.0	12.4	12.9	13.3	13.7	14.1
Projection by gas (Gg CO_2 equivalent)								
Carbon dioxide	25,314.8	27,161.0	31,006.0	34,699.5	34,971.2	38,705.6	41,930.9	44,070.3
Methane	25,284.0	25,497.4	26,165.8	26,645.0	27,145.5	28,279.5	29,209.4	30,175.8
Nitrous oxide	10,398.7	11,373.1	12,279.3	13,499.5	13,883.4	14,909.2	15,625.2	16,372.4
HFC	-	147.5	173.3	404.0	419.5	435.3	446.9	458.9
PFC	515.6	83.8	59.3	84.9	88.2	91.5	93.9	96.4
SF_6	12.3	15.0	12.0	12.4	12.9	13.3	13.7	14.1

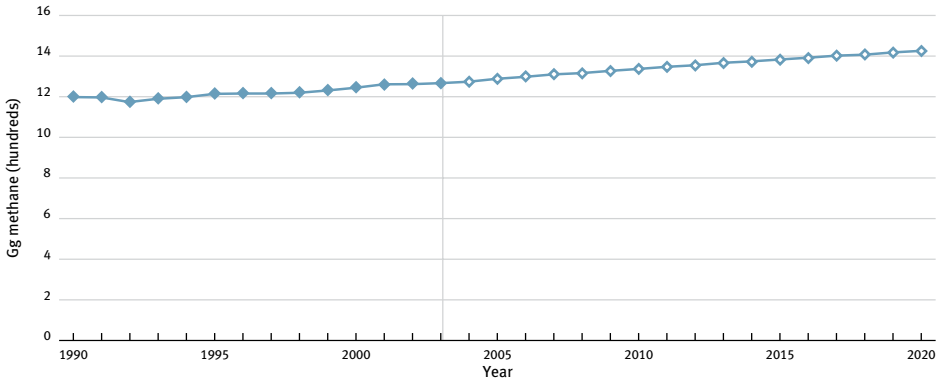
Sources: Ministry of Economic Development, Ministry of Agriculture and Forestry, and Ministry for the Environment

4NC Figure 29: Historical and "with measures" projection of New Zealand total carbon dioxide emissions



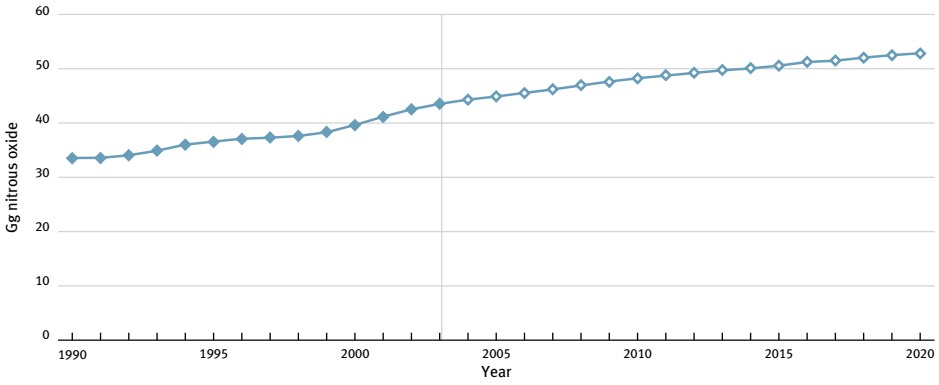
Source: Ministry of Economic Development, Ministry of Agriculture and Forestry, and the Ministry for the Environment

4NC Figure 30: Historical and "with measures" projection of New Zealand total methane emissions



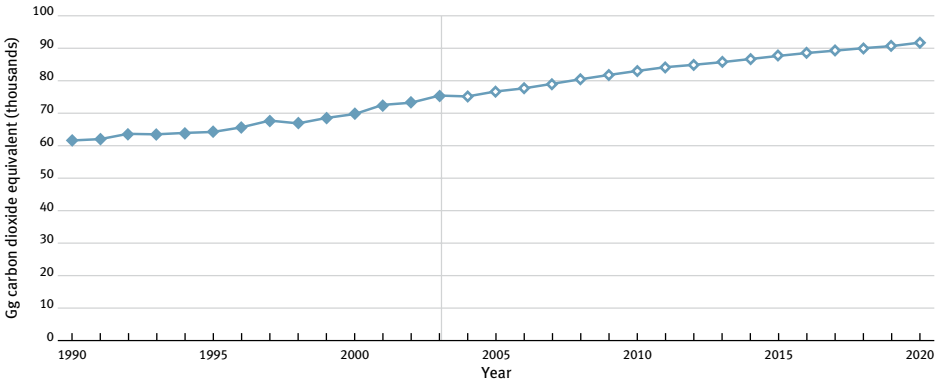
Source: Ministry of Economic Development, Ministry of Agriculture and Forestry, and the Ministry for the Environment

4NC Figure 31: Historical and "with measures" projection of New Zealand total nitrous oxide emissions



Source: Ministry of Economic Development, Ministry of Agriculture and Forestry, and the Ministry for the Environment

4NC Figure 32: Historical and "with measures" projection of New Zealand emissions



Source: Ministry of Economic Development, Ministry of Agriculture and Forestry, and the Ministry for the Environment

4NC Figures 29 to 31 show the historical and projected emissions of three "direct" greenhouse gases – carbon dioxide, methane and nitrous oxide – as total carbon dioxide equivalent. Other gases such as oxides of nitrogen, carbon monoxide and non-methane volatile organic compounds are considered "indirect" greenhouse gases since they react in the atmosphere to form "direct" greenhouse gases. These emissions are not included in the carbon dioxide equivalent calculation. 4NC Figure 32 shows the projected emissions of direct greenhouse gas emissions in carbon dioxide equivalents based on global warming potential. These figures exclude emissions and removals from the land use, land-use change and forestry sector.

Key assumptions

Key assumptions used for projections of emissions for each sector are summarised in 4NC Table 4.

4NC Table 4: Critical assumptions

Calendar Year	1990	1995	2000	2005	2010	2015	2020
GDP (billion 2004 NZ$)	94.6	110.1	125.1	149.1	171.5	190.7	210.8
Oil price (2004 US$/barrel)	23.34	19.28	30.23	50.00	50.00	46.66	43.33
Coal price (2004 NZ$/GJ)	2.60	2.60	2.50	3.75	3.75	3.75	3.75
Exchange rate (NZ$/US$)	0.598	0.6664	0.441	.690	.600	.600	.600
Gas discoveries (PJ/year)	(1)	(1)	(1)	60	60	60	60
Population (million)	3.33	3.67	3.86	4.08	4.22	4.35	4.48

Note:

(1) No directly comparable historical number available

Sources: New Zealand Treasury, Ministry of Economic Development, Ministry of Agriculture and Forestry, and Ministry for the Environment

GDP growth projections are based on current New Zealand Treasury budget forecasts[13] for 2005–2009 and Treasury long-range growth forecasts[14] for 2010–2020, using actual 2004 GDP[15] as the base year. Oil price projections reflect recent levels of New York Mercantile Exchange Light Sweet Crude Futures prices of around US$50 to 2010, then a slow decline reflecting a general expectation among industry forecasters (including the International Energy Agency and the United States Energy Information Administration) of long-term oil prices lower than at present. Coal price projections approximate current North Island levels. Exchange rate projections reflect the long-term average value since the floating of the New Zealand dollar in 1985. Gas discovery projections reflect average historical discoveries, excluding the major Maui field. Population projections are based on Statistics New Zealand "2001 (Base) Series 4" projections assuming "medium fertility, medium mortality and long-term annual net migration of 5,000."[16]

It is assumed that New Zealand's remaining gas-to-methanol plant will close in 2006. This plant is currently using 30 to 40 petajoules per year of gas. Another plant that used a roughly equal amount of gas closed in 2004.

[13] See Table 1.1, GDP (Production Measure), in http://www.treasury.govt.nz/forecasts/befu/2005/1eooutlook.asp

[14] See Table A3.1, p. 33, Real GDP, in http://www.treasury.govt.nz/budget2005/fiscalstrategy/fsr05.pdf

[15] Based on sum of four quarters of 2004 nominal GDP of $145,684 million shown in Table 6.1, in http://www2.stats.govt.nz/domino/external/pasfull/pasfull.nsf/0/4c2567ef00247c6acc257029001021b1/$FILE/2005Q1%20GDP(E)%20current_price.xls

[16] See Table 1, in http://www2.stats.govt.nz/domino/external/pasfull/pasfull.nsf/0/4c2567ef00247c6acc256e770077de92/$FILE/alltabls.xls

Energy sector

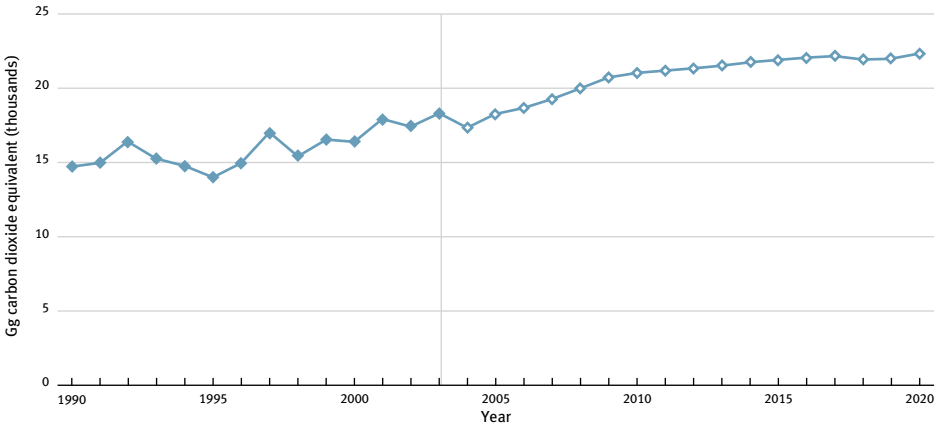
The energy sector as defined in this section includes all energy production, transformation, and consumption other than transport. Greenhouse gas emissions from transport and industrial processes that produce greenhouse gases as a by-product of a chemical reaction other than combustion are treated separately. All industrial fuel combustion, including combustion associated with the processes in the industrial process sector, is treated as part of the energy sector.

Overview

4NC Figure 33 shows a chart of historical and projected carbon dioxide equivalent emissions for the energy sector.

4NC Table 5 shows a summary of historical and projected emissions for the "with measures" case.

4NC Figure 33: Historical and "with measures" emissions projections from the energy sector



Source: Ministry of Economic Development

4NC Table 5: Historical and "with measures" emissions projections from the energy sector (excluding transport) (Gg gas)

	1990	1995	2000	2003	2005	2010	2015	2020
Carbon dioxide	14,019.8	13,285.4	15,562.0	17,441.4	17,164.6	19,271.3	20,539.8	20,614.5
Methane	30.8	29.3	36.7	37.6	42.0	44.2	45.6	46.5
Nitrous oxide	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4
Carbon dioxide equivalent emissions	14,737.5	13,977.6	16,419.5	18,334.9	18,139.6	20,292.5	21,590.4	21,715.0

Note: The numbers from 2005 onward are projections.

Source: Ministry of Economic Development

Residential sub-sector

Residential emissions include only gas, coal, LPG, and oil emissions, since emissions from electric power generation are counted in the electricity generation sub-sector. Approximately 90 percent of New Zealand's residential energy consumption is electric power, and residential emissions are a relatively small component of total energy emissions. Residential emissions declined in the mid-1990s as coal was replaced by electric power as the primary residential energy source. Residential emissions are, however, expected to grow with increasing population and GDP. 4NC Table 6 shows historical and projected residential emissions for the "with measures" case.

Industrial and commercial sub-sector

The industrial and commercial sector includes heavy industries, defined as metals (primarily aluminium and steel), refining, petrochemicals (primarily methanol and urea), forestry processing (primarily pulp and paper and milling), as well as "other industrial and commercial." 4NC Table 7 shows a historical and "with measures" projection of energy emissions from the industrial and commercial sub-sector. Note that this projection excludes industrial process emissions.

4NC Table 6: Historical and "with measures" emissions projections from the residential sector (Gg gas)

	1990	1995	2000	2003	2005	2010	2015	2020
Carbon dioxide	565.8	399.0	555.1	550.5	598.8	675.5	718.4	778.7
Methane	1.84	1.09	1.04	0.96	0.96	0.87	0.81	0.77
Nitrous oxide	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Carbon dioxide equivalent emissions	609.3	425.6	580.8	574.6	622.8	697.5	739.1	798.5

Notes:

The total sum of sub-sectoral emissions from 1990-2003 may not correspond precisely to values in the 2003 Common Reporting Format as an artefact of modelling.

The numbers from 2005 onward are projections.

Source: Ministry of Economic Development

4NC Table 7: Historical and "with measures" emissions projections from the industrial and commercial sector (Gg gas)

	1990	1995	2000	2003	2005	2010	2015	2020
Carbon dioxide	10,022.5	10,001.3	10,135.4	10,533.7	10,238.6	10,555.6	11,264.4	11,206.7
Methane	28.8	28.1	35.5	36.3	40.9	43.2	44.7	45.6
Nitrous oxide	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2
Carbon dioxide equivalent emissions	10,693.9	10,669.3	10,970.3	11,389.1	11,155.3	11,518.4	12,265.0	12,234.1

Notes:

The total sum of sub-sectoral emissions from 1990-2003 may not correspond precisely to values in the 2003 Common Reporting Format as an artefact of modelling.

The numbers from 2005 onward are projections.

Source: Ministry of Economic Development

The heavy industrial sector in New Zealand is dominated by a small number of firms. Since actions by any one of the larger firms could have a significant impact on New Zealand's industrial emissions, projections of these emissions are subject to an unusually high degree of variability as small changes in one firm (or a closure) can dominate the results. For the metals sector, energy growth is projected to be negligible as there are unlikely to be additional amounts of relatively cheap electricity and gas that would make expansion of this sector economically attractive. For the petrochemicals sector a greater than 90 percent decline in gas use from 2003 to 2007 (principally in methanol production) is expected due to the decline of known gas reserves causing sharply increased gas prices. For the forestry processing sector, strong growth is expected due to increased harvesting from the maturation in the period 2010 to 2025 of forest plantings made in the late 1980s and early 1990s.

The levelling in emissions from 2015 to 2020 primarily reflects reduced emissions from the Kapuni gas field, which is assumed to run out in 2018. Kapuni gas contains approximately 50 percent carbon dioxide and this is usually vented to the atmosphere prior to use. The decommissioning of Kapuni results in a reduction of about 0.5 million tonnes of carbon dioxide equivalent emissions.

Electricity generation sub-sector

Electric power emissions are expected to increase sharply between 2005 and 2010 driven by increases in coal-fired generation to meet both overall growth in electric power demand and to substitute for increasingly costly supplies of gas. After 2015, emissions are projected to increase more slowly as growth in demand is increasingly met by wind power. These projections are, however, subject to a great deal of sensitivity to assumptions, particularly cost. Renewables (wind, geothermal, and hydro), gas and coal are all highly competitive for new generation installations in New Zealand; therefore, small changes in cost assumptions could have big impacts on emissions. Such changes in cost could be driven by advances in technology, new gas discoveries, and policies. 4NC Table 8 shows historical and projected electricity generation emissions for the "with measures" case.

4NC Table 8: Historical and "with measures" emissions projections from electricity generation (Gg gas)

	1990	1995	2000	2003	2005	2010	2015	2020
Carbon dioxide	3,485.8	2,919.9	4,896.5	6,335.0	6,405.2	8,494.4	8,676.5	8,986.6
Methane	0.2	0.1	0.2	0.2	0.1	0.2	0.2	0.2
Nitrous oxide	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Carbon dioxide equivalent emissions	3,493.2	2,927.2	4,908.3	6,357.0	6,432.8	8,539.8	8,722.4	9,034.1

Notes:

The total sum of sub-sectoral emissions from 1990-2003 may not correspond precisely to values in the 2003 Common Reporting Format as an artefact of modelling.

The numbers from 2005 onward are projections.

Source: Ministry of Economic Development

4NC Table 9 summarises the underlying engineering analysis of new generation plant potential assumed here. The potential for hydroelectric, geothermal, and wind generation is limited by the availability of suitable sites. The analysis, therefore, broke down the potential for hydro, geothermal, and wind into cost tiers. For this summary table, we have grouped the potential for each of these generation types into two cost tiers.

Comparison with the *Third National Communication*

4NC Table 10 shows a comparison of projected carbon dioxide emissions for the energy sector from the *Third National Communication* with this *Fourth National Communication*. Comparisons of projections for non-carbon dioxide gases are not shown since historical numbers for these gases have been significantly revised, making comparisons of projections not meaningful. These revisions were the result of a 2003 review of emissions factors, which resulted in the replacement of a number of outdated New Zealand-specific emission factors with Intergovernmental Panel for Climate Change default emission factors. There were some revisions to the carbon dioxide emission factors as well, but these were not as significant.[17]

The projected carbon dioxide emissions in this *Fourth National Communication* are higher than in the *Third National Communication* for the 2005–2015 periods, reflecting primarily greater than expected use of coal in power generation. This is the result of the withdrawal of a major hydroelectric development proposal and the more rapid than originally anticipated depletion of the Maui gas field.

The model also now provides a more accurate accounting for emissions from gas flaring and the carbon dioxide-rich Kapuni gas field. In the 2020 period, energy emissions in this *Fourth National Communication* are lower than in the *Third National Communication*, reflecting lower use of coal in power generation. This change is driven primarily by technological improvements that are expected to lead to a greater uptake of wind energy.

4NC Table 9: Indicative new plant generation profiles

Generation Type	Total Cost c/KWh	Potential Capacity MW	Potential Supply GWh pa	Potential Average Load percent
Hydro	7.5 to 9.0	575	3000	60
	11.0 to 13.0	190	1000	60
Geothermal	5.5 to 6.5	385	3000	89
	8.0	45	350	89
Cogeneration	2.5 to 5.0	350	1700	55
Wind	6.5 to 7.0	1220	4800	45
	9.0 to 11.0	950	3300	40
Gas Combined Cycle	5.5 to 7.0	785	4800	70
Coal	10.5 (1)	150	1050	80
Distillate	18.5 to 24.0	no limit	no limit	75

Note:

(1) Flue Gas Desulphurisation

Source: Ministry of Economic Development

4NC Table 10: Comparison of energy sector carbon dioxide emissions in the *Third National Communication* and *Fourth National Communication* (Gg CO_2)

	1990*	1995*	2000*	2003*	2005	2010	2015	2020
Third National Communication	14,019.8	13,285.4	15,562.0	17,441.4	17,130.3	16,935.5	19,258.7	23,399.8
Fourth National Communication	14,019.8	13,285.4	15,562.0	17,441.4	17,164.6	19,271.3	20,539.8	20,614.5

Notes:

*Revised values for historical data

The numbers from 2005 onward are projections.

Source: Ministry of Economic Development

[17] These revisions are discussed in Ministry of Economic Development (2005b), New Zealand Energy Greenhouse Gas Emissions 1990–2003, June 2004, p. v.

Transport sector

Transport accounts for almost half of New Zealand's energy use and a corresponding fraction of energy greenhouse gas emissions. Transport energy use is also quite distinct from other energy uses in that it relies almost entirely on liquid fuels, while other applications of energy use comparatively small amounts of liquid fuels.

Overview

4NC Table 11 shows a summary of historical and projected emissions for the domestic transport sector.

4NC Figure 34 shows a chart of historical and projected carbon dioxide equivalent emissions for the transport sector. 4NC Figure 34 shows that transport sector emissions have grown rapidly, and are projected to continue to grow rapidly reflecting the general growth of the New Zealand economy.

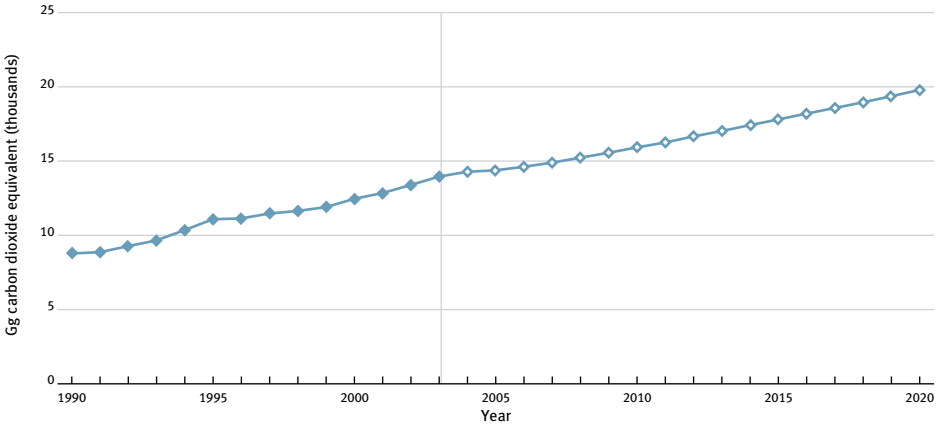
4NC Table 11: Historical and "with measures" emissions projections from domestic transport (Gg gas)

	1990	1995	2000	2003	2005	2010	2015	2020
Carbon dioxide	8,632.8	10,855.9	12,281.2	13,788.1	14,203.1	15,695.0	17,552.1	19,514.0
Methane	7.1	6.4	3.6	2.5	2.6	2.7	2.9	3.1
Nitrous oxide	0.2	0.3	0.4	0.5	0.5	0.6	0.6	0.7
Carbon dioxide equivalent emissions	8,856.6	11,094.9	12,486.3	13,986.0	14,412.7	15,937.7	17,799.0	19,796.1

Note: The numbers from 2005 onward are projections.

Source: Ministry of Economic Development

4NC Figure 34: Historical and "with measures" emissions projections from transport



Source: Ministry of Economic Development

Land transport

4NC Table 12 shows a summary of historical and projected emissions for the land transport sector.

A comparison of the numbers in 4NC Table 12 with those in 4NC Table 11 shows that land transport, which consists primarily of road transport, accounts for the major portion of New Zealand's transport emissions, and the major portion of the growth in these emissions.

Domestic air transport

4NC Table 13 shows a summary of historical and projected emissions for the domestic air transport sector.

Domestic air transport is a relatively small portion of New Zealand's transport emissions, but is growing rapidly.

Domestic sea transport

4NC Table 14 shows a summary of historical and projected emissions for the domestic sea transport sector.

Like domestic air transport, domestic sea transport is also a small portion of New Zealand's total transport emissions. Unlike air transport, however, it is not growing very rapidly.

4NC Table 12: Historical and "with measures" emissions projections from land transport (Gg gas)

	1990	1995	2000	2003	2005	2010	2015	2020
Carbon dioxide	7,612.2	9,675.0	11,077.1	12,258.0	12,759.7	14,111.6	15,797.7	17,588.6
Methane	7.07	6.32	3.59	2.40	2.49	2.65	2.85	3.05
Nitrous oxide	0.21	0.31	0.38	0.43	0.45	0.51	0.59	0.67
Carbon dioxide equivalent emissions	7,826.4	9,903.0	11,271.0	12,441.5	12,951.3	14,326.0	16,040.1	17,860.8

Note: The numbers from 2005 onward are projections.

Source: Ministry of Economic Development

4NC Table 13: Historical and "with measures" emissions projections from air transport (Gg gas)

	1990	1995	2000	2003	2005	2010	2015	2020
Carbon dioxide	772.8	851.5	830.3	1,158.3	1,104.9	1,207.0	1,340.1	1,473.3
Methane	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04
Nitrous oxide	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04
Carbon dioxide equivalent emissions	780.1	859.5	838.0	1,169.2	1,115.1	1,218.1	1,352.5	1,486.9

Note: The numbers from 2005 onward are projections.

Source: Ministry of Economic Development

4NC Table 14: Historical and "with measures" emissions projections from domestic sea transport (Gg gas)

	1990	1995	2000	2003	2005	2010	2015	2020
Carbon dioxide	247.8	329.3	373.8	370.9	338.5	376.4	414.3	452.1
Methane	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04
Nitrous oxide	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Carbon dioxide equivalent emissions	250.3	332.7	377.5	374.7	341.9	380.2	418.5	456.7

Note: The numbers from 2005 onward are projections.

Source: Ministry of Economic Development

International transport

Although not included in the totals shown in 4NC Table 11 on page 99, 4NC Tables 15 and 16 show the imputed emissions from fuel sold in New Zealand for use in international air and sea transport, respectively. The sea transport numbers tend to be highly variable and difficult to project, since international sea carriers have some flexibility to choose the country where they buy their fuel, generally choosing the one offering the best price.

Based on current trends, we expect international air transport emissions to continue to increase rapidly, while international sea transport emissions should decline modestly.

Comparison with the *Third National Communication*

4NC Table 17 shows a comparison of projected carbon dioxide emissions for the transport sector from the *Third National Communication*. As discussed previously, comparisons of projections for the other gases are not shown since historical numbers for these gases have been significantly revised and therefore comparisons of projections are not meaningful.

4NC Table 15: Historical and "with measures" emissions projections from international air transport (Gg gas)

	1990	1995	2000	2003	2005	2010	2015	2020
Carbon dioxide	1,341.0	1,568.6	1,756.7	2,230.2	2,338.5	2,588.8	2,933.8	3,278.7
Methane	0.04	0.04	0.05	0.06	0.07	0.07	0.08	0.09
Nitrous oxide	0.04	0.04	0.05	0.06	0.07	0.07	0.08	0.09
Carbon dioxide equivalent emissions	1,353.5	1,583.2	1,773.1	2,251.0	2,360.1	2,612.7	2,960.8	3,308.9

Note: The numbers from 2005 onward are projections.

Source: Ministry of Economic Development

4NC Table 16: Historical and "with measures" emissions projections from international sea transport (Gg gas)

	1990	1995	2000	2003	2005	2010	2015	2020
Carbon dioxide	1,029.3	1,120.5	741.6	788.9	836.3	805.1	773.9	742.8
Methane	0.10	0.11	0.07	0.07	0.08	0.07	0.07	0.07
Nitrous oxide	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Carbon dioxide equivalent emissions	1,039.9	1,132.0	749.1	797.0	844.7	813.2	781.7	750.2

Note: The numbers from 2005 onward are projections.

Source: Ministry of Economic Development

4NC Table 17: Comparison of carbon dioxide emissions from transport in the *Third National Communication* and *Fourth National Communication* (Gg CO_2)

	1990*	1995*	2000*	2003*	2005	2010	2015	2020
Third National Communication	8,632.8	10,855.9	12,281.2	13,788.1	13,567.0	14,837.2	16,175.2	17,619.1
Fourth National Communication	8,632.8	10,855.9	12,281.2	13,788.1	14,203.1	15,695.0	17,552.1	19,514.0

Notes:

* Revised values for historical data.

The numbers from 2005 onward are projections.

Source: Ministry of Economic Development

Projections of transport carbon dioxide emissions in this *Fourth National Communication* are significantly higher than in the *Third National Communication* due primarily to the more rapid than anticipated growth in road transport demand, especially diesel demand.

Industrial processes sector

Industrial process carbon dioxide emissions in New Zealand consist principally of emissions from the manufacture of steel, aluminium, urea, cement, lime and hydrogen, as well as oil and gas extraction. The outputs of most of these industries are expected to remain fairly stable; however, significant growth is anticipated in the cement industry. There are currently no adopted policies or measures that would have a significant impact on industrial process emissions.

4NC Table 18 compares emission projections in the *Third National Communication* with those in this *Fourth National Communication.* Compared to the *Third National Communication,* industrial process emissions are higher due principally to reclassification of emissions from urea processing, in accordance with Intergovernmental Panel on Climate Change guidelines, as industrial process emissions (they were previously classified as energy emissions).

4NC Table 18: Comparison of carbon dioxide emissions from industrial processes in the *Third National Communication* and *Fourth National Communication* (Gg CO_2)

	1990*	1995*	2000*	2003*	2005	2010	2015	2020
Third National Communication	2,662.2	3,019.8	3,162.8	3,470.0	3,047.8	3,155.0	3,267.7	3,386.3
Fourth National Communication	2,662.2	3,019.8	3,162.8	3,470.0	3,603.5	3,739.3	3,839.0	3,941.8

Notes:

* Revised values for historical data

Third National Communication numbers exclude urea processing.

The numbers from 2005 onward are projections.

Emissions of non-carbon dioxide greenhouse and precursor gases from industrial processing and solvent and other product use make up a small part of New Zealand's total inventory and have not been projected. Emissions of perfluorocarbons, hydrofluorocarbons and sulphur hexafluoride combined make up less than one percent of New Zealand's carbon dioxide equivalent emissions. Emissions from solvents and other product use have simply been extrapolated from actual emissions data from 1990 to 2003. Emissions of perfluorocarbons, hydrofluorocarbons and sulphur hexafluoride were assumed to grow at the same rate projected for emissions of carbon dioxide from the industrial processes sector. New Zealand is reviewing its projection methodology for perfluorocarbons, hydrofluorocarbons and sulphur hexafluoride and will be developing more robust projections for these gases in the future.

Agriculture sector

Overview

The Government's policy for agriculture has been to exempt non-carbon dioxide gases from price-based measures such as carbon taxes in exchange for the agricultural sector carrying out mitigation research. The agricultural sector has an objective of seeking to identify mitigation technologies and management practices that would mitigate nitrous oxide and methane emissions by 20 percent from "business as usual" by the end of the first commitment period. The extent to which this level of mitigation would actually occur on-farm has not been defined.

Projections of methane and nitrous oxide emissions to 2020 from the agricultural sector (4NC Table 19) are driven by future estimates of:

- animal numbers by species: dairy cattle, beef cattle, sheep and deer to 2020 (4NC Table 20).
- enteric methane emissions per animal extrapolated from the annual changes in emissions per animal between 1990 and 2003 (4NC Table 21).
- nitrogen output per animal based extrapolated from annual changes in nitrogen output per animal between 1990 and 2003 (4NC Table 22)
- nitrogen fertiliser use based on annual rates of change of nitrogen fertiliser usage between 1990 and 2003 supplemented by industry forecasts (4NC Table 23).

The rate of growth in emissions from the agriculture sector is expected to decline due to the limitation on the increase in animal numbers or change in animal species balance, imposed by a finite potential agricultural land area and increasing competition from urbanisation.

The projections need to be assessed within the uncertainties of the biological processes involved and the economic circumstances of the agricultural industry, which are largely driven by overseas markets.

4NC Table 19: "With measures" total emissions from the agriculture sector (Gg gas)

		1990	2003	2010	2020
Emissions	Methane	1,053.7	1,150.7	1,241.0	1,332.6
	Nitrous oxide	32.5	42.1	46.5	51.0
	Carbon dioxide equivalent	32,194	37,203	40,476	43,795
Change in emissions from 1990	Gigagrams carbon dioxide equivalent		5,010	8,282	11,601
	Percent change from 1990		15.6	25.7	36.0

Note: The numbers for 2010 and 2020 are projections.

Source: Ministry of Agriculture and Forestry

4NC Table 20: Historic and projected animal numbers (thousand head)

	1990	2010 estimated	2020 estimated
Dairy Cattle	3,390	5,605	5,947
Beef cattle	4,596	3,886	3,636
Sheep	57,850	39,908	38,038
Deer	1,035	1,658	1,711

Source: Ministry of Agriculture and Forestry

Projections of enteric methane emissions per animal

At present, animal performance in New Zealand is well below current biological limits and it seems reasonable to assume that the rate of increase in productivity per animal over the next 15 years should be similar to the rate of increase in animal performance over the past 13 years (4NC Table 21). A linear extrapolation of methane emissions per animal to 2020 was therefore considered appropriate.

At some stage in the future the rate of productivity increase may well decline due to resource and biological limits being reached. However, there are industry strategy plans, such as for the dairy sector, which seek to improve productivity in economic farm surplus by three percent per annum. If successful, this would indicate that future productivity gains could be higher that the historic productivity trend.

Projections of nitrous oxide emissions

Nitrous oxide emissions from animal excreta are a function of the quantity of nitrogen excreted which is estimated from feed intake per annum, the nitrogen content of feed minus the nitrogen retained in animal product. Projections of nitrogen output per animal in 2020 (4NC Table 22) were derived from the linear trends of nitrogen output per animal 1990 to 2003 reported in the national inventory. Nitrous oxide emissions per animal in 2020 were then calculated using the national inventory methodology.

4NC Table 21: Annual methane emissions per animal 1990 and 2020

	1990 kg N/head/annum	2010 estimated kg N/head/annum	2020 estimated kg N/head/annum	Correlation (1)
Dairy cattle	106.2	122.7	130.7	0.952
Beef cattle	65.9	76.5	81.4	0.927
Sheep	12.2	15.9	17.9	0.994
Deer	27.4	31.0	33.2	0.893

Note:

(1) The correlation coefficient (r) for the linear trend in per animal emissions 1990–2003

Source: Ministry of Agriculture and Forestry

4NC Table 22: Annual nitrogen excreta per animal 1990 and 2020

	1990 kg N/head/annum	2010 estimated kg N/head/annum	2020 estimated kg N/head/annum	Correlation (1)
Dairy cattle	106.2	122.7	130.7	0.952
Beef cattle	65.9	76.5	81.4	0.927
Sheep	12.2	15.9	17.9	0.994
Deer	27.4	31.0	33.2	0.893

Note:

(1) The correlation coefficient (r) for the linear trend in per animal nitrogen excreta 1990-2003

Source: Ministry of Agriculture and Forestry

Projection of nitrogen fertiliser use

Nitrogen fertiliser use has increased nearly six-fold from 1990 to 2003. The projected value for 2010 was 433,700 tonnes of nitrogen (4NC Table 24).

Assumptions of future nitrogen fertiliser use

The nitrogen application rate in New Zealand is significantly lower than in most other OECD countries. For example, the amount of fertiliser nitrogen applied per hectare in New Zealand in 2002 was 17.7 kilograms per hectare compared to the OECD country average of 59.3 kilograms per hectare. There is significant potential for large increases in total nitrogen applied.

The limitations on the continuing increasing application of nitrogen fertiliser include policies that limit nitrogen use in some national iconic catchments such as Lake Taupo and Lake Rotorua, the Clean Streams Accord, and other local government directives on good fertiliser practice which seek to limit fertiliser nitrogen application. Another factor limiting the upwards trajectory for nitrogen inputs is the increasing price of nitrogen fertiliser. This will be driven by increasing world energy (natural gas is a significant feedstock in nitrogen fertiliser manufacture) and shipping costs.

The impact of the clover root weevil, a recently discovered biosecurity pest, will also affect future use of nitrogenous fertilisers. Clover root weevil reduces the natural nitrogen fixation from white clover and therefore nitrogen inputs into the agricultural systems. The loss of naturally fixed nitrogen from white clover currently can only be managed by the replacement of lost fixed nitrogen with synthetic fertiliser nitrogen, supplementary feed input or through reduced stocking rates. Trials are underway with a promising biological agent, a parasitic Irish wasp, to mitigate the effects of clover root weevil. If effective, the actual future use of synthetic nitrogen fertiliser may be lower than currently projected.

Other animal species and greenhouse gas sources

No projections were derived for the emissions of minor animal species present in the national inventory; that is, horses, goats, pigs, and poultry. This was also the case for nitrous oxide emission from crop stubble burning, savannah burning and nitrogen-fixing crops. These emission sources make up less than four percent of the agricultural sector emissions. There was no basis to assume that any of these emission sources would be significantly different from the present levels. The impact of large changes in these small emission sources on total national emissions would be small and so 2003 inventory emission levels were used through to 2020.

4NC Table 23: Nitrogen fertiliser applied – actual and projected to 2020 (kilotonnes)

	1990	2003	2010 estimated	2020 estimated
Mean	58	332	421	489
Change from 1990		274	364	431
Percent change from 1990		476	631	749

Sources: Ministry of Agriculture and Forestry, and fertiliser industry estimates

Comparison with the *Third National Communication*

The method of calculation of emissions has been significantly modified in this communication compared with the *Third National Communication,* and therefore the results are not directly comparable. A major revision of the inventory methodology, from a modified Tier 1 approach to a Tier 2 approach (according to IPCC, *Good Practice Guidance,* 2001) was undertaken in 2003. Projections now take into account improvements in animal performance over time, use different methane emission factors based on empirical research carried out in New Zealand, and have different nitrogen input variables for calculating nitrous oxide emissions. These modifications were implemented due to new information obtained from a research programme designed specifically to improve the national inventory for agriculture.

Land use, land-use change and forestry sector

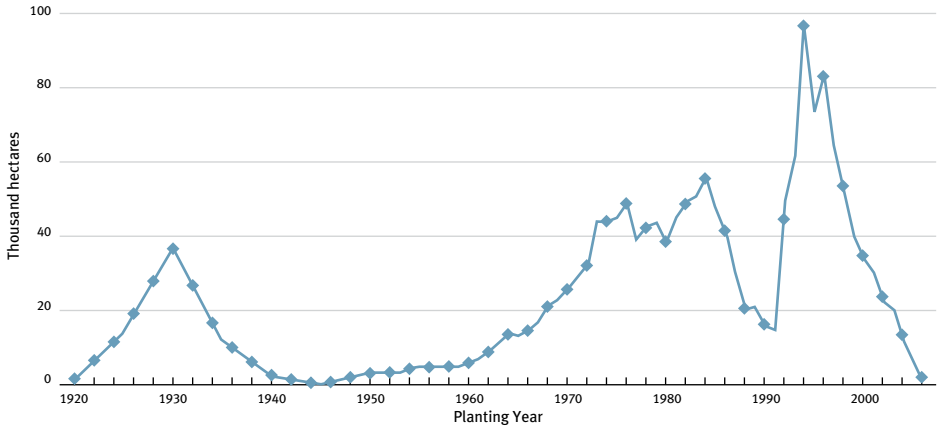
Overview

The land use, land-use change and forestry (LULUCF) sector accounted for net removals (including emissions of methane and nitrous oxide) of approximately 22,861 Gg CO_2 in 2003. This equals 30 percent of New Zealand's total greenhouse gas emissions in 2003.

New Zealand has 6.256 million hectares of natural forest and 1.8 million hectares of planted production forest. It is currently assumed that New Zealand's natural forests are a relatively stable carbon reservoir. A national carbon monitoring system is being established to provide robust estimates of carbon stocks and changes in carbon stocks in natural forests.

Production forest planting rates have fluctuated significantly since afforestation programmes commenced in New Zealand in the 1920s (4NC Figure 35). The average afforestation rate over the last 30 years has been 44,900 hectares per year. In the period from 1992 to 1998, afforestation rates were high (averaging 69,000 hectares per year). Since 1998, the rate of afforestation has declined and in 2003, 19,900 hectares of new forest were established.

4NC Figure 35: Planted production forest afforestation



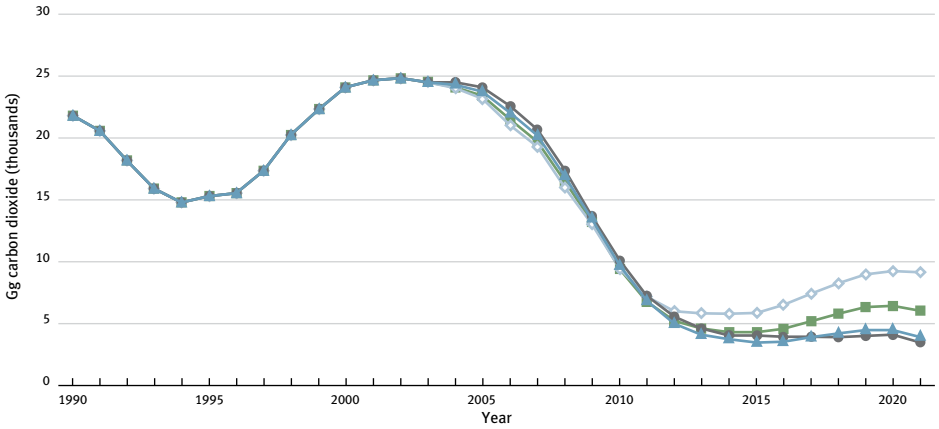
Source: Ministry of Agriculture and Forestry

New investment in forest planting is currently at a low level. It is provisionally estimated that 10,600 hectares of new forest were established in 2004. There are no indications that the level of new planting will increase under current market conditions. Therefore, the scenario presented in these projections of carbon dioxide removals by planted forests is conservative and based on the current afforestation rate of 10,000 hectares per year from 2005.

The projections include carbon stock change on forest land due to forest growth with an allowance for carbon stock change associated with harvesting and the clearance of sparse woody vegetation (scrub) for afforestation. Non-carbon dioxide emissions from wildfires and prescribed burning are also included. However, although Tier 1 estimates were made of carbon stock changes in the non-forest land categories in the 2003 greenhouse gas inventory reported to the UNFCCC, these accounted for only one percent of the 2003 net removals in the sector and have not been estimated for the projections. Soil carbon stock changes have also not been included.

Upper and lower projections for new plantings are within the range from zero to 30,000 hectares per year. Based on the four scenarios for new planting, projected total removals of carbon dioxide by planted forests (net of emissions from land-use changes) are illustrated in 4NC Figure 36. Fluctuations in annual carbon dioxide removals are due to changing rates of new planting and harvesting.

4NC Figure 36: Projected annual net carbon dioxide removals by forests



Note: Numbers from 2004 onward are projections.

Source: Ministry of Agriculture and Forestry

4NC Table 24: Carbon dioxide removals and emissions from land-use change and forestry (Gg CO_2) [5]

	1990	1995	2000	2003	2005	2010	2015	2020
CO_2 removals [1]	-33,200	-30,400	-42,100	-42,900	-44,200	-40,700	-35,400	-36,000
CO_2 emissions from harvesting [2]	10,500	12,900	16,500	17,300	19,900	30,600	31,400	31,100
CO_2 other emissions [3]	900	2,300	1,400	1,100	500	500	500	500
Total CO_2 removals [4]	**-21,800**	**-15,200**	**-24,100**	**-24,400**	**-23,800**	**-9,600**	**-3,400**	**-4,400**

Notes:

(1) CO_2 removals represent the change in plantation living and dead carbon pools. Soil carbon is excluded.

(2) CO_2 emissions from harvesting include harvesting from both plantation and natural forests.

(3) Other CO_2 emissions are from scrub clearance for afforestation. Carbon released in wildfires is not included – only non-CO_2 emissions are reported from this source.

(4) No carbon release/uptake from other land uses (e.g., cropland conversion) is included.

(5) Assumes the current afforestation rate of 10,000 ha/yr from 2005.

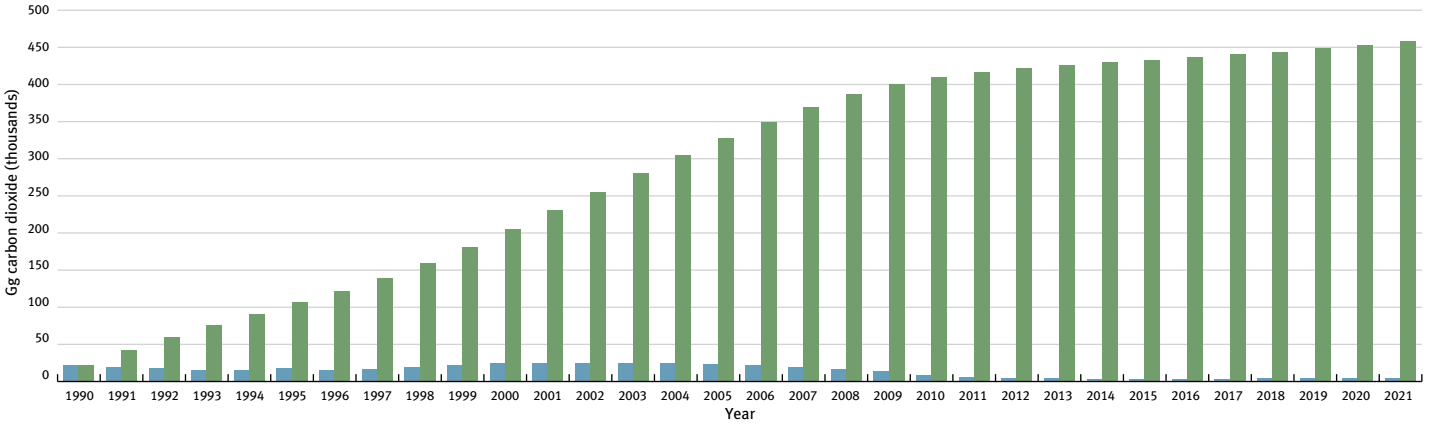
Numbers from 2005 onward are projections.

Carbon dioxide emissions and removals

Carbon dioxide removals by planted forests, emissions from forest harvesting and land conversion to forest land (and hence total carbon dioxide removals) are reported in 4NC Table 24 for the period from 1990 to 2020 and intervening years, using the current afforestation rate.

Measuring and comparing annual total removals of carbon dioxide by planted forests can, however, provide a misleading picture of the underlying changes and processes involved in protecting and enhancing sinks and reservoirs. This is because measuring the relative change in annual removals neglects the magnitude and direction of total carbon storage in the intervening periods. 4NC Figure 37 illustrates the cumulative total of carbon dioxide stored in planted forest stocks and compares this with annual estimates of carbon dioxide removals. The lower planting rates forecasted post-2004 result in a decline in annual carbon dioxide removals by planted forests.

4NC Figure 37: Projected carbon dioxide removals and storage



Note: Assumes the current afforestation rate of 10,000 hectares per year from 2005. Numbers from 2004 onward are projections.

Source: Ministry of Agriculture and Forestry

Non-carbon dioxide emissions

There are limited non-carbon dioxide emissions from the land use, land-use change and forestry sector (4NC Table 25). Non-carbon dioxide emissions primarily occur in the burning of both forest biomass and grassland with woody vegetation.

4NC Table 25: Non-carbon dioxide emissions from land-use change and forestry (Gg CO_2 equivalent)

	1990	1995	2000	2003	2005	2010	2015	2020
CH_4	4.23	6.12	4.39	4.08	3.23	3.10	3.10	3.10
N_2O	0.03	0.04	0.03	0.03	0.02	0.02	0.02	0.02

Notes:

Estimates include emissions from wildfires in forest and scrub and controlled burning of scrub for afforestation.

Estimates do not include non-CO_2 emissions from controlled burning or wildfires in grassland remaining grassland, or non-CO_2 emissions from N fertilisation.

Assumes the current afforestation rate of 10,000 ha/yr from 2005.

Numbers from 2005 onward are projections.

Source: Ministry of Agriculture and Forestry

Comparison with the *Third National Communication*

Projections of annual planting rates of 40,000 and 60,000 hectares in the *Third National Communication* have not occurred. New planting rates have fallen steadily since 2000. In 2004 it is provisionally estimated that just 10,600 hectares of new forest were established. This highlights the considerable uncertainties in predicting future afforestation, particularly in the medium to longer term.

The differences between the projected removals in the *Fourth* and *Third National Communications* result primarily from the changes in forecast harvesting and afforestation rates. The large increase in removals in 2005 is due to a lower actual harvesting rate than was forecast in 2002. Similar removals are projected for 2010. However, with the assumed low rate of future afforestation, carbon dioxide removals out to 2020 are much lower than earlier projections (4NC Table 26).

4NC Table 26: Total carbon dioxide removals from land-use change and forestry: comparison of *Fourth National Communication* and *Third National Communication* projections

	Fourth National Communication (assumes afforestation of 10,000 ha/yr from 2005)	Third National Communication (assumes afforestation of 40,000 ha/yr from 2002)	
	Total removals Mt CO_2	Total removals Mt CO_2	Percentage change
1990	-21.4	-20.9	2%
1995	-14.7	-15.4	-5%
2005	-23.8	-14.5	64%
2010	-9.6	-9.9	-3%
2020	-4.4	-16.9	-74%

Source: Ministry of Agriculture and Forestry

Projections of carbon removed by Kyoto forests in the first commitment period

New Zealand had approximately 660,000 hectares of Kyoto forests (that is, forests planted after 1990) in 2004. High rates of afforestation occurred over the period from 1992 to 1998. Since 1998, afforestation rates have steadily declined. In 2004, afforestation has decreased to 10,600 hectares (provisional). At an assumed afforestation rate of 10,000 hectares per annum from 2005 on, Kyoto forests are projected to remove 94 million tonnes of carbon dioxide from the atmosphere over the first commitment period (4NC Table 30).

A pessimistic scenario of no further new planting would result in 91 million tonnes of carbon dioxide being removed from the atmosphere, with an optimistic scenario of 30,000 hectares per year planted resulting in 101 million tonnes of carbon dioxide being removed from the atmosphere over the first commitment period.

A very recent phenomenon that has started to occur is the conversion of plantation forest land to other land uses. Historically, very little conversion of plantation forest land has occurred in New Zealand. For the purposes of projections, deforestation emissions have been estimated as a range from 6.3 million tonnes of carbon dioxide (historic rate) to 21 million tonnes of carbon dioxide (deforestation of 10 percent of the area expected to be harvested in the first commitment period).

Waste sector

Total methane emissions from waste are projected to continue to decrease to 2020 (4NC Table 28).

Wastewater

Methane emissions from wastewater are projected to increase with population over the next two decades.

Landfill methane

Methane emissions from landfills are expected to be significantly below 1990 levels in the first commitment period of the Kyoto Protocol and continue to decline towards 2020. 4NC Figure 38 presents updated information developed after the 2003 inventory was submitted.

Landfill methane emission calculations were carried out using the IPCC Tier 2, first order decay methodology (Intergovernmental Panel on Climate Change, 2001). Further descriptions of the methodology can be found in the *National Inventory Report*, April 2005. The projections were performed using the same methodologies but allowing for population increase and increased recovery of landfill gas.

4NC Table 27: Projected Kyoto Protocol first commitment period carbon dioxide removals and emissions (Mt CO_2) from planted forests

	Pessimistic	Most Likely	Optimistic
New planting (0, 10k, 30k ha/yr)	91	94	101
Deforestation (10%, 5%, 3% - historic)	-21	-11	-6.4
CO_2 removals less deforestation emissions	70	83	95

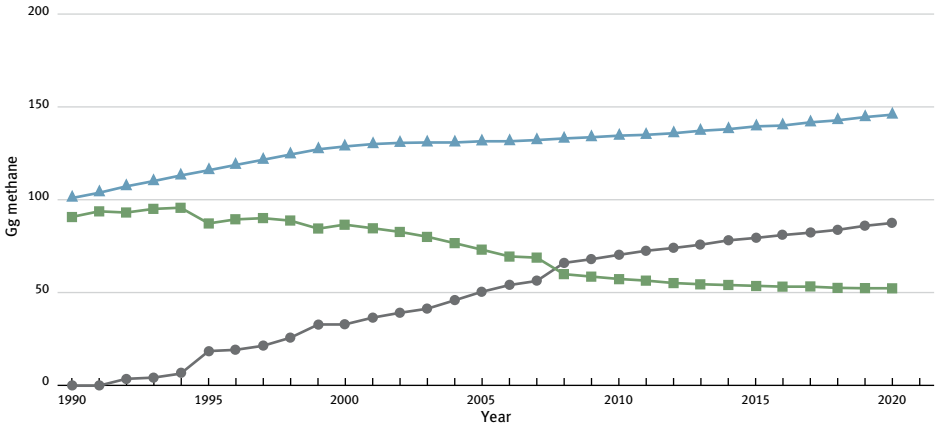
Source: Ministry of Agriculture and Forestry

4NC Table 28: Historical and projected New Zealand waste sector methane emissions (Gg methane)

	1990	1995	2000	2005	2010	2020
Methane	111.2	90.8	74.4	69.3	56.4	52.3

Source: Ministry for the Environment

4NC Figure 38: Gross methane generated, methane recovery, and net methane emissions[1]



Note 1: Waste Management, Landfill Methane Recovery Estimate for Updating the National Greenhouse Gas Inventory from the Waste Sector – Solid Waste Disposal Sites, June 2005

Source: Ministry for the Environment

The Ministry for the Environment developed the Solid Waste Analysis Protocol to monitor compositional changes in waste disposed to landfills. Results from the 2002 survey show that there has been a significant reduction in the proportion of putrescibles in the waste stream. At the same time, the 2003 Landfill Survey showed that the total volume of waste being disposed to landfills has reduced per person.

Estimates of landfill gas recovery have been revised to take account of the national environmental standard to control methane emissions from landfills, which was introduced in October 2004. The standard sets a consistent national approach to the management of landfill methane emissions by requiring all operating landfills over one million tonnes capacity to collect and destroy landfill gas.

Comparison with the *Third National Communication*

There are some significant differences between the data in this report and those contained in the *Third National Communication* for greenhouse gas emissions from the waste sector. These differences are in the 1990 baseline, the gross emissions to 2020 and the recovered emissions to 2020. All of these are due to changes in waste flow composition, reducing waste volumes person, and increasing recovery rates. The change to the 1990 baseline is mostly due to soil moving from the organic waste category to rubble/concrete as a result of the 2003 analysis of solid waste composition.

Chapter 6

Vulnerability assessment, climate change impacts, and adaptation measures

Introduction and overview

A low population density and related long-distance infrastructure, long coastline and varied geomorphology, and an economy reliant on the primary production sector make New Zealand vulnerable to climate hazards. Research and dissemination of findings on the impacts of climate change, vulnerability and adaptation options remain a high priority for New Zealand. In addition the development and dissemination of methodologies for stakeholder-led impacts assessments, and implementing adaptation measures to these impacts, have been a major focus of work over the past four years.

Since the *Third National Communication* there have been several Government-led reviews of climate change impacts and vulnerability on a national or sector-specific basis which have incorporated impacts assessment and adaptation methodologies. In May 2004, the Ministry for the Environment coordinated and published a national review, *Climate Change Effects and Impacts Assessment*, updating the climate change scenarios used in a previous impacts report in 2001. This document serves as a guidance manual for local government and includes extensive guidance and information on impacts assessments.

Much of New Zealand's urban development has occurred in areas vulnerable to the actions of the sea and in recent years, as coastline development has intensified, the potential impacts of coastal hazards has increased. A second major manual, *Coastal Hazards and Climate Change,* focuses particularly on coastal issues and provides guidance to local government on impacts and adaptation methodologies for this area.

Other reports have addressed issues of changes in the risk of flooding and drought.

There are also a range of reports from ongoing research programmes carried out by publicly-owned and private research institutes. The studies are aimed at gaining a better understanding of projected climate changes and their impact on sector-specific production methods, infrastructure, and native ecosystems. Research in this area includes:

- increasing understanding of New Zealand's past and present climate and its variability
- downscaling global climate model results to account for the New Zealand topography in future climate projections, and developing scenarios for rainfall and temperature changes
- increasing understanding of the responses of a range of plant and animal species to elevated temperature and carbon dioxide concentrations and changes in rainfall
- developing and refining crop models based on experimental work
- changing distribution of native and introduced plant species to changing climatic conditions
- developing soils models to increase understanding of the turnover of soil carbon.

More information on research on the impacts of climate change is included in Chapter 8 in this *Fourth National Communication.* A range of regional assessments of vulnerabilities, impacts and adaptation options have also been carried out, often initiated by or in response to requests from local government.

New Zealand has a highly variable climate. Current year-to-year variability is of the same order of magnitude as the projected mean changes to the 2030s, so it is seen as important to consider both anthropogenic and natural variability in developing adaptation strategies.

Scenarios of climate change

For New Zealand, the assessment of climate change impacts is scenario-based. The scenario approach is necessary because of the uncertainty of future greenhouse gas emission levels, differences between modelling results from different global climate models, and uncertainties arising from the downscaling of global model results to the local New Zealand scale.

The most recent downscaled scenarios were developed by the National Institute of Water and Atmospheric Research (NIWA) under contract to the Ministry for the Environment, and are published in *Climate Change Effects and Impacts Assessment (*Ministry for the Environment, 2004). These scenarios are based on transient model simulations by several international groups.

These new scenarios differ from those used in earlier national impacts assessments in that they use the full IPCC scenario range (that is, covering an increase of between 1.4 to 5.8°C in globally-averaged temperature by 2100 compared with 1990). As with the earlier assessments, they do not assume any policy interventions specifically aimed at constraining anthropogenic greenhouse gas emissions. The downscaling has also been extended to include further variables, to provide estimates of "potential evapotranspiration deficit" for use in the studies of drought risk described on the following page.

The downscaled rainfall projections from the majority (but not all) of the global model simulations suggest an increase of the average westerly flow across New Zealand through the coming century, with increased rainfall in western areas and decreases in the east. All of the models suggest that for the coming century the increase in New Zealand-averaged temperature will be less than the increase of globally-averaged temperature, due to the thermal inertia of the Southern Ocean.

Uncertainty of the downscaled model results is still high due to differences in patterns downscaled from different global climate models, particularly in the area of regional rainfall projections. 4NC Table 29 gives the range of projected temperature change, and 4NC Table 30 gives projected rainfall change, for different geographical regions in New Zealand for the 2030s (2020 to 2049) and 2080s (2070 to 2099).

4NC Table 29: Projected changes for each regional council area in seasonal and annual average temperature (in °C)

	Summer	Autumn	Winter	Spring	Annual
Northland					
1990-2030s	0.1 to 1.2	0.1 to 1.4	0.3 to 1.6	0.2 to 1.2	0.2 to 1.3
1990-2080s	0.5 to 3.9	0.5 to 4	0.8 to 4.2	0.6 to 3.8	0.6 to 4
Auckland					
1990-2030s	0.1 to 1.2	0.1 to 1.3	0.3 to 1.6	0.2 to 1.2	0.2 to 1.3
1990-2080s	0.4 to 3.8	0.4 to 3.9	0.8 to 4.0	0.5 to 3.6	0.6 to 3.8
Waikato					
1990-2030s	0.0 to 1.2	-0.1 to 1.3	0.3 to 1.6	0.1 to 1.2	0.1 to 1.4
1990-2080s	0.2 to 3.8	0.3 to 3.9	0.8 to 4.1	0.4 to 3.6	0.4 to 3.8
Bay of Plenty					
1990-2030s	0.0 to 1.2	0.0 to 1.3	0.4 to 1.6	0.2 to 1.2	0.2 to 1.3
1990-2080s	0.3 to 3.8	0.4 to 3.9	0.8 to 4.2	0.4 to 3.6	0.5 to 3.8
Taranaki					
1990-2030s	0.0 to 1.2	0.0 to 1.3	0.4 to 1.6	0.1 to 1.2	0.1 to 1.3
1990-2080s	0.2 to 3.6	0.4 to 3.9	0.8 to 4.0	0.4 to 3.4	0.4 to 3.7
Manawatu/Wanganui					
1990-2030s	-0.1 to 1.2	-0.1 to 1.3	0.3 to 1.7	0.1 to 1.2	0.1 to 1.3
1990-2080s	0.1 to 3.7	0.3 to 3.9	0.6 to 4.2	0.3 to 3.4	0.3 to 3.8
Hawke's Bay					
1990-2030s	-0.1 to 1.3	0.1 to 1.3	0.4 to 1.6	0.2 to 1.3	0.2 to 1.4
1990-2080s	0.3 to 3.9	0.5 to 3.8	0.8 to 4.0	0.5 to 3.3	0.5 to 3.8
Gisborne					
1990-2030s	0.0 to 1.3	0.1 to 1.3	0.4 to 1.6	0.2 to 1.3	0.2 to 1.4
1990-2080s	0.4 to 3.9	0.5 to 3.8	0.8 to 4.1	0.6 to 3.4	0.6 to 3.8
Wellington					
1990-2030s	-0.2 to 1.2	0.1 to 1.2	0.4 to 1.7	0.1 to 1.2	0.1 to 1.3
1990-2080s	0.1 to 3.7	0.5 to 3.7	0.8 to 4.0	0.4 to 3.3	0.5 to 3.6
Nelson					
1990-2030s	0.0 to 1.2	0.1 to 0.2	0.3 to 1.6	0.1 to 1.2	0.1 to 1.3
1990-2080s	0.2 to 3.4	0.3 to 3.6	0.7 to 3.6	0.4 to 3.3	0.4 to 3.5
Marlborough					
1990-2030s	-0.2 to 1.3	0.1 to 1.2	0.3 to 1.8	0.0 to 1.3	0.1 to 1.4
1990-2080s	-0.2 to 3.5	0.4 to 3.6	0.9 to 4.1	0.2 to 3.3	0.4 to 3.5
West Coast					
1990-2030s	-0.1 to 1.1	-0.2 to 1.2	0.2 to 1.6	0.0 to 1.1	0.1 to 1.2
1990-2080s	-0.1 to 3.1	0.1 to 3.7	0.6 to 3.9	0.2 to 3.3	0.2 to 3.5
Canterbury					
1990-2030s	-0.2 to 1.3	0.1 to 1.1	0.3 to 1.8	0.0 to 1.3	0.2 to 1.4
1990-2080s	0.0 to 3.3	0.4 to 3.5	0.8 to 3.9	0.3 to 3.1	0.5 to 3.4
Otago					
1990-2030s	-0.2 to 1.2	0.0 to 1.1	0.2 to 1.8	0.0 to 1.2	0.1 to 1.3
1990-2080s	-0.1 to 2.7	0.4 to 3.3	0.7 to 3.5	0.2 to 3.0	0.4 to 3.1
Southland					
1990-2030s	-0.2 to 1.2	-0.1 to 1.1	0.2 to 1.8	0.0 to 1.1	0.1 to 1.3
1990-2080s	-0.1 to 2.6	0.1 to 3.4	0.7 to 3.5	0.1 to 3.1	0.2 to 3.2

Source: Preparing for Climate Change, Ministry for the Environment, 2004

4NC Table 30: Projected changes for selected rainfall stations within each regional council area in seasonal and annual precipitation

Region	Location	Decade	Summer	Autumn	Winter	Spring	Annual
Northland	**Kaitaia**	2030s	-10 to +7	-6 to +6	-9 to +5	-17 to +9	-5 to +3
		2080s	-2 to +12	-8 to +10	-10 to +4	-32 to -2	-11 to -1
	Whangarei	2030s	-10 to +6	-17 to +7	-12 to +7	-21 to +12	-8 to +2
		2080s	-2 to +9	-17 to +16	-21 to +13	-45 to -6	-16 to 0
Auckland	**Warkworth**	2030s	-13 to +6	-10 to +5	-6 to +6	-19 to +7	-6 to +2
		2080s	-2 to +13	-13 to +11	-6 to +4	-40 to -3	-13 to 0
	Mangere	2030s	-14 to +6	-8 to +4	-1 to +10	-17 to +5	-4 to +3
		2080s	-2 to +17	-11 to +8	-10 to +15	-35 to +1	-8 to +7
Waikato	**Ruakura**	2030s	-13 to +7	-6 to +6	-4 to +16	-12 to +7	-4 to +7
		2080s	-3 to +25	-6 to +17	-14 to +31	-23 to +14	-2 to +19
	Taupo	2030s	-8 to +3	-9 to +4	-3 to +16	-14 to +2	-5 to +3
		2080s	-6 to +31	-12 to +7	-10 to +32	-25 to +4	-6 to +10
Bay of Plenty	**Tauranga**	2030s	-10 to +4	-16 to +4	-5 to +7	-20 to +8	-9 to +2
		2080s	-7 to +19	-18 to +15	-2 to +9	-41 to -3	-15 to +2
Taranaki	**New Plymouth**	2030s	-10 to +6	-7 to +6	-6 to +22	-10 to +9	-4 to +9
		2080s	-4 to +37	-9 to +16	-13 to +45	-26 to +19	0 to +22
Manawatu-Wanganui	**Wanganui**	2030s	-11 to +8	-8 to +6	-11 to +26	-7 to +11	-4 to +11
		2080s	-4 to +43	-10 to +9	-21 to +59	-21 to +24	0 to +26
	Taumarunui	2030s	-11 to +7	-4 to +14	-8 to +29	-9 to +11	-4 to +14
		2080s	-4 to +37	-4 to +29	-16 to +63	-25 to +24	-1 to +32
Hawke's Bay	**Napier**	2030s	-23 to +5	-27 to +1	-18 to +12	-23 to +9	-19 to +1
		2080s	-25 to +21	-48 to +11	-43 to +23	-52 to -4	-32 to +3
Gisborne	**Gisborne**	2030s	-20 to +7	-29 to +2	-14 to +10	-27 to +11	-17 to 0
		2080s	-21 to +19	-54 to +12	-32 to +23	-60 to -6	-31 to +4
Wellington	**Masterton**	2030s	-10 to +5	-11 to 0	-7 to +7	-11 to +5	-8 to +2
		2080s	-15 to +35	-19 to +4	-17 to +10	-20 to +12	-13 to +4
	Paraparaumu	2030s	-10 to +8	-6 to +6	-6 to +28	-10 to +10	-4 to +10
		2080s	-2 to +46	-8 to +11	-6 to +62	-23 to +21	+1 to +26
Nelson	**Nelson**	2030s	-16 to +1	-10 to +4	-3 to +15	-11 to +4	-7 to +2
		2080s	-21 to +33	-13 to +7	-2 to +31	-21 to +3	-7 to +4
Marlborough	**Blenheim**	2030s	-8 to +4	-9 to +3	-5 to +15	-12 to +4	-5 to +3
		2080s	-10 to +40	-13 to +6	-7 to +33	-23 to +9	-4 to +5
West Coast	**Hokitika**	2030s	-10 to +9	-4 to +12	-9 to +41	-12 to +12	-4 to +14
		2080s	+1 to +52	0 to +36	-6 to +90	-22 to +24	+1 to +40
Canterbury	**Christchurch**	2030s	-6 to +8	-20 to –1	-12 to +10	-11 to +4	-10 to +1
		2080s	-12 to +38	-36 to +8	-28 to +9	-21 to 0	-17 to +4
	Hamner	2030s	-16 to +5	-9 to +1	-15 to +11	-11 to +4	-12 to +3
		2080s	-22 to +32	-17 to +5	-32 to +12	-21 to +3	-21 to +3
	Tekapo	2030s	-9 to +8	-4 to +8	-6 to +35	-10 to +17	-3 to +13
		2080s	+1 to +46	-10 to +7	-3 to +76	-18 to +34	+2 to +31
Otago	**Dunedin**	2030s	-7 to +8	-2 to +3	-7 to +15	-4 to +11	-2 to +6
		2080s	+1 to +34	-9 to +46	-5 to +30	-2 to +16	+2 to +14
	Queenstown	2030s	-14 to +11	-3 to +18	-12 to +59	-11 to +23	-4 to +22
		2080s	+3 to +46	-5 to +21	-22 to +129	-15 to +45	+2 to +57
Southland	**Invercargill**	2030s	-9 to +10	-2 to +18	-12 to +28	-9 to +18	-2 to +15
		2080s	+2 to +37	-15 to +40	-19 to +60	-3 to +36	+1 to +37

Current research in the area of climate scenarios includes the development of a regional climate modelling facility at the National Institute for Water and Atmospheric Research. The modelling is based around the United Kingdom Meteorological Office Unified Model. Control runs have been satisfactory and the National Institute for Water and Atmospheric Research is planning to run future scenarios during the 2005/2006 year.

Expected key impacts of climate change

In May 2004, the Ministry for the Environment coordinated and published a national review, *Climate Change Effects and Impacts Assessment*, updating the scenarios used in the previous impacts report published in 2001. The new report uses the updated climate change scenarios that cover the full IPCC scenario range as well as incorporating additional research carried out over the three years since the last Government-led impacts assessment.

The report provides current projections of the expected overall changes in physical variables and emphasises how these compare with present climate extremes and variations. The broad expected pattern of change is:

- increased temperatures (with greater increases in the winter season, and in the north of New Zealand)
- decreased frost risk but increased risk of very high temperatures
- stronger west–east rainfall gradient (wetter in the west and drier in the east)
- increased frequency of extreme (heavy) daily rainfalls
- increased sea level
- increased westerly winds.

The main features of climate change scenarios identified in this report largely agree with those of the earlier impacts report. However some findings relating to changes in extremes are now on a firmer basis, and some general climate change projections have been updated for a wider range of emission scenarios.

The *Climate Change Effects and Impacts Assessment* report is particularly directed at identifying and quantifying potential effects on local government functions and services, and outlining methods for assessing the likely magnitude and relevance of such effects. It shows that the mid-range projected human-induced changes that might be expected over the next 30 years are of similar magnitude as current natural variations of the climate about the long-term mean (such as the El Niño-Southern Oscillation or the Interdecadal Pacific Oscillation). This means that over the next 30 years, natural climate patterns could either offset, or exacerbate, the trend due to anthropogenic climate change.

Changes in the severity and frequency of climatic extremes (that is, droughts and heavy rain) will continue to provide the major risk of short-term impacts on key sectors such as agriculture and urban infrastructure and the magnitude and frequency of these climate-related weather extremes is likely to change.

For example what currently is an unusually warm year could be the norm in about 30 years, while an unusually warm year in 30 years' time is very likely to be warmer than anything experienced at present.

The report provides guidance on how information on the magnitude of climate change effects can be applied to assess the risk associated with various impacts, and on incorporating climate risk assessment into local government regulatory, assessment and planning processes. A summary version of the manual, *Preparing for Climate Change: A Guide for Local Government*, has been published and has been distributed widely.

Coastal hazards

Much of New Zealand's urban development has occurred in areas vulnerable to the actions of the sea and in recent years, as coastline development has intensified, the potential impacts of coastal hazards has increased. The Ministry for the Environment has coordinated and published a manual, *Coastal Hazards and Climate Change* (Ministry for the Environment, May 2004), focusing on coastal issues and providing guidance to local government. The manual provides a risk-based decision-making framework and recommends that, as a minimum, figures for sea level rise of 0.2 metres by 2050 and 0.5 metres by 2100 are used when considering sea-level rise in projects or plans.

Drought risk

Water is a critical resource for New Zealand and drought risk is expected to increase during this century in all areas that are currently already drought-prone. A report commissioned by the Ministry for the Environment and the Ministry of Agriculture and Forestry, *Changes in Drought Risk with Climate Change* (Ministry for the Environment, 2005) gives local government and the agriculture sector an indication of how big the drought changes could be in the various agricultural regions of New Zealand. The report estimates "potential evapotranspiration deficit" from future time series of daily rainfall, obtained by adjusting observed daily rainfalls by factors obtained from the downscaled climate model predictions. Key findings include:

- Under a "low–medium" scenario, by the 2080s severe droughts (defined in the report as the current one-in-twenty year drought) are projected to occur at least twice as often as currently in a number of areas in eastern New Zealand.
- Under a "medium–high" scenario, by the 2080s severe droughts are projected to occur at least twice as often in much of eastern New Zealand and more than four times as often in a number of areas.
- In some dry areas, a drought of what is currently regarded as of medium severity could become the norm by the 2080s.
- The projected increase in the accumulated potential evapotranspiration deficit would probably produce an expansion of droughts into the spring and autumn months. For a "medium–high" scenario, the drying of pasture in spring is advanced by about a month in the 2080s in dry eastern regions, relative to the present climate.

Additional studies carried out by the National Institute for Water and Atmospheric Research and the economic consultancy Infometrics show that climate variations can have significant economic impacts on the production from dairy output (Tait et al., 2005). This is further confirmed by economic modelling carried out by the Treasury (Treasury, 2002), which indicated that droughts are one of the leading causes for yearly fluctuations in New Zealand's GDP, in addition to currency fluctuations and import and export price shocks.

A related study by the National Institute for Water and Atmospheric Research commissioned by the New Zealand Fire Service indicates that the increasing dryness of the landscape is likely to increase the fire risk in many parts of New Zealand, with potential consequences for the managed and natural ecosystems, housing and infrastructure (New Zealand Fire Service, 2005).

Flood risk

Climate change is expected to bring an increase in heavy rainfalls as well as an increase in drought. The increased frequency of extreme heavy rainfalls is expected to lead to an increased risk of flooding in some areas, and this has been the subject of several reports. The Ministry for the Environment is leading a two-year work programme to improve how New Zealand manages its flood risk and river control. One of the factors included in the work is consideration of the changing flood risk in a time of climate change.

Economic impacts

While the preceding reports have been concerned primarily with the physical impacts of climate change, the potential economic vulnerability for flooding has also been studied. A report, *The Waikato Weather Bomb: Understanding the Impact,* (Ministry for the Environment, 2004) has been produced for the Ministry of the Environment by the New Zealand Institute for Economic Research, the Institute of Geological and Nuclear Sciences, the National Institute for Water and Atmospheric Research and the University of Tasmania.

The report looked at the economic costs and community understanding and responses to flood risk for the Coromandel area following the 21 June 2002 "weather bomb" that caused major flooding to a number of townships in the area. It addressed the need to both understand the economic effects of extreme events and to understand the way in which communities understand, perceive and prepare for such risks.

Energy sector impacts

The Ministry of Economic Development's energy supply and demand model SADEM has been run on a number of climate scenarios relating to global climate change and expected extreme events. Using data from the National Institute for Water and Atmospheric Research and additional modelling from Infometrics, analysis on the effect of climate change on the wider economy is being assessed.

Initial studies indicate that climate change in general should be beneficial to New Zealand in an energy production and demand sense. Stronger westerly winds and warmer ocean conditions are expected to result in greater rainfall in the upper catchment areas of New Zealand's southern hydroelectricity generation lakes. These lakes are responsible for 40 to 50 percent of New Zealand's electricity generation.

The stronger winds in general are also expected to supplement wind power generation. New Zealand currently has some of the best wind sites in the world with an average utilisation factor in the order of 45 percent (compared to a European average of 25 percent). Whilst wind provides only two to three percent of current generation, this is expected to increase to more than 10 percent by 2020. On the demand side, higher temperatures should ameliorate heating demand. Whilst cooling demand is also likely to increase, the energy demand ratio is overwhelmingly in favour of the former in New Zealand's predominantly temperate environment, although there will be significant regional differences in the resulting changes in summer cooling and winter heating demand.

These initial studies have not included the effects of natural long-term climate variability. Wratt (2003) suggests that a change in the phase of the Interdecadal Pacific Oscillation relative to that over 1978–1998 might mean the anticipated increased rainfall in the southern upper catchment areas would not eventuate over the next 20 to 30 years. There may also be competition for water resources with irrigation in increasingly dry eastern areas.

Health

Potential negative impacts on human health from climate change have been identified in the spread of vector-borne diseases, heat waves, and pollution of water supplies in rural areas. Positive health effects are expected from warmer winters and related reduction in cold-related illnesses.

Health risks from the introduction of disease vectors are being addressed as part of New Zealand's biosecurity mechanisms, including the Biosecurity Science Strategy. Other potential health impacts from climate change are generally incorporated into ongoing public health policies as they typically do not represent new threats, but rather a possible exacerbation of existing problems, such as clean water supply and direct impacts of heat waves, or a likely reduction in winter illnesses. However, with the exception of the introduction of disease vectors, other pressures on the public health system in many instances appear to outweigh the need for climate change-specific adaptation measures in the New Zealand context.

The modelling of the potential future suitability and distribution of vector-borne diseases is facilitated by the HotSpots integrated assessment system (refer "Regional and sectoral tools and impact studies" in Chapter 6 for more details).

Agriculture

Agriculture is likely to experience benefits from extended growing seasons in the south and from carbon fertilisation, as well as negative impacts from droughts, floods and erosion, invasion of subtropical species, and warmer winters leading to increased spread of some pests and diseases. The balance between benefits and costs is not yet clear but will depend on regions, frequency of extreme events compared to average changes, and the extent of adaptation to changes.

In addition to the general impact studies and those on drought and flood risk, mentioned above, a number of research programmes provide specific information on impacts and adaptation in the area of agriculture. These include investigating the response of various pasture and arable species to changes in temperature, carbon dioxide concentration and rainfall, and the adaptive breeding of new cultivars (for example, kiwifruit with reduced winter chill requirements, drought resistant pastures and high-quality subtropical pastures).

Recent research on climate change effects on pastoral ecosystems has shown that long-term biogeochemical feedbacks reduce the fertilisation effect of elevated carbon dioxide. Pasture soils under elevated carbon dioxide appear less able to supply plants with nitrogen and phosphate leading to a syndrome known as "progressive nutrient limitation"; this syndrome has been observed in a wide range of ecosystems internationally as well as in New Zealand. There are significant implications of progressive nutrient limitation for agriculture – including changes in fertiliser requirements – and in natural ecosystems because of the strong link between nutrient supply and biodiversity. This phenomenon is being studied in the New Zealand Free Air Carbon Dioxide Enrichment (FACE) experiment.

Improved ecosystem models have become available in the past four years offering the possibility of more accurate predictions of pasture responses to elevated carbon dioxide and temperature, more relevant regional projections and a better tool for testing adaptation options.

Potential impacts and adaptation measures in the eastern agricultural regions of New Zealand have been explored in a series of community workshops. The publication that resulted, *View from the Ground* (Earthwise Consulting, 2003), offered a farmer's perspective on climate change and adaptation. Largely positive and proactive because of the perceived capacity of farmers to adapt, the report has led to further workshops and the production of a resource kit (Earthwise Consulting, 2005) for the farming communities in these areas. Among the adaptation measures required are management of irrigation schemes and water supply systems and changing land use in response to changing erosion and drought risk. The potential for soil erosion in these areas is expected to increase if there is an increase in drought frequency and severity coupled with episodes of heavier rainfall.

Biodiversity

Some native ecosystems may be put under additional pressure from climate change, with little ability of migration to adapt to changes because of the fragmented landscape. Areas at risk include dry lowland forests, some specific species with a limited climatic envelope, several freshwater species requiring cold conditions, and flow-on effects in predator/prey relationships following climate extremes. Knowledge about the impacts of climate change on New Zealand native ecosystems is currently limited. Most at risk is the native bird fauna threatened by the recent advance of avian malaria.

Emerging infectious diseases are an increasing threat to natural biodiversity, due to human movement, habitat destruction and climate change. Increasing vector distributions are of particular concern. Over the past three decades, the mosquito vector of avian malaria in Hawaii (where the disease has wiped out half the native bird species) has been spreading south through New Zealand. This raises the possibility that, as climate change and land use continue to alter mosquito distributions, much of New Zealand's native avifauna may be at risk. In conducting the first survey for avian malaria in New Zealand for more than 50 years, Landcare Research has demonstrated that avian malaria is now present and that such a fate is a likely possibility, indicating that pre-emptive management against disease may be necessary.

Fisheries, aquaculture and marine ecosystems

Increasing water temperatures and associated changes in oceanic and atmospheric circulation are likely to present a number of challenges for New Zealand's marine industries. The surface of the ocean surrounding New Zealand has warmed by near 1ºC over the past century. For many fish species, a one degree change can be very significant, either in terms of affecting juvenile survival, modifying predator–prey relationships, or changing preferred spawning and/or feeding regions.

For one of the most valuable fisheries, hoki, relatively low recent recruitment in the western stock has shown some correlation with climate. As a consequence of a decline in stock biomass, the hoki catch quota has been reduced from 250,000 to 100,000 tonnes in the past four years. Although other factors may have contributed to the decline, it is possible that recruitment to the stock is, or has become, more sensitive to climatic variation, and that recent conditions have been detrimental to recruitment. In a similar way to hoki, the recruitment of red cod has also been relatively high during colder conditions, which are associated with the El Niño event.

Conversely, for snapper, relatively high recruitment and faster growth rate have been correlated with warmer conditions. A similar pattern of recruitment has been found for gemfish. For the former two species, climatic indices have been incorporated into the calculation of short- or medium-term predicted yields. El Niño appeared to be associated with the invasion of the Chilean jack mackerel into New Zealand waters in the mid-1980s, and this species now dominates the jack mackerel fishery in some areas.

Climate changes are likely to be significant also for local aquaculture. In the Marlborough Sounds, changes in wind circulation and associated rainfall patterns modify coastal river flows, and lead to changes in the stratification of the water column in the vicinity of mussel farms, influencing the nutrient supply. Such changes have been observed in relation to the El Niño/La Niña cycle, and the expected increase in drought risk in eastern regions of New Zealand is likely to have a long-term influence on the character of coastal waters in the Sounds and elsewhere.

Māori

Māori have a disproportionate economic interest in land and forestry assets. In considering the output from agriculture alone, Māori output is estimated to be approximately $700 million dollars representing about 7.4 % of New Zealand's total agricultural output (New Zealand Institute of Economic Research, 2003), against a land resource base of approximately 5 percent of land in New Zealand.

Some areas of land owned by Māori are prone to erosion. However, there is targeted Government assistance such as the East Coast Forestry project that promotes commercial forestry to control soil erosion in the region. In the year 2000 there were 25,854 hectares of plantings. To 2005 plantings increased up to 30,000 hectares.

Māori also place high cultural value on land, including areas that could be impacted by events like flooding or ocean surge due to climate change. Statutory and cultural imperatives on land ownership more particularly for Māori, may make relocation in response to climate change more difficult. In addition prioritisation in terms of adaptation, as well as cost, could hinder implementation of adaptation measures. This can contribute to the risk of reduced economic output from Māori land compared to other New Zealand land, and also from other assets.

In response to climate change the Government has consulted with Māori since climate change became a significant issue and continues to work with this area with Māori.

Regional and sectoral tools and impact studies

An integrated impact assessment tool developed in New Zealand is the CLIMPACTS model system and its derivatives. These models incorporate the patterns of regional climate change, such as those developed by the National Institute of Water and Atmospheric Research, and scale them relative to modelled, time-dependent global temperature changes (for example, from IPCC), in order to create scenarios that are used directly for impact assessments. The climate change scenario generator is integrally linked with sectoral impact models (for example, crop models, hydrological models). The main advantage of this system is that it provides a high degree of flexibility in terms of the scenarios and impacts that can be evaluated. It is readily updated to reflect the latest findings of the IPCC and allows comprehensive evaluation of environmental sensitivities for selected sectors.

The CLIMPACTS programme has developed a range of different application scales for national, regional and site-specific impacts and adaptation assessments. The main scales are: national (0.05° latitude/longitude grid; monthly climate normals); regional council (0.01° latitude/longitude grid; time series of monthly and daily climate data); site-specific (time series of monthly and daily climate data).

A variation of the CLIMPACTS model has been developed to predict changes in suitable habitats of several mosquito species capable of transmitting diseases such as Ross River virus and dengue fever – the HotSpots model (developed jointly by the International Global Change Institute and the Wellington School of Medicine, with funding from the New Zealand Health Research Council). The model includes spatial climate and land-cover data, the typical entrance points of these diseases' vectors through shipping ports and airports, and social transmission conditions such as population density. Combined, these factors allow not only projection of changing suitability of habitats, but also estimations of changes in the establishment of risk vectors and eventual disease outbreak under current social and health care conditions.

The CLIMPACTS programme, with Foundation for Research, Science and Technology funding and with additional support from international agencies such as the United Nations Environment Program Global Environment Facility and the Asian Development Bank, has recently developed methods and tools for assessing the "human dimensions" of climate change. These developments include the capacity to generate scenarios of land use changes, to examine adaptation options and to evaluate benefits and costs. Part of the effort has been to create a flexible "open framework" model system (SimCLIM) that can be customised by end-users. These tools are part of a larger methodology, called CCAIRR (Climate Change Adaptation through Integrated Risk Reduction) which promotes the "mainstreaming" of adaptation into decision-making. These integrated methods and tools, developed and applied initially in New Zealand, have also been applied in, for example, Australia, Sri Lanka and various Pacific Island countries.

Details on the CLIMPACTS model and its applications are available on the internet at *www.waikato.ac.nz/igci/climpacts.*

Regional assessments

Under New Zealand's devolved system of resource and environmental management, concrete actions to address and minimise impacts of climate change are to a large extent the responsibility of local government. This responsibility has seen a number of authorities commission reports identifying the possible climate change hazards specific to their regions. These have included Environment Bay of Plenty (Griffiths et al., 2003); Environment Canterbury (Tait et al., 2005a); Horizons Manawatu Regional Council (Tait et al., 2005b) and Wellington Regional Council (Tait et al., 2002). The Ministry for the Environment has also studied a number of location-specific case studies to demonstrate impacts assessment methodologies and location-specific decision problems. These case studies include stormwater design for existing and greenfield developments, an economic assessment of the implications of sea-level rise for the management of housing stock, and an analysis of the barriers and solutions in decision-making by local government.

A new product developed by the National Institute for Water and Atmospheric Research offers geographic layers of both current values and future scenarios of selected climate parameters (for example, temperature, rainfall, potential evapotranspiration deficit).

Councils can use these along with layers they already hold in their Geographic Information Systems (for example, topography, soils, infrastructure) to explore possible impacts of various future scenarios, and also to explore possible suitability of other land uses under a changed future climate.

Private-sector assessments

Natural hazards represent a major insurance field. Some parts of the insurance industry in New Zealand are active in modelling future risk in a changed climate (Insurance Australia Group, 2004, 2005).

Aside from the insurance industry the private sector has focused predominantly on managing the impacts of climate variability and adapting to well-known natural patterns of climate change within shorter time horizons. Most of this work occurs in the agriculture sector with regard to the management of droughts and through seasonal climate forecasts, and the building sector including through assessments undertaken by the Building Research Association of New Zealand (Building Research Association of New Zealand, 2004). The land transport agency, Transit New Zealand, has also developed a preliminary position and undertaken some scoping work on the relevance of climate change impacts on the roading network and the possible adaptation options in high risk areas.

Adaptation policy

Under the New Zealand approach to the management of natural resources and the risks from natural hazards, most concrete actions to address and minimise effects of climate change fall under the authority of local government (city, district and regional councils). Planning to reduce the adverse effects of natural hazards is particularly important at local government level because of the local effects the hazards or resources usually have, which may require locally distinct management and adaptation methods.

A focus of recent work has been the development of guidance to assist local government agencies manage the effects of climate change. The New Zealand approach to adaptation policy consists of a hierarchical set of legislation, guidance material on impacts assessment and the scoping of adaptation options, case studies, and underpinning information material. This set of adaptation policy measures is outlined on the following page.

Legislative background

In New Zealand, legislation establishes the responsibilities of local authorities for avoiding, minimising, and mitigating the costs and effects of natural hazards and managing natural resources:

- Local government is responsible for the avoidance and mitigation of natural hazards through plans and rules prepared under the Resource Management Act 1991. Under the Act, councils must protect the life-supporting capacity of air, water, soils and ecosystems; generally by regulating the effects of human development on the environment. The councils and their communities decide how to protect the environment using rules in district and regional plans, which are legally binding documents.
- Local government has responsibility under the Civil Defence Emergency Management Act 2002 for “civil defence”. The Act seeks to improve New Zealand’s resilience to emergencies through promoting a comprehensive, all hazards approach to managing risk.

- Under the Local Government Act 2002, local government has a responsibility for providing services and utilities necessary for "community well-being" while taking a sustainable development approach and a long-term focus. Community well-being includes four dimensions: environmental, social, economic and cultural.

Strengthening of the legislative mandate to address climate change effects

The large uncertainties in local projections of the impacts of climate change make it difficult to mandate or implement specific actions at a national scale aimed at adaptation to climate change. To provide greater legal certainty about the responsibilities by local government to consider the effects of climate change, the Resource Management Act was changed in March 2004 to require all persons exercising duties and functions under the Act to have particular regard to the effects of climate change (s. 7(i) Resource Management Act). This legislation change has removed earlier ambiguities in interpreting the scope of the Act by local government and other stakeholders engaged in managing natural resources and hazards at the local level.

Guidance and information materials

Support for local government to meet the provisions of this legislation has included the guidance manuals referred to earlier *(Climate Change Effects and Impacts Assessment,* Ministry for the Environment, 2004; *Coastal Hazards and Climate Change,* Ministry for the Environment, 2003), the summary guide *Preparing for Climate Change: A Guide for Local Government* and an introductory brochure, primarily for elected officers *(Local Communities: Planning for Climate Change,* Ministry for the Environment, 2004). The legislative and planning context is further outlined in a best practice guidance note *(www.qp.org.nz/content.php?id=313)* providing information on how to assess the significance of, and respond where necessary to, the effects of climate change within the local government planning and decision-making system.

The guidance manuals contain detailed quantitative information on the likely biophysical changes in climate for different regions of New Zealand, including information on the likely changes in extreme events. In addition, they provide the legislative context for decision-making, and outline a methodology for assessing climate change impacts in a way that facilitates adaptation within standard decision-making processes.

A particular focus of this guidance is to outline to councils how to integrate the assessment of climate change impacts into their existing risk assessment, policy-making and decision-making processes. The guidance material recommends a staged approach to climate change assessment in planning. It starts with a qualitative assessment of potential risks for functions and services provided by councils, followed by a preliminary quantitative ("screening") analysis of the likely impacts of climate change for specific issues. If the simple screening analysis shows a potentially significant impact from climate change on natural resources or hazards, the methodology then recommends a more detailed analysis using complex and location-specific models and scenarios.

In addition to the generic assessment methodology outline in the guidance material, several case studies supported by the Ministry for the Environment (see URS NZ, 2004; Harris Consulting, 2003; Opus International, 2003; and Lawrence Cross and Chapman, 2003) give practical examples of the methodologies used to incorporate provision for climate change into urban stormwater design, floodplain management, flood risk management, and coastal hazards. These may be downloaded from *http://www.climatechange.govt.nz/resources/local-govt/guidance.html*

The guidance material advises that for nearly all resources and natural hazards, the mean changes associated with climate change over the next 30 years are generally expected to be comparable with the extremes from existing natural climate variability. Hence they are of a type and magnitude already known to local government and can be planned for and managed using current systems simply by mainstreaming a climate change component into current local government planning and management practice. The extremes in a changed climate will likely lie outside the current range and may require new adaptation measures. However the congruence between expected mean changes and current extremes makes it easier for councils to incorporate climate change in their activities, building on current known vulnerabilities to climate variability and extremes. It also means that adaptation can be seen as a "no regrets" policy, because it leads to a reduction in vulnerability to existing hazards as well as making communities more resilient against future pressures arising from climate change.

Other adaptation measures

Notwithstanding the responsibilities of local government, it is recognised as important that policy makers at national level, and decision makers within industry groups, take account of the possible effects of climate change in formulating policy and developing strategic plans.

MetService, the state-owned enterprise responsible for weather forecasting in New Zealand, is under contract to the Government to provide storm warnings and warnings of high rainfall events to the New Zealand public, as well as maintain its routine weather forecasting duties. Further, the National Institute of Water and Atmospheric Research produces monthly climate forecasts with a time horizon of three months. These forecasts are primarily intended for the farming community but can also be of use to local government in managing water supplies.

Adaptation in the international context

New Zealand recognises that adaptation plays a significant role internationally, and has supported a range of measures to share information and best practice with other countries. New Zealand believes that despite differences in national circumstances, a range of important lessons regarding effective implementation and enabling policy frameworks can be learnt and shared between different countries.

In October 2004, New Zealand hosted an international workshop on adaptation in developed countries, in partnership with Australia, to share information about the status and focus of current adaptation programmes, and to discuss key issues, barriers and solutions for topics and sectors of relevance. A summary report of the workshop has been made available *(www.climatechange.govt.nz/about/international-workshop/index.html)*.

New Zealand also actively engages in sharing of information and funding of adaptation activities in developing countries, particularly in the Pacific. Actions include the provision of seasonal climate forecasts, in-country capacity building and enhancement of climate monitoring and data analysis, and support for specific adaptation projects through its overseas development aid programme. The CLIMPACTS integrated assessment tool has been used widely as a training and capacity building tool in a range of countries.

At the multilateral level, New Zealand officials also participate in a range of fora that aim to gain a better understanding of the role of adaptation in future climate change commitments, and options to assess the effectiveness of adaptation measures and support for adaptation. Relevant activities where New Zealand continues to actively

participate include the pre- and in-session workshops by the Subsidiary Bodies for Scientific and Technological Advice; the Annex I Experts Group and Global Forum for Sustainable Development of the OECD; and the Centre for Clean Air Policy's "Future Actions Dialogue".

Future research and implementation issues

The comprehensive analysis by the National Science Strategy Committee for Climate Change of gaps in vulnerability and adaptation, conducted in 2001, remains largely valid. Particular current priorities in the climate change area are:

- improved climate modelling, particularly of water resources and extreme events including floods and droughts, at a range of scales
- economic assessments of the costs associated with climate change impacts and adaptation and residual costs
- dissemination of existing knowledge to end-users and stakeholders across central and local government and the private sector to support mainstreaming of adaptation into sector-specific assessment and decision-making processes.

While for some sectors the primary effort is likely to lie in the dissemination of existing knowledge to support decision-making by stakeholders, in other sectors additional knowledge would be available. These sectors include:

- marine ecosystem and fisheries
- terrestrial natural ecosystems and biodiversity
- the effects of climate change on the indigenous Māori population and their traditional resource management approaches.

New Zealand has not at this stage developed an assessment of critical limits or tolerable windows with regard to climate change impacts and coping capacity.

Another important area for future work is the merging of top-down and bottom-up approaches to impacts assessment and adaptation. Most assessments have used top-down approaches based on model projections, but an increasing body of work in the agriculture sector has used bottom-up assessments. Future work may address the merging of such bottom-up approaches with model-based and economic assessment studies.

Chapter 7

Financial resources and transfer of technology

Contributions to the financial mechanism

The Global Environment Facility is the international entity entrusted with the operation of the financial mechanism of the UNFCCC. The Global Environment Facility distributes financial assistance associated with the major multilateral environment agreements on climate change, biodiversity, ozone layer, as well as activities relating to land degradation, chemicals and international waters. New Zealand contributed NZ$12.13 million to the third replenishment of the Global Environment Facility (GEF3), which covers the years 2002–2006. New Zealand is fulfilling its Article 4.3 commitments through its contribution to the Global Environment Facility. 4NC Table 31 provides details of New Zealand's annual contributions to the Global Environment Facility for the years 2001 to 2004.

Negotiations are underway on the fourth replenishment of the Global Environment Facility (GEF4) for the period 2006–2010 and are scheduled for completion in late 2005.

Actions to implement Articles 4.3, 4.4 and 4.5 of the UNFCCC

Articles 4.3, 4.4 and 4.5 of the UNFCCC relate to the commitments of developed country Parties (Annex II Parties) regarding financial resources and technology transfer to enable developing country Parties to implement the provisions of the UNFCCC, and for adaptation assistance.

New Zealand is particularly focused on helping to meet the concerns and needs of Pacific Island countries. Pacific Island countries are on the front line of climate change impacts – in some instances climate change is an issue of national survival – yet their contribution to the problem is negligible.

In 2001, New Zealand also joined with several other countries in a Political Declaration on Financial Support for Developing Countries. New Zealand's share of this voluntary commitment is NZ$5 million per year from 2005. The voluntary commitment comprises the proportion of funds from New Zealand's total Global Environment Facility contribution that is likely to be spent on climate change projects; the New Zealand Agency for International Development's climate change-related support in the Pacific; funding for lump sum contributions to one or more of the UNFCCC funds; and funding for ad hoc contributions towards projects which advance international action to address climate change.

New Zealand recognises the need to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation (Article 4.4). For example, the New Zealand Agency for International Development 's draft environment policy, which will be used to guide the agency's decision-making, stresses the importance of assisting adaptation.

4NC Tables 33 to 36 contain details of financial contributions made in relation to adaptation.

New Zealand recognises its commitments under Article 4.5 to take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention.

New Zealand does this primarily through the work of the New Zealand Agency for International Development (NZAID). New Zealand also contributes through various Global Climate Observing System-related initiatives in the Pacific region; for example supporting initiatives to restore and upgrade the regional upper-air networks, produce a Pacific regional climate bulletin, recover historical climate data, and assist with capacity building in Pacific Island hydrological and meteorological services.

The transfer of environmentally sound technologies is, however, largely undertaken by the private sector. The New Zealand Government has a role in facilitating technology development in New Zealand, including through the Technology for New Zealand initiative and other technology-related initiatives such as the Research for Industry, and Grants for Private Sector Research and Development.

Financial resources provided through bilateral, regional, and other multilateral channels

The New Zealand Agency for International Development was established in 2002. It is semi-autonomous within the Ministry of Foreign Affairs and Trade, with a mandate focused on poverty elimination. The Agency's policy framework is being progressively developed. At the time of reporting this *Fourth National Communication,* the draft environment policy is under preparation. In its current form, the draft policy recognises the significance of climate change for poverty elimination, particularly in the small island developing states of the Pacific region which is the principal geographic focus of the New Zealand Agency for International Development. Research carried out for the preparation of this policy showed that managing the impacts of climate change (including integration into national sustainable development planning, capacity building, and implementing adaptation plans) is one of the Agency's Pacific Island partners' priorities. The final policy will guide the restructuring of its Pacific regional environment programme, including the Pacific Initiative for the Environment reported in New Zealand's *Third National Communication.*

Current support to climate change activities in the New Zealand Agency for International Development's programmes reflects:

- support to climate change programmes of Pacific regional organisations and multilateral organisations (refer 4NC Table 32)
- a number of bilateral country activities where New Zealand Agency for International Development engagement has been sought by partner governments (refer 4NC Tables 33 to 36)
- support to Pacific regional climate change policy processes (refer 4NC Table 37).

The environment policy will also guide future engagement and funding allocations. In the interim, the New Zealand Agency for International Development is assisting Pacific regional agencies in their development of regional policy, strategies, and partnership initiatives concerning climate change. Principal among these is the review and refinement of the Pacific Framework for Climate Change. The New Zealand Agency for International Development is funding this process, which will provide an umbrella framework for all Pacific priority actions on climate change. The New Zealand Agency for International Development and other donors anticipate that this will form the central framework for alignment of future climate change assistance.

In particular New Zealand will look to the framework to guide future contributions under the voluntary commitment that was made in 2001. In October 2005, Pacific Forum leaders endorsed the Pacific Islands Framework for Action on Climate Change as a regional mechanism to support responses to climate change and related concerns for the period 2006–2015. They noted the need to develop and implement national action plans for climate change and related issues consistent with the framework and other regional frameworks (for example, the Pacific Regional Framework for Action for Building the Resilience of Nations and Communities to Disasters).

Pacific preparations for the 2002 World Summit on Sustainable Development included the identification of 14 regional priorities for achieving sustainable development by Pacific Island states. These were subsequently developed into Pacific umbrella Type 2 partnership initiatives and coordinated by regional agencies. Of the 14, four are climate change-related focusing on: adaptation, vulnerability, water and sanitation, and energy. Most of these are still in the process of development as funding mechanisms. The New Zealand Agency for International Development is committed to investigating all four for support and is currently assisting those on vulnerability and water and sanitation. Completion of the development of the adaptation initiative is anticipated in 2006/07.

The New Zealand Agency for International Development is also a major funder of the Pacific regional agencies, with the South Pacific Applied Geoscience Commission (SOPAC) and the Secretariat of the Pacific Environment Programme, in particular, having climate change responsibilities. The Agency is progressively moving to a programme-funding basis for all Pacific regional agencies. This will mean that agencies are free to allocate funding between programmes within their overall strategic plan. Donor funding is not monitored at a level that traces individual donor funds to specific activities. This is also the case for multilateral allocations, hence the figures in 4NC Table 32 are total allocations to agencies and incorporate, but are not exclusively, climate change expenditure.

Mitigation

The New Zealand Agency for International Development's main areas of engagement have been in energy and forestry. The main energy projects have been for comprehensive energy efficiency and use of renewables in Tokelau and the Niua outer islands of Tonga. Over this reporting period, the Agency has moved into the final phase of support to the Bukidnon plantation forestry project in the Philippines which has now begun its harvesting cycle. Apart from these large projects, the Agency's effort in both these sectors has been small scale.

Adaptation

In 2001-2004, most of the New Zealand Agency for International Development's support to adaptation has been around Pacific regional processes, planning, strategy, and initiatives development. New Zealand has also played an active role in UNFCCC negotiations supporting the needs of least developed countries and developing countries in respect of adaptation. The Agency anticipates committing a significant proportion of New Zealand's voluntary commitment to Pacific adaptation priorities. At the time of reporting the Pacific's regional umbrella initiative on adaptation is not yet operative. The Agency is, however, a partner in the Pacific umbrella partnership initiative on water and sanitation, in particular supporting climate forecasting and meteorological services training. It has also provided substantial financial assistance for the regionally developed Environmental Vulnerability Index. The Agency continues to support water and sanitation initiatives at a local scale. For many small island developing states, and in particular atoll countries, increasing rainfall variability is anticipated to exacerbate water supply difficulties putting a premium on water collection and storage infrastructure.

4NC Table 31: Financial contributions to the Global Environment Facility (GEF)

	Contribution [1] (millions of NZ [2] dollars)			
	2001 [3]	2002	2003	2004
Global Environment Facility	1.740	2.073	3.150	4.065

Notes:

(1) "Contribution" is interpreted here as the combined total of New Zealand's encashments for the GEF Trust Fund; for 2001 and 2002 this equates to the sum of contributions made to GEF1 and GEF2, and for 2003 and 2004 the sum of contributions made to GEF1, GEF2 and GEF3. Contributions made to the GEF Trust Fund are not apportioned to specific areas of the GEF's work. GEF projects address six global environmental issues, of which climate change is one.

(2) Contributions to the GEF Trust Fund are made in New Zealand dollars.

(3) Years in the table refer to GEF financial years (July to June).

4NC Table 32: Financial contributions to multilateral institutions and programmes

Institution or programme	Contribution (millions of NZ dollars)			
	2001	2002	2003	2004
Multilateral institutions:				
1. World Bank Consultant Trust Fund	0.57	0.55	0	0
2. International Finance Corporation	0.40	0	0	0
3. Asian Development Bank	9.23	9.91	9.91	12.58
4. United Nations Development Programme	6.0	6.28	6.28	6.4
5. United Nations Environment Programme	0.136	0.136	0.311	0.235
6. UNFCCC Supplementary Fund for Participation	0	0	0	0
7. Montreal Protocol	0.68	0.91	0.80	0.71
Multilateral scientific, technological and training:				
1. South Pacific Regional Environment Programme	1.88	0	0.95	2.03
2. South Pacific Applied Geoscience Commission	0.95	0.05	0.97	2.67
3. Consultative Group on International Agricultural Research (CGIAR)	1.09	0.93	0.77	0.87
4. Commonwealth Science Council	0.28	0.33	0	0
5. International Fund for Agricultural Development (IFAD)	0.72	0.72	0	0

4NC Table 33: Bilateral and regional financial contributions related to the implementation of the Convention, 2001 (millions of NZ dollars)*

Recipient country/region	Mitigation						Adaptation			
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity building	Coastal zone management	Water resources	Other vulnerability assessment
Tokelau	1.44									
Philippines			0.75		0.16			0.01		
Solomon Islands	0.25									
Niue			0.25							
Viet Nam	0.22		0							
Tonga	0.06		0.14							
Sri Lanka					0.17					
Pacific region							0.13		0.04	
Cook Islands					0.16					
China			0.16							
Cambodia	0.15									
Pakistan	0.15									
Vanuatu			0.06							
Nepal	0.01									

Note: * (2001 1$US = $NZ 2.3817)

4NC Table 34: Bilateral and regional financial contributions related to the implementation of the Convention, 2002 (millions of NZ dollars)*

Recipient country/region	Mitigation						Adaptation			
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity building	Coastal zone management	Water resources	Other vulnerability assessment
South Asia region	0.19								0.6	
Philippines	0.15		0.45		0.15					
Pacific region			0.01	0.24			0.33			
Vanuatu			0.08						0.5	
Cambodia	0.15								0.37	
Pakistan	0.43									
Global (Geothermal training)	0.3									
Tonga	0.02								0.27	
Tokelau	0.29									
Niue	0.1		0.14							
Laos									0.08	
Samoa					0.06					
Solomon Islands									0.02	
Africa region	0.02									
Cook Islands					0.01					

Note: *2000 1$US = $NZ 2.1633

4NC Table 35: Bilateral and regional financial contributions related to the implementation of the Convention, 2003 (millions of NZ dollars)*

Recipient country/region	Mitigation						Adaptation			
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity building	Coastal zone management	Water resources	Other vulnerability assessment
Cambodia	0.21			0.09			0.46		0.18	
Tonga	0.03		0.54						0.13	
South Asia region	0.23								0.39	
Vanuatu			0.03						0.56	
Philippines			0.32						0.17	
Pakistan	0.31									
Tokelau	0.23				0.03					
Samoa					0.25					
Pacific region			0.03				0.11		0.08	
Global (Geothermal Training)	0.2									
Solomon Islands							0.19			
Nepal									0.08	
Fiji	0.07									
Viet Nam	0.04									
Uruguay							0.03			
Sri Lanka									0.02	
Niue			0.01							
Cook Islands					0.01					

Note: *2003 1$US = $NZ 1.724

4NC Table 36: Bilateral and regional financial contributions related to the implementation of the Convention, 2004 (millions of NZ dollars)*

Recipient country/region	Mitigation						Adaptation			
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity building	Coastal zone management	Water resources	Other vulnerability assessment
Pacific region				0.27	0.53		1.34		0.36	
Tonga					0.01		0.25		0.92	
Solomon Islands	1									
South Asia region	0.15								0.49	
Philippines	0.29							0.1	0.11	
Fiji				0.42			0.04		0.02	
Vanuatu									0.22	
Indonesia	0.05		0.11							
Niue	0.02				0.1					
Tokelau					0.1					
Papua New Guinea							0.09			
Viet Nam									0.09	
Cambodia				0.09						
Cook Islands					0.06					
Samoa							0.04			
Kiribati					0.03					
Sri Lanka									0.02	

Note: *2004 1$US = $NZ 1.509

4NC Table 37: Description of selected projects or programmes that promised practicable steps to facilitate and/or finance the transfer of, or access to, environmentally-sound technologies

Project/programme title
Niuas Electrification Project: Tonga

Purpose:
To design an island-wide, locally sustainable, system of electrification for the Niuas - a remote outer island group of Tonga.

Recipient Country	Sector	Total funding	Years in operation
Tonga	Energy	NZ$111,293	1998

Description
The outer islands of Tonga are home to a significant proportion (about a third) of Tonga's population. The Government of Tonga (GOT) sees the provision of improved infrastructure services, including basic electrification facilities, as an important contribution to the creation of a more attractive environment in the outer islands, thus helping to mitigate urban drift to the main island, and overseas. Against this background the GOT requested the New Zealand Agency for International Development to fund an electrification feasibility study for the Niua islands. The New Zealand Agency for International Development commissioned a feasibility analysis of various electrification options for the two major islands of the Niuas in 2001-2002 including the financial, economic, social, environmental and institutional aspects of electrification projects in the Niuas. The analysis concluded that the circumstances found on the Niuas favour the use of solar power as populations are small and scattered, there is a consequent low power demand, and the isolated islands are difficult to access. The study recommended distributed (i.e. individual household) solar electrification as an appropriate solution for Niuafo'ou (which is the most remote island in Tonga). Final design and construction will begin in 2005.

Indicate factors which led to project's success
While the project is currently proceeding from design to implementation it is too early to call it a success; however, the project has been evaluated as being on track for successful conclusion. Key indicators include: The concept arose from the island communities' own decision-making and design was undertaken in a locally appropriate, participatory way.

- The activity will meet the local communities' desired outcomes and will be implemented according to a locally developed approach (for example, as part of the project small committees will be set up in each village to operate and manage the solar power scheme; also the power project will provide lighting for village community halls in the evenings which will assist with holdings of meetings and other community gatherings).
- There is also an education and training component (there will be training of individuals on Niuafo'ou in the management, operation/maintenance of generating parts, and securing supplies of consumables; and also there will be some upskilling of the Energy Planning Unit personnel who will be supervising the setting up of the project and monitoring its progress over the longer term).

Technology transferred
Solar technology and its support infrastructure will be transferred as the project is implemented. Information and participatory planning approaches have contributed to the outer island development process more generally.

Impact on greenhouse gas emissions/sinks (optional)
The solar electrification will result in a reduction in greenhouse gas emissions be replacing diesel generation, although this will be minimal because of the scale of the project. The total island population is 760, comprising 170 households. The principal focus of the project is on energy efficiency and sustainability of electrical energy supply.

Chapter 8

Research and systematic observations

Introduction

New Zealand has continued to promote and collaborate in research and systematic observations, as required by Articles 4 and 5 of the UNFCCC. Estimated central Government expenditure on climate change-related research and systematic observations for the 2003/04 financial year is NZ$31.9 million, an increase of NZ$10.9 million over the amount reported in the *Third National Communication* (Ministry for the Environment, 2001). This expenditure was complemented by an estimated NZ$0.1 million expenditure by regional government, and NZ$1.2 million by the private sector. Expenditure on systematic observations by central Government included NZ$8.5 million through contracts to the Meteorological Service of New Zealand Limited (MetService) for its observing network and NZ$1.4 million through contracts to the National Institute of Water and Atmospheric Research for maintaining the National Climate Database. Through this expenditure, climate observations have been maintained, new knowledge has been generated about climate change and its impacts in New Zealand and the southwest Pacific, and adaptation and mitigation options are being developed.

New Zealand is making a substantial input to the *Fourth Assessment Report* of the Intergovernmental Panel on Climate Change, by supporting one scientist as a member of the IPCC Bureau and providing convening lead authors for two chapters, and lead and

contributing authors and review editors for several more chapters. Officials have participated in planning and other meetings related to the Group on Earth Observations (GEO) and the Global Climate Observing System (GCOS). Research groups participated in international research and observation programmes of the World Meteorological Organization; World Climate Research Programme; International Geosphere-Biosphere Programme, including GCOS and its Pacific component, PI-GCOS; and the Asia-Pacific Network for Global Change Research. MetService, under a New Zealand Government contract, provides some assistance to a number of Pacific Island nations with their weather and climate observing systems. Past New Zealand Overseas Development Aid programmes have covered training in technical maintenance and observing practices in several of these states. New Zealand continues to lead the publication of the *Island Climate Update,* a monthly paper and web publication produced by the National Institute of Water and Atmospheric Research with the support and collaboration of various organisations in the Pacific Islands, Australia, United States, and France. The *Island Climate Update* provides updates of current climate conditions and outlooks for the coming season to assist Pacific Island nations in adapting to climate variability and change.

Research and systematic observations policy and funding

Strategy for research and systematic observations

The New Zealand Government is operating a balanced portfolio of research that aims to address core national needs, to support areas of national research excellence. It also aims to maintain and develop international linkages that ensure collaboration with international research programmes and the contribution to, and rapid uptake of, emerging new global technologies.

Research providers are selected through competitive bidding. To be allocated funding, the areas of research must align with strategic directions and goals set by the Government and contained in long-term goals such as the Sustainable Development Programme of Action, and sector-specific research strategies. Funding for climate change research is dominated by central Government programmes, with additional contributions from local government and the private sector, including a number of joint ventures and partnerships. Government-funded research ranges from fundamental and underpinning research to applied research and operational research, including the development of specific tools and technologies. The range of different funding mechanisms is explained in more detail on later pages.

New Zealand faces a number of significant challenges in meeting its climate change research needs. The diversity of the country, with climatic zones ranging from subtropical to subantarctic, means that research has to address climate change projections and the likely effects of climate change on a very diverse range of ecosystems. Mitigation and adaptation research has to cover equally diverse issues including energy, transport in a country with a low population base but large travel distances, substantial agricultural and forestry activities, energy demand and supply, and the sustainable development of growing urban settlements, often at or near coastal areas. The dependence of New Zealand's economy on export and international trade also means that mitigation options that are being developed and implemented need to be compatible with the commercial requirements and technology standards of the international market.

The current portfolio of climate change research has grown out of the work of the National Science Strategy Committee for Climate Change, set up by the Government in 1991. The committee developed a comprehensive strategy for climate change research in 2002 (the New Zealand Climate Change Research Strategy 2002). The strategy provides advice on strategic research needs and efforts between Crown research institutes, universities, Government departments and the private sector. In 2003, the committee was disestablished and the responsibility for reviewing the strategy was transferred to the Ministry for the Environment. The Ministry for the Environment works with other Government departments involved in climate change policies and strategic policy development, and liaises closely with New Zealand scientists and science organisations, to monitor and review the adequacy of the climate change research portfolio to meet national needs.

Because of New Zealand's unique emissions profile (with around 50 percent of greenhouse gas emissions generated from agriculture) and the significant contribution to the economic productivity from the agriculture sector, there is a particular need to undertake research to understand the effects and adaptation options as well as options to reduce greenhouse gas emissions for this sector. The Government has joined with the private sector to form the Pastoral Greenhouse Gas Research Consortium (which funds research into reducing agricultural methane and nitrous oxide emissions), aiming to develop tools that allow mitigation of non-carbon dioxide greenhouse gas emissions from the agricultural sector without loss of productivity.

Additional input to strategic research directions comes from the Royal Society of New Zealand's Climate Committee, which provides advice on the establishment and maintenance of linkages with international climate change research programmes including the World Climate Research Programme and the International Geosphere Biosphere Programme. The committee also facilitates interaction between scientists and stakeholders in New Zealand.

Funding policies

The Foundation for Research, Science and Technology has the main responsibility for funding climate change research from public investment. The Foundation's investment structure comprises 18 portfolio research strategies that provide overall direction for its research investment. Each strategy is further arranged into Target Outcomes and Themes that relate to a specific desired outcome. Most of the Foundation's investment in climate change research is funded within the Understanding and Adapting to Global Environmental Change (GLO) portfolio which invests in knowledge and datasets that underpin and enable management of the social, economic and environmental risks and opportunities associated with global environmental change and variability.
The Global Environmental Change portfolio has two Target Outcomes:

GLO1 – Characteristics, causes and consequences of global change and variability
Increased understanding of the characteristics, causes and consequences of global processes, variation and change (in and between the atmospheric, biogeophysical environments and in the Antarctic and surrounding oceans and seabeds), as a basis for anticipating and managing future opportunities and impacts within New Zealand and globally.

GLO2 – Mitigation and adaptation responses to global change and variability

New Zealand has tools to enable it to respond to environmental change in a timely manner that minimises negative impacts and maximises economic opportunities and based on a better understanding of what motivates people to mitigate and adapt to global change and variability.

Climate change research is also undertaken within other Foundation for Research, Science and Technology portfolios, where climate change and variability may have a significant impact on aspects of that sector. For example, the Sustainable Production Systems portfolio research strategy has a Target Outcome:

SPS1 – Environmentally, economically and socially sustainable primary production

New Zealand's primary production value chains are internationally recognised and accepted as best practice in terms of environmental, economic and social sustainability. This recognition ensures a cost-competitive position and ongoing access to world markets.

Under Target Outcome SPS1 sits a theme:

1.1 International treaty obligations

Management systems, tools, devices, materials and genetics implemented to allow New Zealand's primary sector industries to meet Montreal Process and Kyoto Protocol obligations for verification and mitigation of greenhouse gas emissions, and to benefit from opportunities created by those agreements.

Research within such a portfolio would contribute to mitigating the industry's effect on the environment including the production of greenhouse gases.

The Foundation for Research, Science and Technology also collates information on all research relevant to climate change conducted within all its portfolios for the purpose of analysing the contribution being made to New Zealand's climate change effort overall. Data is self-reported by contract holders and audited by Foundation for Research, Science and Technology staff.

The Foundation for Research, Science and Technology's investment strategies for climate change research are developed in consultation with key stakeholders, as described in "Strategy for research and systematic observations" section on page 141.

Funding levels

Funding for climate change research and systematic observations in New Zealand is administered through several channels. The predominant channel for central Government funding of strategic research is the Foundation for Research, Science and Technology. The Foundation purchases a portfolio of climate change research from various providers (Crown research institutes, universities and private organisations), guided by the funding policies outlined in the previous section. The Foundation's funding also covers the archiving and part of the collection costs for systematic climate observations. Some additional Government support for research comes through the Marsden Fund, administered by the Royal Society of New Zealand and not subject to Government research priorities; through funding for university research within Vote: Education; the Health Research Council through Vote: Health; and the Pastoral Greenhouse Gas Research Consortium through Vote: Agriculture.

There is also direct funding of research in some climate change areas by core Government departments to meet operational and policy development needs.

Systematic observations are in part-funded through the Crown contract for public weather forecasts and warnings administered by the Ministry of Transport and awarded to the Meteorological Service of New Zealand, which covers routine upper air and surface weather observations that are also used for climate purposes. Further observations for climate needs are funded by the Foundation for Research, Science and Technology and both weather and climate observations are incorporated in the National Climate Database, managed by the National Institute of Water and Atmospheric Research under contract to the Foundation. Additional support for observations in the Pacific is provided through the New Zealand Agency for International Development division of the Ministry of Foreign Affairs and Trade.

New Zealand's 15 regional councils, which have primary responsibility for resource and hazard management, along with some other local councils, also undertake environmental monitoring and fund some climate change research to help them develop community or regional policies.

4NC Table 38: Estimated annual investment (New Zealand dollars) in climate change research and systematic observations, by funding source

Funder	Estimated annual climate change research and observation funding
Central Government research funds and universities (Breakdown: FRST $22.4M; Marsden $1.6M; universities $0.3M; CRIs $0.8M; HRC $0.2M)	$25,179,246
Central Government – systematic observations	$9,900,000
Central Government – research from operational funds	$6,692,415
Regional government	$142,372
Private sector	$1,151,332
Overall total	$43,674,644

Note: Funding is for 2003/04

4NC Table 39: Estimated annual investment (New Zealand dollars) in climate change research (not including systematic observations), by research category

Research category	Expenditure	Percentage of total expenditure
Fundamental knowledge generation	$15,964,135	47%
Scenarios, prediction and impacts modelling	$6,830,917	20%
Mitigation – reduction of greenhouse gas emissions	$6,601,702	20%
Adaptation to the effects of climate change	$2,808,827	8%
Human behaviour and socio-economic impacts	$1,569,065	5%
Total expenditure	$33,774,646	

4NC Tables 38 and 39 summarises the estimated annual investment in climate change-related research and monitoring from the sources outlined above, as well as from the private sector. The tables are based on information in the annual survey of climate change research for 2003/04 conducted by the Ministry for the Environment, and figures supplied by the Meteorological Service of New Zealand and the National Institute of Water and Atmospheric Research.

Information exchange and dissemination of knowledge

Domestically, the Ministry for the Environment works to disseminate research findings on climate change, mitigation options and adaptation processes and methodologies, to ensure New Zealanders:

- are well-informed on human modification of climate
- better understand existing knowledge and uncertainties regarding the effects of climate variability and future climate change
- identify and implement technologies that underpin New Zealand's Kyoto Protocol commitments and long-term needs to substantially reduce greenhouse gas emissions
- participate effectively in managing and adapting to the impacts of climate change, including making use of any opportunities that may arise.

International exchange of data and information

New Zealand exchanges data and information with other countries in line with the policies of the World Meteorological Organization. Appropriate weather observations useful for climate modelling are disseminated in real time through standard World Meteorological Organization channels, and climate and greenhouse gas monitoring data is provided to appropriate World Data Centres.

New Zealand has identified particular opportunities for the dissemination of real-time climate data through the Pacific, to provide up-to-date information on current climate conditions and seasonal outlooks to Pacific Island nations and help them deal with climate variability. This led to the establishment of the *Island Climate Update,* a monthly paper and web publication produced by the National Institute of Water and Atmospheric Research with the support and collaboration of organisations in the Pacific Islands, Australia, United States, and France. The National Institute of Water and Atmospheric Research also produces a similar monthly publication for New Zealand (the *Climate Update*). Additional exchanges of information occur under the auspices of PI-GCOS and the Asia-Pacific Network for Global Change Research.

Partnerships

Bilateral partnerships

New Zealand has established a climate change partnership with the United States to enhance dialogue and practical cooperation on climate change issues. The partnership was launched on 25 October 2002. As an example of the scope of this partnership, the most recent projects, announced in July 2004, covered: a study of global methane emissions; the rescue and digitisation of historic climate data; work on carbon dioxide sequestration in coal seams; work to develop new materials for the hydrogen economy; work on nitrous oxide emissions from grazed pastures, and the hosting of a joint event with Australia, to work with developing countries in the Pacific on climate observation.

A second bilateral climate change partnership, between Australia and New Zealand, was announced on 7 July 2003.

Multilateral partnerships

New Zealand is a member of the International Energy Agency and the International Partnership for the Hydrogen Economy and has observer status at the Carbon Sequestration Leadership Forum.

International organisations

New Zealand is an active member of the World Meteorological Organization (WMO) and exchanges information and data both through WMO and through its subsidiary and associated bodies. Through membership of GCOS and its Pacific arm, PI-GCOS, and through the Asia-Pacific Network for Global Change Research, New Zealand works to further facilitate such data exchange.

Research

This section provides information on highlights, innovations and significant efforts made with regard to climate change research in New Zealand. More details about the research projects funded by the Foundation for Research, Science and Technology can be obtained from their searchable database of abstracts and project reports *(http://www.frst.govt/nz/database),* using the search term "climate change".

Trends from New Zealand climate observations, research-based scenarios for future regional changes, and research results on impacts vulnerability and adaptation are currently being compiled and assessed for the Australia and New Zealand chapter of the Working Group II volume of the IPCC's *Fourth Assessment Report,* scheduled for completion in 2007.

Climate processes and climate system studies

Atmospheric chemistry

Measurements and computer modelling are continuing to improve knowledge about the sources, sinks and transport of greenhouse gases in the atmosphere. This work includes participation in the international total carbon column observing network, and isotope ratio measurements of methane from container ships travelling regularly between New Zealand and Japan. Carbon 14 isotope measurements made over the past two solar cycles indicate there has been little change in atmospheric concentration of the hydroxyl radical, despite changes in atmospheric composition through that period. The constituents of air trapped in Antarctic firn (packed snow) are being analysed to improve understanding of holocene climate. Research is also under way on the implications of climate change for the recovery of stratospheric ozone concentrations.

Ocean–atmosphere gas exchange

New Zealand scientists led the international SAGE experiment in April 2004, in which iron fertilisation of the sub-Antarctic ocean led to very little response in terms of algal bloom or associated enhanced uptake of carbon dioxide from the atmosphere. Researchers are now attempting to understand the biological and physical factors leading to this limited response. New Zealand is hosting a SOLAS workshop, a project of the International Geosphere Biosphere Programme (IGBP), to review all of the ocean iron fertilisation experiments undertaken to date and their implications for oceanic carbon dioxide uptake. Work is also continuing on improved techniques for assessing the effects of biogenic sulphur emissions on aerosol and cloud properties that may affect the radiation balance over the Southern Ocean.

Land–atmosphere and land–ocean interactions

Research which was reported in the *Third National Communication* on land–atmosphere exchange of carbon dioxide and the effects of land-use changes, land management and erosion, has now been operationalised into the national carbon monitoring systems for forest and scrub vegetation and for soil carbon. Research continues on carbon dioxide fluxes over scrubland, and on validation by both flux-based and inventory methods of estimates of total exchange and net sequestration of carbon dioxide (and its spatial variability).

New Zealand riverine sediments and carbon yields have been estimated at the national scale, showing that erosion exacerbated by past deforestation causes significant amounts of carbon to enter the sea surrounding New Zealand. Marine geological evidence has been examined, showing that the great majority of terrigenous sediment is trapped on coastal shelves. An important research question now is to determine the fate of such terrigenous carbon on the New Zealand continental shelf – is it sequestered (buried or transported to abyssal depths), or volatilised and eventually released to the atmosphere as carbon dioxide?

Climatic variability and trends

Work continues on identifying and understanding the causes of variability and trends in atmospheric, oceanic, mountain glacier and sea ice conditions in New Zealand, the southwest Pacific and Antarctica. This includes work on the influences of the El Niño Southern Oscillation and the Interdecadal Pacific Oscillation on New Zealand patterns of rainfall, temperature, wind and river flow, on the predictability of seasonal climate variability, and on separating these effects out from the long-term trends which may be due to anthropogenic forcing. Increased emphasis is being given to studies of changes in the frequency of extremes such as frost and intense rainfall, and their statistical significance. Trends in ocean circulation in the South Pacific and their relationship to atmospheric changes have been analysed, and New Zealand has played a major part in deploying Argo floats in the South Pacific (with financial support from the United States). Research is also in progress on sea ice in the Ross Sea area of Antarctica, and relationships between its extent and atmospheric circulation.

Paleoclimate

The New Zealand INITIMATE (Integrated Ice, Marine and Terrestrial records) project is identifying timing of major climatic events and shifts over the past 30,000 years from New Zealand glacial and non-glacial landscape changes, terrestrial and marine sediment records, pollen and other biological records, speleothems and tree rings. The aim is to identify past inter-hemispheric climate linkages to determine the relative roles of greenhouse gas changes and changes in the ocean thermohaline circulation. This project aligns with the goals of the PANASH project of the IGBP PAGES programme. Speleothem and tree-ring records are also being examined for periodicities, including the effects of past El Niño – La Niña cycles. Studies of early Cenozoic sedimentary rocks exposed in eastern New Zealand are being used to validate general circulation models for the Eocene (50 million years ago), a time when atmospheric greenhouse gas concentrations approached 500 parts per million.

The Cape Roberts drilling project (Ross Dependency, Antarctica) has documented changes in Antarctic climate, sea level and ice cover from 34 to 17 million years ago. Planning is underway for drilling two more cores in the McMurdo Sound region in 2006 and 2007, as part of the international ANDRILL project to better understand Antarctic climate, ice and sea level changes over the last several million years with a special interest in warm periods.

New Zealand is developing a capability, integrated within the SCAR ITASE project, to use ice cores for studying climate behaviour over the Antarctic margin over the last few thousand years.

Modelling and prediction, including general circulation models

Regional climate scenarios for New Zealand through the 21st century, based on statistical downscaling from global climate models, were extended to correspond to the full range of global temperature projections resulting from the SRES scenarios used in the 2001 IPCC *Assessment Report*. Future scenarios for soil moisture changes (expressed in terms of potential evapotranspiration deficit) were also developed, to investigate possible changes in drought frequency.

Staff from the National Institute for Water and Atmospheric Research (NIWA) collaborated with scientists from the United Kingdom Meteorological Service under the C20C (climate of the 20th century) international research project. The United Kingdom Unified Model was run on NIWA's Cray computer to simulate the Earth's climate between 1870 and 2000 under natural forcing alone, forcing by the historical concentrations of greenhouse gases through this period alone, and the combination of these. A regional climate modelling capability has now also been implemented at NIWA based on the UK Unified Model. It has so far been used to simulate current climate and paleoclimate conditions, as a prelude to future climate runs to complement scenarios developed by statistical downscaling. Atmospheric transport and chemistry modelling capabilities have also been developed around the Unified Model, and applied in the atmospheric chemistry work reported earlier in this chapter.

Ocean modelling capability has also been implemented on the NIWA Cray, using the UK Unified Model, and also using a separate ocean model (ROMS). Initial validation runs and sensitivity experiments have been undertaken.

Research on the impacts of climate change

Recent and ongoing impacts research includes the following topic areas.

Hydrology

Research drawing on a range of IPCC scenarios and climate models has suggested soils in the east of New Zealand will experience more long dry periods (droughts) over the coming century. Initial results are now also available on implications of these same scenarios for future river flows, and further analysis and research on this topic is planned. Initial research and modelling has also been undertaken on possible increases in the frequency of heavy rainfall events, and potential implications for flooding in some locations.

Coastal impacts

Further analyses have been published on long-term trends in New Zealand sea level measurements, and on the effects of the Interdecadal Pacific Oscillation. Several regional studies have identified potential changes in probability of exceedance curves of extreme high water levels over the next century for various sea-level rise scenarios, and have also considered possible implications of climate change for coastal erosion. A software tool called CoastCLIM, comprising a linked place-specific sea-level scenario generator and shoreline change model has been developed for examining the sensitivity of coastal systems to various model parameters and their uncertainties.

Fisheries

Recent research has provided further evidence that the stocks of certain New Zealand fish species are influenced by climate variability, and also that year-to-year changes in ocean temperature and freshwater runoff from the land can affect some coastal aquaculture operations. However knowledge of the response of ocean conditions and ecosystems around New Zealand to climate change is still insufficient to confidently predict future impacts on fisheries and aquaculture.

Agriculture

Potential changes in drought frequency over the coming century have been identified for a range of climate scenarios, which are likely to affect dryland farming in eastern areas of New Zealand. The continuing long-term FACE (Free Air Carbon Dioxide Enrichment) experiment is studying a grazed pasture ecosystem under the carbon dioxide concentration expected in 2030. As well as production data and evaluation of appropriate plant germplasm for the future, the research is directed at changes in biodiversity and the long-term consequences of elevated carbon dioxide for nutrient cycling and availability. These findings are integrated in an ecosystem model ("EcoMod") to evaluate interactions with other drivers such as temperature, rainfall and land use.

Research is underway, in collaboration with European groups, on the influence of elevated atmospheric carbon dioxide levels on the nutrient quality of grain crops. A range of projects are examining adaptation and physiological responses to climate for various horticultural crops.

Plantation forestry

A study has recently been completed on likely changes in forest fire risk over New Zealand in coming decades as a consequence of climate change.

Natural ecosystems

Ongoing research includes studies of the influence of climate change and rising carbon dioxide levels on the alpine tree line, the influence of temperature on the biology of native invertebrates and reptiles, and on the influence of climate on mast (synchronised episodic) seeding in New Zealand plants. Development continues of models to predict vegetation composition from climate parameters. Scientists and Māori groups are collaborating on research on indigenous forest regeneration in relation to future climate scenarios, and in studying the impacts of climate–ocean variability on the population of various sea-bird species.

Urban environment, transport and energy

Research is continuing on identifying likely future impacts of climate change on buildings, due to changes in (for example) temperature, heavy rainfall frequency and flood risk. Various regional studies have identified potential impacts of changing climate on stormwater drainage, flood risk to roads, bridges and structures, and coastal development. Research is also under way to evaluate impacts of present climate variability and projected future changes on renewable energy supply and energy demand.

Health

An empirical model has been developed to predict changes in the geographic areas at risk of dengue fever transmission under current and future climate scenarios. Analysis of dengue fever has suggested a role of inter-annual changes in climate in the timing of epidemics. Analyses have quantified the role of weather and seasonal patterns on certain gastrointestinal diseases. Descriptive studies have assessed the interaction between climate, ecosystem changes and population vulnerability in determining current and future impacts of climate change on human health.

Māori

Collaborative research with Māori on impacts of present and future climate on forest regeneration, and on indigenous sea bird species including titi (a traditional food for some iwi) has been mentioned above. Work is also under way with some rural Māori groups to identify potential impacts of climate change on their activities (and ways in which Māori have traditionally adapted to climate variations).

Socio-economic analysis, including impacts and response options

The CLIMPACTS programme has recently developed methods and tools for assessing the "human dimensions" of climate change. These developments include the capacity to generate scenarios of land-use changes, to examine adaptation options and to evaluate benefits and costs. Part of the effort has been to create a flexible "open framework" model system (SimCLIM) that can be customised by end users. These tools are part of a larger methodology, called CCAIRR (Climate Change Adaptation through Integrated Risk Reduction) which promotes the "mainstreaming" of adaptation into decision-making. These integrated methods and tools, developed and applied initially in New Zealand, have also been applied in Australia, Sri Lanka and various Pacific Island countries.

Economic modelling work has identified impacts of climate variations on New Zealand GDP through changes in dairy production. Similar work is in progress to identify impacts flowing through the energy sector due to climate-induced variations in water inflows to hydroelectricity generation systems and in energy demand for space-heating.

An integrated socio-economic/natural-science land-use model is now being developed for use in policy design and analysis for land-use and climate change issues. Initial studies with the model are exploring the likely influence on changes of land use into and out of "Kyoto" forests of various possible policies, including different levels of carbon pricing. A further economics research project has examined greenhouse gas emission paths in connection with different New Zealand economic development scenarios.

Research and development on mitigation

Research and development on mitigation has expanded since the *Third National Communication*. This has been driven by New Zealand's ratification of the Kyoto Protocol and amendments to the Resource Management Act which place responsibilities on local government to "have particular regard to the effects of climate change" when making decisions. A major development has been the establishment of the Pastoral Greenhouse Gas Research Consortium, to understand, and provide mitigation solutions for, greenhouse gases produced by grazing animals.

Agricultural greenhouse gas emissions

This research has two strands: improving the inventory of New Zealand agricultural methane and nitrous oxide emissions, and identifying and developing ways to reduce emissions. Improved methods for measuring methane emissions at animal, herd and farm scale are relevant to both strands since they provide validation for emission reductions technologies and assist with inventory improvement. In addition, greenhouse gas emissions functions have been integrated into an ecosystem model ("EcoMod") in a joint New Zealand–Australian project. The model is being used to evaluate mitigation options and to refine methodologies used in compiling the national inventory.

Methane emission inventories

Agricultural inventory research funded by the Ministry of Agriculture and Forestry includes: validating the SF_6 (sulphurhexafluoride) technique used for measuring animal methane emissions, using calorimetry (joint research with Australian researchers); exploring whether the emission factor for growing lambs is different from that for mature stock; exploring whether afforestation of pasture increases methane uptake; and using satellite imagery to assess the time changes in mean nitrogen concentrations and digestibility values of pasture for incorporation into the national inventory.

Methane inventory work funded from other sources includes: developing and validating methods for estimating methane emissions at paddock, farm and regional scales; developing low-cost sensor technology for measuring on-farm methane concentrations; use of open path laser technology for verifying paddock-scale methane emissions; investigating how ruminant emissions might change as a result of climate change (for example, from feeding on vegetation growing under higher carbon dioxide concentrations); and exploring the methane sink activity of New Zealand's native and exotic forests. "Methanet" is a network through which New Zealand researchers and the Ministry of Agriculture and Forestry coordinate their methane inventory research.

Nitrous oxide emission inventories

Inventory research funded by the Ministry of Agriculture and Forestry includes: extending the range of information and identifying the key processes controlling nitrous oxide emissions from hill-country pastures; effects of soil compaction on nitrous oxide emissions; measuring indirect nitrous oxide fluxes from agricultural streams; improved methods for determining nitrous oxide emissions from New Zealand soils; review of the emission rate from deposition of dung and urine onto pasture; paddock-scale comparison and validation of nitrous oxide prediction methods.

Other nitrous oxide inventory research includes developing a New Zealand version of the DNDC (de-nitrification and decomposition) model in collaboration with United States researchers, to enable scaling up to regional and national scale emissions. "NzOnet" (a network of researchers coordinated by the Ministry of Agriculture and Forestry) provides coordination between New Zealand groups researching nitrous oxide emissions and inventories.

Mitigation of agricultural emissions

Most of this work is now undertaken through the Pastoral Greenhouse Gas Research Consortium. A particular focus is investigation of rumen microbial strategies to lower methane emissions. New information has been obtained on rumen factors that affect methanogen survival and which have potential for use in methane-abatement strategies. Investigation of forage plants to affect methane formation in the rumen continues as does research on levels of animal variation in the level of methane emitted. One of the early opportunities identified for methane-abatement, the "methane vaccine", has so far proved unsuccessful in New Zealand.

The consortium is also undertaking research on potential management practices to reduce nitrous oxide emissions. This includes linking with an industry trial to evaluate intensive dairy farm systems involving treatments with integration of nitrogen fertiliser, maize silage and winter management strategies. Potentially the integration of low protein forage (for example, maize), to reduce dietary-nitrogen concentration or winter management practices to reduce excreta to soil can mitigate environmental nitrogen emissions and increase efficiency.

Land use, land-use change, and forestry (LULUCF) – inventories and mitigation research

Research on land–atmosphere exchange of carbon dioxide is summarised earlier in this chapter, under "land-atmosphere interactions". Research is being undertaken to improve inventory methods and models to estimate carbon in each of the five land use, land-use change, and forestry carbon pools. The emphasis of this work is with planted forests and their soils. Research is also under way on improving methods of using historic remotely-sensed information to develop land-use histories across New Zealand associated with regenerating native forest, planting of forest species, patchy shrub cover in pastoral hill country, and other land-use information. Research is continuing on radar remote sensing from aircraft (and eventually satellite) for estimating woody biomass, and on scanning LIDAR (Light Interception Detection and Ranging) to estimate tree heights and forest health. Research into barriers and opportunities for enhancing the area of forest sinks includes investigating indigenous reforestation as a land-use option to gain income from forest credits or provide opportunities for businesses to exhibit "carbon neutrality", and using the Kyoto Protocol as a mechanism to encourage more sustainable land use.

Research results are being used to improve various indigenous forest biomass data sets and forest inventory methods. These include biomass data sets and functions to predict live tree biomass and coarse woody debris decay rates. To improve Kyoto forest inventories and projections, exotic live and dead tree biomass data sets are being prepared, as are functions to predict live tree and coarse woody debris biomass. Forest and soil carbon model validation studies are under way.

Energy efficiency, renewables, mitigation of industrial emissions

Research on improving energy efficiency includes measuring energy use in homes; development and evaluation of energy-efficient designs and technologies for commercial buildings and homes; developing more energy-efficient technologies for industries including dairy, pulp and paper, and wood drying; and social science research on barriers to increased uptake of energy conservation in households and communities.

Renewable energy research projects include small renewable energy applications for rural Māori communities; developing and assessing socio-economic impacts of biomass energy including potential to provide carbon-sink revenue; biomass energy systems; distributable renewable energy systems and integrating them into existing energy supply infrastructure; advanced solar cell technology; research and development for geothermal, wind and wave energy technologies.

New Zealand scientists are also involved in an Australian cooperative research centre programme on carbon dioxide sequestration.

Transport

Research and development work to reduce net greenhouse gas contributions from transport includes behavioural influences on fuel use for household transport, systematic and individual barriers to more fuel-efficient travel and social impacts of reduced fuel use; optimising modes for transport of wood fibre; biodiesel from animal tallows; reducing transport-related energy use in the tourism sector; scenarios for urban sustainability; technology, knowledge and expertise necessary to underpin the introduction of a hydrogen infrastructure based on hydrogen from coal.

Research and development on adaptation

While research on climate change impacts has been a high priority for New Zealand, research, development and dissemination of methodologies for implementing adaptation measures to these impacts has also been a major focus of work. In May 2004, the Ministry for the Environment coordinated and published the report *Climate Change Effects and Impacts Assessment,* which is intended to serve as a guidance manual covering such methodologies for local government.

Adaptation

Over the past four years considerable effort has gone into developing research-based information to help local government, farmers, the energy industry and other climate-sensitive sectors adapt to both natural climate variability and future climate change. Funders of this work include the Ministry for the Environment, the Foundation for Research Science and Technology, individual local authorities, and the insurance industry. The substantial impacts of a number of extreme meteorological events occurring over this period, such as the Manawatu floods in February 2004, have increased the demand for such information.

As part of developing adaptation guidance manuals for local government, researchers have developed new climate and sea-level scenarios for New Zealand based on the full range of IPCC global temperature projections for the coming century (mentioned earlier in this report); identified local and regional activities likely to be vulnerable to such changes; and developed risk assessment and management methodologies to address such impacts. Particular attention has been given to potential impacts of increases in high intensity rainfall, providing data which can be used for assessing stormwater drainage capabilities, and methodologies for identifying areas at risk of inundation.

Research is also under way on implications of climate variability and change (including interdecadal variability) and change for renewable energy (hydro, wind) generation, to help the energy industry plan for future changes. Research has also continued on seasonal climate forecasting, and on methodologies for mapping climate and soils (and potential climate changes) and using the results to identify appropriate areas for growing new niche crops or making other sustainable land-use changes.

Systematic observations

New Zealand has continued to build up an archive of systematic atmospheric, oceanic and terrestrial observations based on the monitoring activities described in the first, second and third national communications. Details of these observations are tabulated in the *Global Climate Observing System* report provided separately to the UNFCCC as an annex to this *Forth National Communication* (Ministry for the Environment, 2006).

Atmospheric observing systems

There are two prime sources of New Zealand atmospheric observations relevant to climate change: the routine surface and upper air weather observations undertaken by MetService, and dedicated climate observations and atmospheric constituent measurements undertaken by the National Institute of Water and Atmospheric Research. The Institute is assisted by many voluntary observers, especially for rainfall monitoring. MetService forwards its weather observations to the Institute, where they are archived in the National Climate Database along with the Institute's own measurements. MetService and the Institute both play particular attention to quality control. The Institute's climate monitoring and archiving programme carries ISO9002 certification, and MetService has ISO9001 certification.

Support

Funding for the core weather observations is from a Ministry of Transport contract to MetService, with some extra observations funded out of commercial revenue. Dedicated climate observations are funded by a contract to the National Institute of Water and Atmospheric Research from the Foundation for Research, Science and Technology, which recognises the climate database as a "database of national importance". Support for the climate database and monitoring has recently been reviewed by the Foundation as part of its "advancement" process for global environmental processes and change research, and a new contract providing additional resources has been agreed. Atmospheric constituent measurements are also funded by the Foundation as part of specific research programmes.

National climate network

The National Institute of Water and Atmospheric Research's plans for the national climate network include continuing with gradual automation as finances permit, and its staff regularly review the network in the light of user requirements. Planning for climate and atmospheric constituent measurements takes place as part of the Foundation for Research, Science and Technology proposal and contracting process. Particular attention is paid to continuity of the 25-station reference climate network.

Availability and exchange

The National Institute of Water and Atmospheric Research has developed user-friendly web access to the National Climate Database, implementation on a subscription basis. The institute's staff answer data requests from both New Zealand and overseas. Arrangements and conditions for data provision are consistent with World Meteorological Organization (WMO) Resolution 40(Cg-XII) on policy and practice for the exchange of meteorological and related data and products. Appropriate weather observations are forwarded to other countries by the MetService in real time, through WMO networks. New Zealand provides climate and greenhouse gas monitoring data to international data centres under the WMO/ICSU (International Council of Scientific Unions) programmes that comprise the Global Climate Observing System.

Weather and climate observations

New Zealand has nine stations providing data to international data centres as part of the Global Surface Network (GSN) of the Global Climate Observing System, and four stations which report as part of the Global Upper Air Network (GUAN). A total of 219 stations provide 9.00 a.m. climate observations to the National Climate Database, and 144 of these are automatic stations, which also provide information at other times of day.

Of the 219 stations, the 144 automatic sites provide a sufficiently broad suite of climate measurements to be useful for national climate monitoring. There are currently 589 stations providing daily rainfall information into the database. In addition, the National Institute of Water and Atmospheric Research maintains satellite data archives for the New Zealand region of the National Oceanic and Atmospheric Administration's (NOAA) satellites High Rate Picture Transmission (HRPT) data (1992–present), Global Geostationary Meteorological Satellite data products (August 1998–present) and SeaStar SeaWiFS HRPT data (May 2000–present).

Atmospheric constituents

New Zealand has two stations providing atmospheric constituent data to international data centres as part of the Global Atmospheric Watch. Concentrations and isotope ratios in carbon dioxide, methane and nitrous oxide, as well as aerosol properties and non-methane hydrocarbons, are monitored at the Baring Head clean air monitoring station. Some of these gases are also monitored at two other sites, including one in the Antarctic. Surface ozone is monitored at seven stations (including one in Antarctica), column-integrated ozone concentrations are measured at two stations (including one in Antarctica), and a regular balloon-borne sampling programme for vertical profiles of ozone concentrations is operated at one station.

Ocean observing systems

There are 11 open-coast sea level monitoring gauges operating around the New Zealand coast, and 13 coastal stations at which sea surface temperatures are measured. In addition, 90-year tide gauge records are held for the ports of Auckland, Wellington, Lyttelton and Dunedin, and short records from several other ports. Since the 1980s, New Zealand has maintained a network of around seven drifting buoys in the Tasman Sea, and two sub-surface floats under the ARGO programme. In collaboration with Australian and United States research institutions, New Zealand's National Institute of Water and Atmospheric Research maintains three high resolution XBT (Expendable Bathythermograph) sections in the Tasman/Coral Sea area to monitor vertical ocean temperature profiles. Ocean waves are routinely monitored at five sites around the New Zealand coast. Remote coastal video cameras have been installed for long-term monitoring of beach conditions and erosion at seven sites. The Ministry of Fisheries contracts out regular surveys of various fish species, in order to set maximum allowable catch limits and quotas. The resulting data sets may also be relevant for assessing climate change impacts on fisheries.

Terrestrial observing systems

There are approximately 500 streamflow gauges in operation around New Zealand, and around 300 groundwater monitoring sites. End-of-summer snowline elevations and photographic images of 46 glaciers from special aircraft flights are available annually since 1979, and the terminus positions of key glaciers in the Southern Alps are available from 1800 to the present. A soil carbon monitoring system for New Zealand has been developed and is currently being enhanced to reduce uncertainties for some land-use changes. The national Land Cover Database, developed using SPOT satellite imagery in 1995, has been repeated for 2000/01 using Landsat ETM+ satellite imagery. Associated with the New Zealand Carbon Accounting System it is planned to complete a land use map for 1990. This 1990 mapping will use Landsat 4 satellite imagery as well as existing aerial photography. It is planned to be further updated in 2008. The National Vegetation Survey Databank (NVS) maintained by Landcare Research holds records from approximately 45,000 vegetation survey plots around New Zealand, including 12,000 permanent plots. In addition, Landcare Research maintains five New Zealand long-term ecological research and monitoring sites, and also monitors the presence or range of self-advective fungal and insect species.

The Ministry of Agriculture and Forestry maintains a planted forest cover database, and keeps records of carbon absorbed in new planting and lost through logging, fires and vegetation clearance.

Observing, data and monitoring system support for developing countries

The Meteorological Service of New Zealand (MetService), under a New Zealand Government contract, provides general assistance to Kiribati, Tuvalu, Samoa, Tokelau, Tonga, Niue and the Cook Islands to assist those countries' weather and climate observing systems to run smoothly and maintain the quality of the observations. Targeted New Zealand Overseas Development Aid programmes have covered training in technical maintenance and observing practices in the Cook Islands, Tuvalu and the Tokelaus. MetService also administers the Meteorological Office, United Kingdom's Pacific Trust Fund which supports upper air observations (part of GUAN) at Tuvalu, Kiribati and Penrhyn, and provides technical support regarding the operation of these stations. A component of this support is also funded through MetService's Crown contract.

In addition to operational funding, in collaboration with the Meteorological Office of the United Kingdom, a number of projects have been supported by the Pacific Fund and undertaken by MetService to upgrade existing infrastructure at these GUAN stations and at other locations. More are planned. MetService supplied and maintains a dual automatic weather station at Pitcairn Island funded through the Pacific Trust Fund. Support has now been extended under Global Climate Observing System (GCOS) funding and MetService has been contracted to supply additional support to the south-west Pacific under the PI-GCOS Technical Support Project. MetService has been further contracted by GCOS to undertake technical surveys of silent GUAN stations at Vanuatu and the Solomon Islands, and to complete an upgrade of the GUAN station at Galapagos Islands, Ecuador.

The National Institute of Water and Atmospheric Research also assists meteorological services undertaking climate observations in the south-west Pacific, through informal advice when requested, by backing up climate records from many of the islands in the New Zealand climate database, and by providing data from this database to them when requested. The institute has run and partnered several training programmes supported by the Asia-Pacific Network for Global Change Research. These have included training staff from Pacific Island developing states with recovering historical data records and defining and coding meta-data. In 2004, the Asia-Pacific Network for Global Change Research supported a "training institute" at the University of the South Pacific in Fiji on "Extreme Weather Events". The training staff were drawn from the National Institute of Water and Atmospheric Research, the East-West Centre in Hawaii, United States and from the University of the South Pacific in Suva, Fiji. The training modules developed for the training institute will be taken to individual communities in Samoa and to Kiribati in 2005. With the support of the New Zealand Agency for International Development through the South Pacific Applied Geoscience Commission, NIWA scientists have worked with staff from various organisations in the Pacific Islands, Australia, United States and France to produce the monthly *Island Climate Update*, which summarises recent climatic conditions and provides climate outlooks for the next three months. The New Zealand Agency for International Development has also supported the training of staff from the Fijian Meteorological Service on climate database management and quality control at NIWA's National Climate Centre.

A Pacific Island GCOS (PI-GCOS) Committee was formed in 2000 with Pacific Island and regional representatives and New Zealand has been an active participant since its inception. This committee has developed a regional implementation plan with 36 discrete projects that will help the Pacific region contribute to the GCOS objectives. The development has involved a high degree of collaboration between the Pacific Island countries and donors and in particular New Zealand has supported initiatives to:

- restore and upgrade the regional upper-air networks
- produce a Pacific regional climate bulletin
- recover historical climate data
- assist with capacity building within the Pacific Island hydrological and meteorological services.

Concluding remarks

An assessment of the adequacy of the current research strategy and portfolio will be undertaken by the Ministry for the Environment in 2006. Subject to this assessment, a more complete review of the strategy may be initiated by the Government.

This chapter has focused on research explicitly directed at climate change issues. There is a range of other research being undertaken in New Zealand in areas with co-benefits to climate change issues and providing opportunities to mainstream climate change concerns into a broader context. These include, but are not limited to, sustainable energy, health, housing and transport.

Chapter 9

Education, training and public participation

General public information and participation

"4 Million Careful Owners" public awareness and education campaign

In 2003, the Government agreed to a three-phase public awareness and education programme to improve New Zealanders' understanding of the issues relating to climate change and to bring about changes in behaviours that would assist in the reduction of greenhouse gas emissions.

This decision followed extensive research which revealed a strong demand for greater public information and education about climate change and the issues involved. It was also clear from the research that New Zealanders wanted practical advice on what they could do to help reduce the effects of climate change.

The integrated campaign was designed to prompt debate and move New Zealanders through the awareness stage and into action mode. The approach is whole-of-Government, led by the Ministry for the Environment, with involvement from the Energy Efficiency Conservation Authority, the Ministry of Agriculture and Forestry, and the Ministry of Transport in programme development and implementation.

The campaign has been designed in three phases with the first phase, launched in December 2003, focused on reaching out to the public and raising awareness. Phase Two (November 2004–February 2005) of the programme built on these messages and moved to making a difference through behaviour change. Phase Three will further the objectives of the second phase.

A core challenge was to make climate change more tangible for New Zealanders by providing people with specific actions they could take to reduce greenhouse gas emissions and the impacts of climate change.

The campaign has centred on one core brand, "4 Million Careful Owners," which comprises elements of inclusiveness, community, collective response and pride. The brand was specifically developed to have a life beyond the campaign and to be applicable for a range of environmental public education initiatives in the future. The campaign also features the call to action of "your country needs you" featuring New Zealanders telling their own stories and actions people can take to reduce greenhouse gas emissions.

The main thrust of the first phase was via a specifically designed interactive website at *www.4million.org.nz*. In this phase, the site provided useful tips on how to reduce emissions from transport, energy-use and waste as well as general information about climate change, a provision for people to pledge their support to undertake particular actions to reduce emissions, and a poll where they could measure their greenhouse gas-reducing and energy efficient behaviours compared to other New Zealanders. Other elements included press, radio and internet advertising, news media, and stakeholder communications and cooperation.

Research carried out at the end of the phase clearly showed that it was successful against the three objectives of creating awareness, engaging New Zealanders, and preparing the ground for a long-term campaign aimed at behavioural change. To provide just two examples of the measure of this success, over 35,000 visits were made to the campaign website over the six-week period of the campaign's first phase and the increase in the level of concern declared over the issue of climate change increased by seven percent in July 2003 to 66 percent following this phase of the campaign (January 2004).

The second phase of the campaign was about building on the messages conveyed in Phase One and aimed to bring about long-term behavioural change. As in the first phase, the emphasis was on climate change issues and how New Zealanders can address them, rather than on the science or international mechanisms (e.g., the Kyoto Protocol).

Key stakeholders (considered important opinion leaders and first movers to reduce greenhouse gas emissions) were engaged and co-opted to help increase awareness of climate change issues in their own sectors, as well as encouraging tactical and long-term changes in behaviour to reduce emissions.

An industry reference group was established which included senior representatives from a broad range of sectors such as farming, transport, regional and district councils, dairy, large corporate service organisation and business. The group acted as a sounding board to provide input and feedback on climate change communication initiatives for the campaign, and was essential to establish what was practical and possible to voluntarily reduce emissions in respective sectors.

The reference group stated their bi-monthly meetings were useful and prompted them to place climate change higher on their agendas than it was previously. Many members said they had started or were already planning to implement more initiatives to reduce greenhouse gas emissions as a result of their involvement. Most stakeholders wanted to continue their involvement with the Ministry for the Environment and said they were prepared to participate in the third phase of the campaign.

The public was the other important audience for the campaign's second phase, particularly in addressing attitudes and behaviour towards the energy people use, the transport they take, how they dispose of their waste and how they farm their land, with the ultimate goal of encouraging people to reduce emissions in these areas.

This second phase was launched very successfully with an event at Wellington's central train station. Thousands of train commuters entering the city were applauded by Convenor of the Ministerial Group on Climate Change and Government officials. A large on-site banner was used to point out the connection between using public transport and helping to address climate change. Commuters also received a flyer outlining how their actions help reduce the effects of climate change and directing them to the new climate change quiz on the "4 million careful owners" website. At the same time, two half-tonne ice blocks, symbolising melting polar ice caps due to global warming, were placed in Auckland and in Wellington. Banners inside each block directed onlookers to the campaign website, and both blocks attracted a great deal of interest from central city shoppers and passers-by. These events received excellent television, radio, internet and print media coverage.

The whole campaign website was completely revamped for this phase with a new design, as well as more and better information. One of the new elements of the site was the development of a fun, interactive online quiz for the general public which aimed to increase awareness and motivate action. The quiz takes people through a series of questions to uncover their current behaviours around energy efficiency, transport use and waste disposal, and how their choices contribute to greenhouse gas emissions. Answers also give advice about better choices people can make. On completing the quiz, they receive a response outlining how they compare to the national average and what personal changes they can make to reduce emissions. A second quiz was developed later, specifically for businesses, showing how employers and employees can help to address the problem in the workplace.

Other elements of the campaign included nationwide advertising via various media channels and the distribution of positive media stories around the country.

In addition, an extension of the public campaign was completed with the production of a climate change education unit for teachers, distributed to nearly 3,000 primary and intermediate schools around the country.

This was supported by a new section for school students on the "4 Million Careful Owners" website, including an online activity called *Play it Cool* (see details on the education unit and the schools' website section in *Material for schools* further in this chapter). The booklet has been highly successful with many requests for more copies.

Following this phase of the campaign, a survey undertaken showed that the number of New Zealanders who considered that climate change was a serious problem increased from 66 percent to 73 percent. Also, the number of people who attributed climate change to human-caused emissions (rather than natural climate variations) increased from 63 percent to 71 percent over the same period. In addition, there were thousands of visits to the revamped website with many taking part in the online quiz.

The media also noticeably changed its attitudes during phase two of the campaign. Up until this phase, it was rare for the media to cover climate change, and if they did, it was often sceptical and focused on debating the science. This has changed. Climate change has received extensive media coverage and is now regularly in the national news media – the sceptics are now fully challenged and represent a minority view.

It is intended that the third phase of the campaign will take place when the new climate change policies are announced. The campaign will build on the positive relationships the Ministry for the Environment has developed with climate change stakeholders, including; the fertile big-business environment that is putting climate change near the top of its agenda, the high level of awareness amongst the public that climate change is happening, and the general willingness amongst businesses and the general public to do something to address the situation.

As well as continuing to engage with the public, phase three will also need to address small and medium enterprises and energy-intensive businesses, audiences which were not directly addressed in phases one and two. The significance to such audiences of the carbon tax needs to be matched by a context of understanding of climate change and actions to reduce greenhouse gas emissions.

Website and publications

The Government's climate change website at *www.climatechange.govt.nz* was completely re-designed and revamped in 2003 to become a far more comprehensive, informative and easily navigable site. It regularly receives a high rate of visits nationally and internationally, and was named a "best practice example of an individual website" in the *Achieving E-Govt* report released by the State Services Commission in November 2004. The site is frequently amended to remain as up-to-date as possible. It includes details about climate change and how it might affect us, the Kyoto Protocol, domestic and international policies and initiatives (such as Projects to Reduce Emissions and Negotiated Greenhouse Agreements), how people can take action to help reduce greenhouse gas emissions and specific material for school students.

A wide range of publications have been produced since the *Third National Communication* in 2001. These have included general information sheets on how to take action to reduce greenhouse gas emissions, booklets to help inform local government on how they can help prepare communities for climate change, case studies on projects people are undertaking in the community to reduce emissions, and publications explaining specific policy areas.

Consultation

A second round of consultation was undertaken following the first round in 2001 on New Zealand ratifying the Kyoto Protocol and domestic policy options for New Zealand to meet its Kyoto Protocol emissions-reduction target (as reported in the *Third National Communication*).

In this second consultation, held in May 2002, the Government asked New Zealanders for their views on the preferred policy options which were developed using feedback from the first round. Input from the second consultation was used in the formation of the confirmed policy package to address climate change which was announced in October 2002.

As in the first round of consultation, this second round involved the wide distribution of consultation documents followed by nationwide meetings with the public, local government representatives, business and special interest groups, and hui with Māori. New Zealand school children were again involved in the consultation process with consultation kits sent to schools across the country.

Further consultation on design and implementation details of Negotiated Greenhouse Agreements and Projects to Reduce Emissions was carried out in early 2003. In addition, consultation with the farming sector took place in June and July 2003 on how a levy to research agricultural emissions reduction could be collected and administered.

Following the 2005 review of climate change policy, a further series of consultation meetings was organised in early 2006 to discuss the outcome of the review. At the time of this publication, the Government anticipates further public consultation on climate change policy related to the work programmes currently under consideration.

Seminars and workshops

A large number of seminars and workshops have been carried out since the *Third National Communication* was produced. These have included meetings carried out in conjunction with the two rounds of consultation (over the ratification of the Kyoto Protocol and the preferred domestic policy package) in 2001 and 2002, workshops elaborating on climate change science, seminars explaining specific policies (for example, the Projects to Reduce Emissions programme, Negotiated Greenhouse Agreements and the carbon tax) and climate change policy in general, and meetings focusing on specific sector groups such as agriculture and business.

Material for schools

Students and teachers continue to be a key audience for building awareness of climate change and how we can help reduce greenhouse gas emissions. Teachers educate their students who then pass on information to their parents and future offspring. So efforts in this area reach a wide audience.

As outlined in the *Third National Communication*, a booklet for school students was produced for the first consultation round in 2001 and explains what greenhouse gases and climate change are, what could happen to New Zealand's climate in the future, and how the Kyoto Protocol works. There was a great response from students around the country who sent in submissions on what they thought of the Government ratifying the Kyoto Protocol and what they could do help reduce greenhouse gas emissions.

Since then, a second booklet was produced and was distributed around schools nationwide during the second consultation in 2002. This booklet provides information on what New Zealand is doing about climate change and what simple things people can do to reduce greenhouse gas emissions – in homes, schools and communities.

Both booklets are still relevant and are requested quite frequently by teachers.

In early 2005, it was recognised that more material needed to be developed to meet the needs of educating our young people about climate change. This brought about the production of a new education unit for teachers called *Our Climate is Changing*. The booklet outlines a wide range of cross-curricular ideas and activities to assist those teaching climate change to Year 5 to Year 10 students. It includes class activities, downloadable photographs, a web-based interactive activity, a list of useful websites, and details on where teachers can access more information to successfully develop a unit on climate change.

This unit was supported by the creation of a new section for school students on the "4 million careful owners" campaign website. Along with the two climate change booklets, a picture resource, experiments such as how to see the greenhouse effect in a jar and materials for teachers, a new online interactive activity called *Play it Cool* has been developed. This activity, in which two children direct their father on what they think are the best choices he should make regarding energy use, transport and waste, has proven highly popular with hundreds of visits since its launch.

Information, education and training for specialist groups

Communities for Climate Protection™ – New Zealand

The Government recognises that local authorities have a significant role to play in New Zealand's national climate change response. The Communities for Climate Protection New Zealand™ (CCP–NZ) programme provides a strategic framework which assists councils and their communities to take action to reduce greenhouse gas emissions. As a successful global programme, councils participating in CCP–NZ benefit from international best practice and experience.

CCP–NZ is a voluntary programme which is fully funded by the Ministry for the Environment. It is delivered in New Zealand by the International Council for Local Environmental Initiatives, a not-for-profit local government association.

The CCP–NZ programme builds capacity within local authorities to develop emission inventories, set targets for emission reductions, agree action plans for achieving these and monitor progress towards targets on an ongoing basis. On joining the programme, councils commit to achieving these milestones by passing a council resolution.

The International Council for Local Environmental Initiatives supports councils to achieve these milestones and works with them to develop a strategic agenda to reduce their greenhouse gas emissions.

Fifteen councils have joined the programme to date, representing 45 percent of the total New Zealand population. This is the fastest uptake of the programme anywhere in the world.

Energy-intensive businesses

In March 2005, Cabinet confirmed additional policy to assist energy-intensive businesses to reduce greenhouse gas emissions through improved energy efficiency.

The policy will be implemented through measures which include:

- training for company directors to influence a conservation culture in corporate governance
- education for company managers and staff about energy efficiency
- demonstrations of energy-efficient technologies to provide support for innovation and technology uptake
- financial grants to assist capital investment in technologies to improve energy efficiency.

Information on specific policy areas

There are several specific policies for which seminars and workshops have been provided to inform key groups. These include the Projects to Reduce Emissions programme and Negotiated Greenhouse Gas Agreements (refer Chapter 4, "Policies and measures"). The seminars were held to explain the details of these policies, invite discussion and questions, and obtain feedback.

Annex A

Summary of emissions and removals from New Zealand's 2003 national inventory

Common Reporting Format for the provision of inventory information by Annex I Parties to the UNFCCC

4NC Table A1: Emissions trends (CO_2)

Greenhouse Gas Source and Sink Categories	Base year (1990) (Gg)	1991 (Gg)	1992 (Gg)	1993 (Gg)	1994 (Gg)	1995 (Gg)
1. Energy	**22,652.6323**	**23,040.6307**	**24,798.1322**	**24,075.0182**	**24,263.4540**	**24,141.2548**
A. Fuel Combustion (Sectoral Approach)	22,031.3465	22,332.5861	24,123.2683	23,440.5281	23,585.4837	23,505.1896
1. Energy Industries	6,024.7996	6,099.4373	7,542.9562	6,529.8761	5,389.6471	4,674.4840
2. Manufacturing Industries and Construction	4,538.6117	4,942.4410	4,592.2955	4,707.3963	5,130.3417	5,036.4416
3. Transport	8,632.8050	8,639.9631	9,024.7479	9,440.6414	10,143.7333	10,855.8742
4. Other Sectors	2,835.1302	2,650.7447	2,963.2688	2,762.6142	2,921.7615	2,938.3899
5. Other	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	621.2858	708.0446	674.8639	634.4902	677.9703	636.0652
1. Solid Fuels	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
2. Oil and Natural Gas	621.2858	708.0446	674.8639	634.4902	677.9703	636.0652
2. Industrial Processes	**2,662.1821**	**2,787.2158**	**2,893.3275**	**3,039.1210**	**2,943.2796**	**3,019.7925**
A. Mineral Products	448.2800	437.1627	500.5182	553.2498	565.9611	586.0167
B. Chemical Industry	426.5780	441.4380	403.2500	425.1910	449.6860	424.6760
C. Metal Production	1,787.3242	1,908.6151	1,989.5593	2,060.6803	1,927.6325	2,009.0998
D. Other Production	NE	NE	NE	NE	NE	NE
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	NE	NE	NE	NE	NE	NE
3. Solvent and Other Product Use	**IE,NE**	**IE,NE**	**IE,NE**	**IE,NE**	**IE,NE**	**IE,NE**
4. Agriculture						
A. Enteric Fermentation						
B. Manure Management						
C. Rice Cultivation						
D. Agricultural Soils (2)						
E. Prescribed Burning of Savannas						
F. Field Burning of Agricultural Residues						
G. Other						
5. Land Use, Land-Use Change and Forestry	**-21,370.4538**	**-20,100.5490**	**-17,663.6191**	**-15,241.8085**	**-14,160.8152**	**-14,652.0220**
6. Waste	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**
A. Solid Waste Disposal on Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
B. Waste-water Handling						
C. Waste Incineration	NE	NE	NE	NE	NE	NE
D. Other	NO	NO	NO	NO	NO	NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LULUCF (4)	**3,944.3606**	**5,727.2975**	**10,027.8406**	**11,872.3308**	**13,045.9184**	**12,509.0253**
Total CO_2 emissions excluding net CO_2 from LULUCF (4)	**25,314.8144**	**25,827.8465**	**27,691.4597**	**27,114.1393**	**27,206.7336**	**27,161.0473**
Memo Items:						
International Bunkers	**2,374.1423**	**2,194.8290**	**2,176.9807**	**2,244.1642**	**2,755.1750**	**2,692.8488**
Aviation	1,340.9639	1,281.6352	1,310.6254	1,329.5027	1,431.5750	1,568.5705
Marine	1,033.1784	913.1938	866.3554	914.6615	1,323.6000	1,124.2783
Multilateral Operations	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass	**2,599.1348**	**2,791.6400**	**2,661.0056**	**2,691.9901**	**3,169.4801**	**3,200.3117**

All footnotes for this table are given at the end of the table on page 172

1996	1997	1998	1999	2000	2001	2002	2003	Change from base to latest reported year
(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
25,188.0743	**27,543.3665**	**26,011.3207**	**27,292.2076**	**27,843.2089**	**29,728.2110**	**29,768.2913**	**31,229.5125**	**37.8626**
24,538.8780	26,841.6028	25,336.8622	26,662.1948	27,255.6394	29,099.5078	29,152.8920	30,579.4734	38.7998
5,241.4246	6,843.3344	5,175.8577	6,410.2624	6,041.9167	7,240.1963	6,420.4940	7,581.5967	25.8398
5,543.5950	6,000.9413	5,997.1613	5,682.2815	5,890.7774	5,990.9960	6,304.1824	5,840.1897	28.6779
10,941.5881	11,257.7299	11,448.8523	11,698.5632	12,281.1819	12,657.6878	13,230.7051	13,788.1302	59.7178
2,812.2702	2,739.5972	2,714.9909	2,871.0877	3,041.7635	3,210.6277	3,197.5105	3,369.5568	18.8502
NA	NA	NA	NA	NA	NA	NA	NA	0.0000
649.1963	701.7637	674.4585	630.0129	587.5694	628.7032	615.3993	650.0391	4.6280
NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0.0000
649.1963	701.7637	674.4585	630.0129	587.5694	628.7032	615.3993	650.0391	4.6280
2,988.0816	**2,890.9232**	**3,047.7134**	**3,212.2415**	**3,162.8373**	**3,255.2304**	**3,242.8502**	**3,470.0353**	**30.3455**
580.9092	598.6790	574.0420	638.2510	629.7730	627.6370	652.4170	638.8270	42.5063
410.9640	435.6720	480.6600	527.7650	514.1590	557.1670	539.3940	572.2690	34.1534
1,996.2084	1,856.5722	1,993.0114	2,046.2255	2,018.9053	2,070.4264	2,051.0392	2,258.9393	26.3867
NE	NE	NE	NE	NE	NE	NE	NE	0.0000
NE	NE	NE	NE	NE	NE	NE	NE	0.0000
IE,NE	**IE,NE**	**IE,NE**	**IE,NE**	**IE,NE**	**IE,NE**	**IE,NE**	**IE,NE**	**0.0000**
-14,924.8874	**-16,459.2679**	**-19,304.5579**	**-21,112.2871**	**-22,823.3545**	**-23,190.9988**	**-23,330.8121**	**-22,865.7081**	**6.9968**
NA,NE,NO	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**0.0000**
NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0.0000
NE	NE	NE	NE	NE	NE	NE	NE	0.0000
NO	NO	NO	NO	NO	NO	NO	NO	0.0000
NA	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.0000**
13,251.2684	**13,975.0218**	**9,754.4762**	**9,392.1620**	**8,182.6917**	**9,792.4426**	**9,680.3294**	**11,833.8397**	**200.0192**
28,176.1559	**30,434.2897**	**29,059.0341**	**30,504.4491**	**31,006.0462**	**32,983.4414**	**33,011.1415**	**34,699.5478**	**37.0721**
2,696.2108	**2,819.6890**	**2,772.8246**	**2,856.9927**	**2,502.2198**	**2,670.4131**	**2,974.4184**	**3,023.2188**	**27.3394**
1,634.5737	1,708.8020	1,700.5094	1,942.0695	1,756.6720	1,879.9480	1,918.7194	2,230.2158	66.3144
1,061.6371	1,110.8870	1,072.3151	914.9232	745.5478	790.4651	1,055.6991	793.0030	23.2463
NE	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**0.0000**
3,145.3945	**2,961.6107**	**3,092.7435**	**3,808.2256**	**3,890.8019**	**3,355.4603**	**3,520.8058**	**3,625.8473**	

4NC Table A1: Emissions trends (CH_4)

Greenhouse Gas Source and Sink Categories	Base year (1990) (Gg)	1991 (Gg)	1992 (Gg)	1993 (Gg)	1994 (Gg)	1995 (Gg)
Total CH_4 emissions	**1,203.9988**	**1,196.0021**	**1,175.6560**	**1,189.8507**	**1,200.1805**	**1,214.1620**
1. Energy	**37.9484**	**32.7610**	**32.4207**	**31.6283**	**33.2826**	**35.6502**
A. Fuel Combustion (Sectoral Approach)	9.9827	9.7025	9.7083	9.6097	8.9447	8.4867
1. Energy Industries	0.2634	0.2812	0.3186	0.2942	0.2379	0.1941
2. Manufacturing Industries and Construction	0.3777	0.4176	0.3912	0.3983	0.4792	0.4991
3. Transport	7.1163	7.1486	7.1800	7.2002	6.7768	6.3718
4. Other Sectors	2.2254	1.8552	1.8185	1.7170	1.4508	1.4218
5. Other	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	27.9657	23.0585	22.7123	22.0186	24.3379	27.1635
1. Solid Fuels	12.9605	8.7340	9.0388	8.6082	10.1859	13.4714
2. Oil and Natural Gas	15.0052	14.3245	13.6735	13.4104	14.1521	13.6921
2. Industrial Processes	**1.0280**	**1.7080**	**1.4490**	**1.6260**	**2.0250**	**2.8160**
A. Mineral Products	NA	NA	NA	NA	NA	NA
B. Chemical Industry	1.0280	1.7080	1.4490	1.6260	2.0250	2.8160
C. Metal Production	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO
D. Other Production						
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use						
4. Agriculture	**1,053.6608**	**1,048.9578**	**1,046.0159**	**1,060.8875**	**1,073.7006**	**1,084.6042**
A. Enteric Fermentation	1,025.2747	1,020.9187	1,018.3487	1,033.1250	1,045.5367	1,056.0998
B. Manure Management	27.3575	26.9907	26.6407	26.7224	27.1344	27.4790
C. Rice Cultivation	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Prescribed Burning of Savannas	0.1342	0.1329	0.1272	0.1024	0.0810	0.0654
F. Field Burning of Agricultural Residues	0.8943	0.9155	0.8993	0.9377	0.9485	0.9600
G. Other	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**0.2016**	**0.1853**	**0.2105**	**0.2689**	**0.3023**	**0.2915**
6. Waste	**111.1600**	**112.3900**	**95.5600**	**95.4400**	**90.8700**	**90.8000**
A. Solid Waste Disposal on Land	103.7000	104.8900	88.0300	87.8800	83.2800	83.1700
B. Waste-water Handling	7.4600	7.5000	7.5300	7.5600	7.5900	7.6300
C. Waste Incineration	NE	NE	NE	NE	NE	NE
D. Other	NO	NO	NO	NO	NO	NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
	NA	NA	NA	NA	NA	NA
Memo Items:						
International Bunkers	**0.1316**	**0.1190**	**0.1146**	**0.1196**	**0.1621**	**0.1456**
Aviation	0.0298	0.0285	0.0292	0.0296	0.0319	0.0349
Marine	0.1018	0.0905	0.0854	0.0900	0.1303	0.1107
Multilateral Operations	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass						

All footnotes for this table are given at the end of the table on page 172

1996	1997	1998	1999	2000	2001	2002	2003	Change from base to latest reported year
(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1,218.2463	**1,217.2955**	**1,221.8350**	**1,232.5942**	**1,245.9897**	**1,263.0712**	**1,265.0155**	**1,268.8083**	**5.3829**
35.4672	**36.9458**	**40.0152**	**42.0355**	**40.3580**	**41.8021**	**41.1411**	**40.0466**	**5.5291**
7.8497	7.4058	6.8150	6.2004	5.7349	5.2415	4.8402	4.4171	55.7525
0.2182	0.2718	0.2042	0.2579	0.2495	0.2939	0.2483	0.2418	8.1703
0.5207	0.5079	0.5247	0.5760	0.5994	0.5708	0.6032	0.5556	47.1146
5.7381	5.2676	4.7387	4.0781	3.6479	3.2425	2.9032	2.4779	65.1803
1.3727	1.3585	1.3474	1.2885	1.2382	1.1343	1.0855	1.1418	48.6921
NA	NA	NA	NA	NA	NA	NA	NA	0.0000
27.6174	29.5400	33.2002	35.8350	34.6231	36.5606	36.3009	35.6295	27.4043
13.9432	13.6306	16.2593	16.8421	16.1922	16.9739	16.8609	15.8215	22.0753
13.6742	15.9095	16.9409	18.9930	18.4308	19.5867	19.4400	19.8080	32.0071
3.7510	**3.8770**	**3.6670**	**4.1033**	**4.9704**	**4.4103**	**4.6558**	**2.0434**	**98.7743**
NA	NA	NA	NA	NA	NA	NA	NA	0.0000
3.7510	3.8770	3.6670	4.1033	4.9704	4.4103	4.6558	2.0434	98.7743
IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	0.0000
NA	NA	NA	NA	NA	NA	NA	NA	0.0000
1,090.0191	**1,096.6949**	**1,098.9097**	**1,108.5949**	**1,126.0519**	**1,142.2849**	**1,144.2056**	**1,150.7340**	**9.2129**
1,061.4970	1,068.4534	1,070.9870	1,081.0173	1,098.7404	1,115.0634	1,116.9759	1,123.4387	9.5744
27.4611	27.1378	26.8381	26.5491	26.2797	26.1351	26.1175	26.1640	4.3626
NO	NO	NO	NO	NO	NO	NO	NO	0.0000
NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
0.0593	0.0532	0.0402	0.0365	0.0384	0.0439	0.0404	0.0401	70.1088
1.0018	1.0504	1.0445	0.9919	0.9935	1.0424	1.0718	1.0912	22.0075
NO	NO	NO	NO	NO	NO	NO	NO	0.0000
0.3290	**0.3579**	**0.2930**	**0.2605**	**0.2093**	**0.2039**	**0.1931**	**0.1943**	**3.6186**
88.6800	**79.4200**	**78.9500**	**77.6000**	**74.4000**	**74.3700**	**74.8200**	**75.7900**	**31.8190**
81.0200	71.7300	71.2300	69.8400	66.6100	66.5500	66.9600	67.8800	34.5419
7.6600	7.6900	7.7200	7.7600	7.7900	7.8200	7.8600	7.9100	6.0322
NE	NE	NE	NE	NE	NE	NE	NE	0.0000
NO	NO	NO	NO	NO	NO	NO	NO	0.0000
NA	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.0000**
NA	NA	NA	NA	NA	NA	NA	NA	0.0000
0.1406	**0.1468**	**0.1426**	**0.1323**	**0.1116**	**0.1188**	**0.1455**	**0.1268**	**3.6259**
0.0364	0.0380	0.0378	0.0432	0.0391	0.0418	0.0427	0.0496	66.3144
0.1042	0.1088	0.1048	0.0891	0.0726	0.0769	0.1028	0.0772	24.1276
NE	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**0.0000**

4NC Table A1: Emissions trends (N_2O)

Greenhouse Gas Source and Sink Categories	Base year (1990) (Gg)	1991 (Gg)	1992 (Gg)	1993 (Gg)	1994 (Gg)	1995 (Gg)
Total N_2O emissions	**33.5442**	**33.6285**	**33.9342**	**34.8772**	**35.9172**	**36.6874**
1. Energy	**0.4663**	**0.4670**	**0.4961**	**0.5118**	**0.5552**	**0.5891**
A. Fuel Combustion (Sectoral Approach)	0.4663	0.4670	0.4961	0.5118	0.5552	0.5891
1. Energy Industries	0.0206	0.0164	0.0298	0.0208	0.0185	0.0194
2. Manufacturing Industries and Construction	0.1216	0.1297	0.1204	0.1247	0.1464	0.1431
3. Transport	0.2398	0.2422	0.2597	0.2791	0.3062	0.3396
4. Other Sectors	0.0844	0.0786	0.0862	0.0872	0.0841	0.0871
5. Other	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO
1. Solid Fuels	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
2. Oil and Natural Gas	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO
2. Industrial Processes	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**
A. Mineral Products	NA	NA	NA	NA	NA	NA
B. Chemical Industry	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO
C. Metal Production	NA	NA	NA	NA	NA	NA
D. Other Production						
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**0.1340**	**0.1380**	**0.1390**	**0.1410**	**0.1430**	**0.1450**
4. Agriculture	**32.4738**	**32.5535**	**32.8190**	**33.7443**	**34.7389**	**35.4631**
A. Enteric Fermentation						
B. Manure Management	0.1224	0.1231	0.1255	0.1322	0.1430	0.1511
C. Rice Cultivation						
D. Agricultural Soils	32.3290	32.4076	32.6712	33.5892	34.5733	35.2894
E. Prescribed Burning of Savannas	0.0017	0.0016	0.0016	0.0013	0.0010	0.0008
F. Field Burning of Agricultural Residues	0.0208	0.0212	0.0207	0.0215	0.0216	0.0218
G. Other	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0001**
6. Waste	**0.4700**	**0.4700**	**0.4800**	**0.4800**	**0.4800**	**0.4900**
A. Solid Waste Disposal on Land						
B. Waste-water Handling	0.4700	0.4700	0.4800	0.4800	0.4800	0.4900
C. Waste Incineration	NE	NE	NE	NE	NE	NE
D. Other	NO	NO	NO	NO	NO	NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
	NA	NA	NA	NA	NA	NA
Memo Items:						
International Bunkers	**0.0669**	**0.0620**	**0.0613**	**0.0632**	**0.0776**	**0.0758**
Aviation	0.0378	0.0361	0.0369	0.0375	0.0403	0.0442
Marine	0.0291	0.0259	0.0244	0.0257	0.0372	0.0316
Multilateral Operations	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass						

All footnotes for this table are given at the end of the table on page 172

1996	1997	1998	1999	2000	2001	2002	2003	Change from base to latest reported year
(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
37.0543	**37.3649**	**37.6127**	**38.3359**	**39.6108**	**41.2578**	**42.4935**	**43.5469**	**29.8193**
0.5991	**0.6202**	**0.6251**	**0.6611**	**0.6938**	**0.7184**	**0.7497**	**0.8078**	**73.2354**
0.5991	0.6202	0.6251	0.6611	0.6938	0.7184	0.7497	0.8078	73.2354
0.0208	0.0315	0.0221	0.0296	0.0252	0.0339	0.0323	0.0586	185.0074
0.1437	0.1378	0.1430	0.1517	0.1562	0.1554	0.1610	0.1695	39.4763
0.3490	0.3646	0.3742	0.3872	0.4146	0.4277	0.4511	0.4704	96.1624
0.0856	0.0863	0.0859	0.0925	0.0978	0.1014	0.1052	0.1093	29.5003
NA	NA	NA	NA	NA	NA	NA	NA	0.0000
IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	0.0000
NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0.0000
IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	0.0000
IE,NA,NE,NO	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**0.0000**
NA	NA	NA	NA	NA	NA	NA	NA	0.0000
IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	0.0000
NA	NA	NA	NA	NA	NA	NA	NA	0.0000
NA	NA	NA	NA	NA	NA	NA	NA	0.0000
0.1480	**0.1490**	**0.1500**	**0.1510**	**0.1520**	**0.1530**	**0.1560**	**0.1560**	**16.4179**
35.8170	**36.1056**	**36.3374**	**37.0237**	**38.2649**	**39.8763**	**41.0777**	**42.0575**	**29.5121**
0.1571	0.1611	0.1659	0.1718	0.1783	0.1861	0.1917	0.1970	61.0004
							NA	0
35.6366	35.9202	36.1476	36.8294	38.0641	39.6664	40.8615	41.8354	29.4055
0.0007	0.0007	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	70.1088
0.0226	0.0237	0.0234	0.0221	0.0220	0.0232	0.0240	0.0246	17.9270
NO	NO	NO	NO	NO	NO	NO	NO	0.0000
0.0002	**0.0002**	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**3.6186**
0.4900	**0.4900**	**0.5000**	**0.5000**	**0.5000**	**0.5100**	**0.5100**	**0.5254**	**11.7969**
0.4900	0.4900	0.5000	0.5000	0.5000	0.5100	0.5100	0.5254	11.7969
NE	NE	NE	NE	NE	NE	NE	NE	0.0000
NO	NO	NO	NO	NO	NO	NO	NO	0.0000
NA	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.0000**
NA	NA	NA	NA	NA	NA	NA	NA	0.0000
0.0758	**0.0792**	**0.0779**	**0.0802**	**0.0702**	**0.0750**	**0.0834**	**0.0849**	**26.9841**
0.0461	0.0482	0.0479	0.0547	0.0495	0.0530	0.0541	0.0629	66.3144
0.0298	0.0311	0.0299	0.0255	0.0207	0.0220	0.0294	0.0221	24.1276
NE	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**0.0000**

4NC Table A1: Emissions trends (HFCs, PFCs and SF_6)

Greenhouse Gas Source and Sink Categories	Base year (1990) (Gg)	1991 (Gg)	1992 (Gg)	1993 (Gg)	1994 (Gg)	1995 (Gg)
Emissions of HFCs[5] - (Gg CO_2 equivalent)	**IE,NA,NO**	**NA,NO**	**1.8200**	**5.4600**	**25.8655**	**83.7772**
HFC-23	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-32	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.0004
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	NA,NO	NA,NO	NA,NO	NA,NO	0.0012	0.0005
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	IE,NA,NO	NA,NO	0.0014	0.0042	0.0161	0.0398
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	0.0004	0.0012
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	NA,NO	NA,NO	NA,NO	NA,NO	0.0004	0.0079
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	0.0000	0.0001
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed HFCs [6] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of PFCs[5] - (Gg CO_2 equivalent)	**515.6000**	**651.6400**	**638.1000**	**524.8000**	**183.6000**	**147.5000**
CF_4	0.0680	0.0844	0.0826	0.0680	0.0240	0.0190
C_2F_6	0.0080	0.0112	0.0110	0.0090	0.0030	0.0020
C_3F_8	NA,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.0008
C_4F_{10}	NA,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
c-C_4F_8	NA,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_5F_{12}	NA,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_6F_{14}	NA,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Unspecified mix of listed PFCs [6] - (Gg CO_2 equivalent)	NA,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Emissions of SF6[5] - (Gg CO_2 equivalent)	**12.3324**	**12.6431**	**12.9777**	**14.0532**	**14.4117**	**15.0092**
SF_6	0.0005	0.0005	0.0005	0.0006	0.0006	0.0006

All footnotes for this table are given at the end of the table on page 172

1996	1997	1998	1999	2000	2001	2002	2003	Change from base to latest reported year
(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
139.0257	**114.2695**	**210.6913**	**174.8195**	**173.2844**	**254.1239**	**387.6822**	**403.9601**	**100.0000**
NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.0000
NA,NE,NO	NA,NE,NO	NA,NE,NO	0.0074	NA,NE,NO	0.0001	0.0009	0.0018	100.0000
NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.0000
NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.0000
0.0067	0.0105	0.0095	0.0104	0.0041	0.0128	0.0194	0.0236	100.0000
NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.0000
0.0716	0.0379	0.1138	0.0757	0.1054	0.1239	0.1923	0.1806	100.0000
0.0004	0.0002	0.0004	0.0017	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.0000
NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.0000
0.0071	0.0093	0.0094	0.0110	0.0064	0.0149	0.0216	0.0266	100.0000
0.0001	0.0001	0.0001	0.0002	0.0002	0.0002	0.0003	0.0003	100.0000
NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.0000
NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.0000
NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.0000
265.4000	**166.2000**	**130.2000**	**74.2000**	**59.2500**	**59.2500**	**83.5000**	**84.9000**	**83.5337**
0.0300	0.0210	0.0100	0.0100	0.0077	0.0077	0.0110	0.0110	83.8235
0.0040	0.0030	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	87.5000
0.0048	0.0003	0.0080	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.0004	0.0006	100.0000
NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	0.0000
NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	0.0000
NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	0.0000
NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	0.0000
NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	0.0000
14.7941	**15.2960**	**14.0293**	**13.1928**	**11.9500**	**12.0456**	**12.5714**	**12.3802**	**0.3876**
0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005	0.0005	0.3876

4NC Table A1: Emissions trends (Summary)

Greenhouse Gas Emissions	Base year (1990) CO_2 equivalent (Gg)	1991 CO_2 equivalent (Gg)	1992 CO_2 equivalent (Gg)	1993 CO_2 equivalent (Gg)	1994 CO_2 equivalent (Gg)	1995 CO_2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF [4]	3,944.3606	5,727.2975	10,027.8406	11,872.3308	13,045.9184	12,509.0253
CO_2 emissions excluding net CO_2 from LULUCF [4]	25,314.8144	25,827.8465	27,691.4597	27,114.1393	27,206.7336	27,161.0473
CH_4	25,283.9751	25,116.0440	24,688.7769	24,986.8644	25,203.7913	25,497.4010
N_2O	10,398.7099	10,424.8469	10,519.5908	10,811.9245	11,134.3448	11,373.0872
HFCs	IE,NA,NO	NA,NO	1.8200	5.4600	25.8655	83.7772
PFCs	515.6000	651.6400	638.1000	524.8000	183.6000	147.5000
SF_6	12.3324	12.6431	12.9777	14.0532	14.4117	15.0092
Total (including net CO_2 from LULUCF)[4]	**40,154.9780**	**41,932.4715**	**45,889.1060**	**48,215.4329**	**49,607.9317**	**49,625.7999**
Total (excluding net CO_2 from LULUCF)[4]	**61,525.4318**	**62,033.0205**	**63,552.7251**	**63,457.2414**	**63,768.7469**	**64,277.8219**
Greenhouse Gas Source and Sink Categories						
1. Energy	23,594.1102	23,873.3693	25,632.7451	24,897.8622	25,134.5120	25,072.5288
2. Industrial Processes	3,211.7025	3,487.3669	3,576.6542	3,617.5802	3,209.6818	3,325.2149
3. Solvent and Other Product Use	41.5400	42.7800	43.0900	43.7100	44.3300	44.9500
4. Agriculture	32,193.7569	32,119.6971	32,140.2241	32,739.3637	33,316.7606	33,770.2643
5. Land Use, Land-Use Change and Forestry [7]	-21,366.1916	-20,096.6317	-17,659.1675	-15,236.1232	-14,154.4226	-14,645.8581
6. Waste	2,480.0600	2,505.8900	2,155.5600	2,153.0400	2,057.0700	2,058.7000
7. Other	NA	NA	NA	NA	NA	NA
Total (including LULUCF) [7]	**40,154.9780**	**41,932.4715**	**45,889.1060**	**48,215.4329**	**49,607.9317**	**49,625.7999**

(1) The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the COP. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

(2) Fill in net emissions/removals as reported in Table Summary 1.A. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(3) The information in these rows is requested to facilitate comparison of data, because Parties differ in the way they report CO_2 emissions and removals from LULUCF.

(4) Enter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as CO_2 equivalent emissions.

(5) In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is Gg of CO_2 equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

(6) These totals will differ from the totals reported in table Summary 2 if Parties report non-CO_2 emissions from LULUCF.

(7) Includes net CO_2, CH_4 and N_2O from LULUCF.

1996	1997	1998	1999	2000	2001	2002	2003	Change from base to latest reported year
CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	%
13,251.2684	13,975.0218	9,754.4762	9,392.1620	8,182.6917	9,792.4426	9,680.3294	11,833.8397	200.0192
28,176.1559	30,434.2897	29,059.0341	30,504.4491	31,006.0462	32,983.4414	33,011.1415	34,699.5478	37.0721
25,583.1726	25,563.2059	25,658.5346	25,884.4773	26,165.7829	26,524.4942	26,565.3261	26,644.9743	5.3829
11,486.8337	11,583.1309	11,659.9233	11,884.1405	12,279.3339	12,789.9169	13,172.9809	13,499.5297	29.8193
139.0257	114.2695	210.6913	174.8195	173.2844	254.1239	387.6822	403.9601	100.0000
265.4000	166.2000	130.2000	74.2000	59.2500	59.2500	83.5000	84.9000	83.5337
14.7941	15.2960	14.0293	13.1928	11.9500	12.0456	12.5714	12.3802	0.3876
50,740.4945	**51,417.1240**	**47,427.8546**	**47,422.9921**	**46,872.2928**	**49,432.2732**	**49,902.3899**	**52,479.5839**	**30.6926**
65,665.3820	**67,876.3920**	**66,732.4125**	**68,535.2792**	**69,695.6474**	**72,623.2720**	**73,233.2020**	**75,345.2920**	**22.4620**
26,118.6178	28,511.4834	27,045.4305	28,379.8830	28,905.7929	30,828.7499	30,864.6664	32,320.9222	36.9872
3,486.0724	3,268.1057	3,479.6410	3,560.6231	3,511.7005	3,673.2662	3,824.3756	4,014.1870	24.9863
45.8800	46.1900	46.5000	46.8100	47.1200	47.4300	48.3600	48.3600	16.4179
33,993.6749	34,223.3260	34,341.6954	34,757.8542	35,509.2091	36,349.6438	36,762.3977	37,203.2368	15.5604
-14,917.9305	-16,451.7011	-19,298.3622	-21,106.7782	-22,818.9297	-23,186.6867	-23,326.7299	-22,861.6001	6.9989
2,014.1800	1,819.7200	1,812.9500	1,784.6000	1,717.4000	1,719.8700	1,729.3200	1,754.4781	29.2566
NA	NA	NA	NA	NA	NA	NA	NA	0.0000
50,740.4945	**51,417.1240**	**47,427.8546**	**47,422.9921**	**46,872.2928**	**49,432.2732**	**49,902.3899**	**52,479.5839**	**30.6926**

Annex B

Supplementary information on projections modelling methodology

Agriculture

Projections of the animal numbers

Projections of the livestock numbers for dairy cattle, beef cattle, sheep and deer are undertaken with an econometric model, the Pastoral Supply Response Model (PSRM). The PSRM is an annual time-series model that is representative of the biological constraints and investment decisions made by New Zealand farmers. The projections are based predominantly on the final June 2004 results of Statistics New Zealand's Agricultural Production Survey. Product prices are those used in Ministry of Agriculture and Forestry projections prepared for the Treasury's Pre-Election Economic and Fiscal Update.

Post-model adjustments are carried out based on known and estimated factors that may reduce the land area available for livestock as follows:

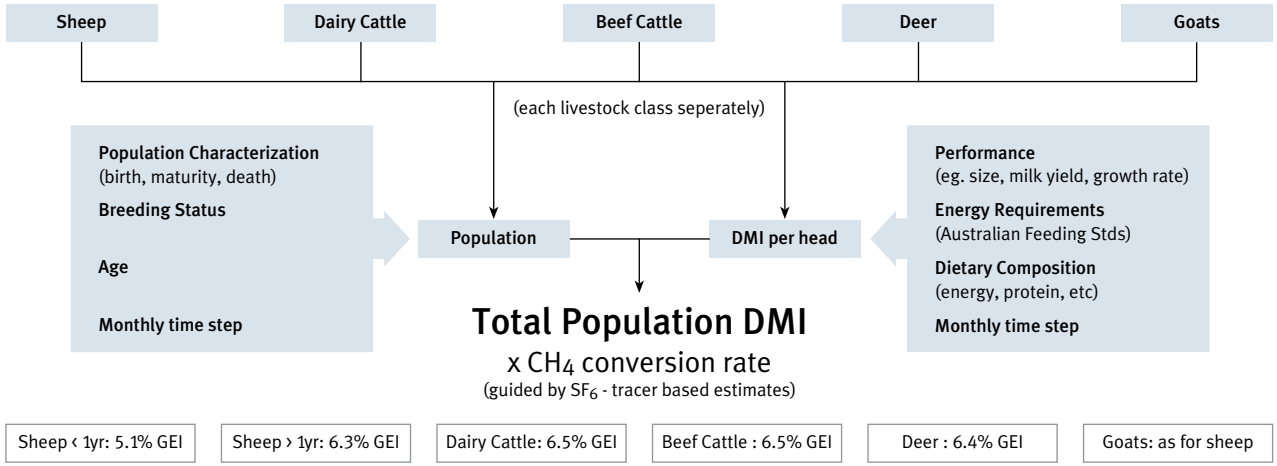
- The removal of South Island high country leasehold areas from livestock farming from June years 2002 to 2013 has an estimated cumulative loss of 0.5 million stock units (SU).
- The annual area of grazing land converted to forestry rises from the current low of 10,600 hectares in the year to June 2004 to 18,700 hectares in 2010, and to 20,000 hectares in 2020. This compares with the Ministry of Agriculture and Forestry's separately provided scenarios of 10,000 hectares, 20,000 hectares and 30,000 hectares for June 2010. It is assumed that these areas displace sheep.
- Anticipated deforestation of an estimated total of 34,000 ha spread over June years 2005 to 2010 in the central North Island. The land will go mostly into dairy.
- Sheep numbers are adjusted down in 2009 so that total SU of livestock plus the cumulative opportunity loss of SU displaced by forestry are equal to the level as at June 2008. The maximum SU is 97.711 million with 94.153 million from dairy, beef, sheep, deer and goats, and the balance is the cumulative SU displaced by forestry. This ensures that feed demand approximates feed supply over the longer term.

Livestock numbers for June 2020 are extrapolations from projections to 2014. These assume constant levels for dairy, beef and deer, while sheep numbers decrease in line with increasing new plantings of plantation forestry.

Projections of enteric methane emissions per animal

Projections of methane emissions per animal in 2020 are derived from linear trends of the methane emissions per animal 1990-2003, extended out to 2020. The per animal emissions used to derive the linear trends are sourced from the current national methane inventory and are calculated using a model (Clark et al., 2003) (4NC Figure B1).

4NC Figure B1: Outline of the process used to calculate methane emissions in the national inventory



The model determines monthly feed intakes for different age classes of each animal species based on the mean national animal performance data derived from national statistics. For example, in dairy cattle, inputs include: animal liveweight, milk production per animal, milk fat percent per animal and milk protein percent per animal. For each animal species, an empirical relationship has been derived for the amount of enteric methane produced per unit of feed intake.

These relationships have been developed in New Zealand for deer, beef and dairy cattle, and sheep using the SF_6 (sulphur hexafluoride) tracer technique to assess methane emissions from animals consuming forage based diets. From these estimates of feed intake per animal, and methane produced per unit of intake, an implied annual emission factor has been calculated per animal that takes into account the changes in animal performance over time.

The implied methane emission factors for dairy cattle, beef sheep and deer in 1990, 2010 and 2020 along with the correlation coefficient (r) for the linear trend in per animal emissions 1990–2003 are presented in 4NC Table 21, Chapter 5. These data indicate a strong linear trend in the increase in methane emission per animal over the period 1990 to 2003.

The models discussed above developed by Clark *et al.* for methane emissions provide all the information needed to estimate nitrogen output per animal.

Projection of nitrogen fertiliser use

Nitrogen fertiliser use has increased nearly six-fold from 1990 to 2003. Two methods were used to assess projections of nitrogen fertiliser to 2010. Further assumptions were made for the change in nitrogen fertiliser use between 2010 and 2020. The first method used projections of nitrogen fertiliser use derived from a linear trend of fertiliser use from 1990 to 2003. The correlation (r) was 0.96. The projected value for 2010 was 433,700 tonnes of nitrogen.

The second method used best fertiliser industry estimates provided through the Fertiliser Manufacturers Research Association which takes into account future exchange rates, agricultural commodity prices, shipping costs and general projected economic circumstances for agriculture. The projected best estimate value for 2010 was 408,500 tonnes.

The mean value between these two estimates of 421,100 tonnes was used for estimating nitrous oxide emissions in 2010.

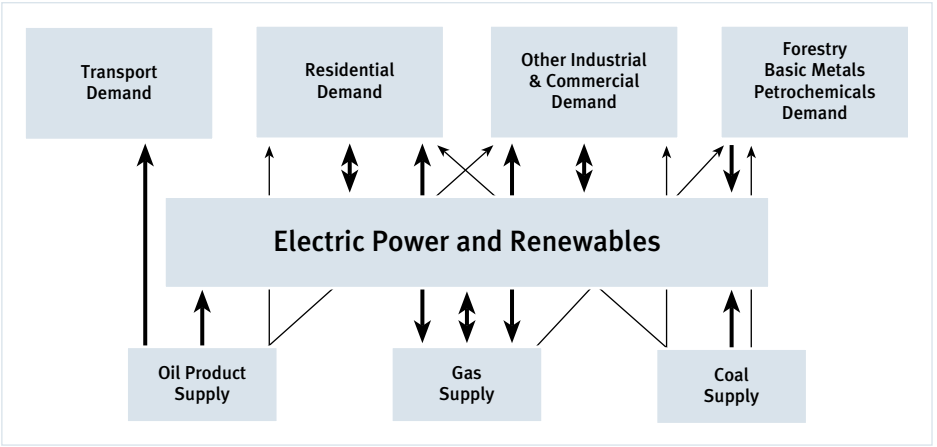
The approach to assessment of usage from 2010 to 2020 used different assumptions. These involved projections on world growth in consumption using extensions of the projections of future consumption by the International Fertiliser Industry Association of 1.5 percent per annum.

Energy

The greenhouse gas emissions from the energy, transport, and industrial processes sectors are obtained from the Ministry of Economic Development's Supply and Demand Equilibrium Model (SADEM). The Ministry has used SADEM since the early 1990s for both internal policy analysis and to prepare published projections of New Zealand's energy supply, demand, and prices.

SADEM is really a collection of models. There are supply models for electricity and various fuels, and demand models by sector or industry. Most of these models are quite simple. The notable exception is the model that deals with electric power and renewables, which is reasonably complex.

4NC Figure B2: Overview of SADEM



Note: Prices flow up, demand flows down

4NC Figure B2 summarises the design of SADEM. Each box represents a separate model. The arrows indicate the connections; note that some arrows flow "under" the Electric Power and Renewables box. If an arrow points upward, it means that prices generated by the lower model feed into the upper model. If the arrow points downward, it means that quantities of energy demanded feed from the upper model back to the lower model. If the arrows point in both directions, it means that prices are flowing up and quantities are flowing down. These bidirectional arrows indicate "equilibrium relationships", where a solution requires the quantity supplied to equal the quantity demanded.

The arrows coming out of oil product supply and coal supply point upwards only. This is because the model assumes oil and coal supply to be perfectly elastic. That is, their prices are fixed, so prices flow upward only. New Zealand is assumed to be a price taker in these markets.

Heavy industries on the other hand – forestry, basic metals (steel and aluminium), and petrochemicals (methanol, urea, and refineries – are assumed to have inelastic demand. That is, their demand is fixed by assumption and does not respond to price. The Ministry currently lacks an understanding of how these industries would respond to changes in energy prices, but has recently initiated a study to address the issue.

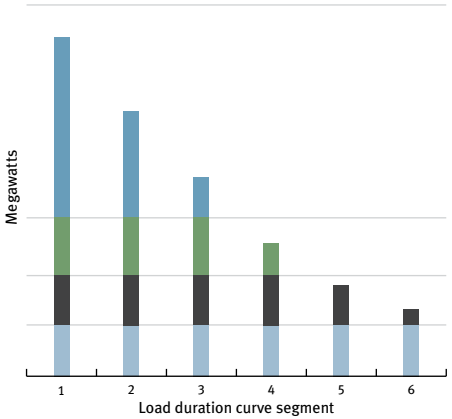
SADEM thus equilibrates the four models in the right half of this diagram: gas supply, electric power and renewables, residential demand, and other industrial and commercial demand. The model finds the equilibrium prices and quantities through an iterative process of trying various values until it finds the right one.

The model first finds the year of gas exhaustion, which determines the gas price path, as well as the electric power prices, so as to equilibrate the supply and demand for gas and electric power, given an assumed fleet of generators. Once it has found a set of electric and gas prices that equilibrate supply and demand, it then asks if it is profitable to add more generation. If so, it adds some generation of the most profitable type and recalculates the gas and electric power prices. It continues to add generation until it has either used all the available sites (hydroelectricity, geothermal, and wind potential are limited by the available sites) or until no more generation can be profitably added, which is when the algorithm stops.

The electric power and renewables sector

SADEM models the electric power and renewables sector by simulating generation dispatch for each of the seasons of each year many times – currently it cycles through each year 550 times. For each season, the model draws a water inflow from a random distribution, developed in consultation with the New Zealand's National Institute of Water and Atmospheric Research. At the end of the season, the ending reservoir levels become the starting reservoir levels for the next season. Individual hydroelectricity projects are not represented; rather the model assumes New Zealand has one giant hydroelectricity reservoir.

4NC Figure B3: Merit order generation dispatch



Source: Ministry of Economic Development

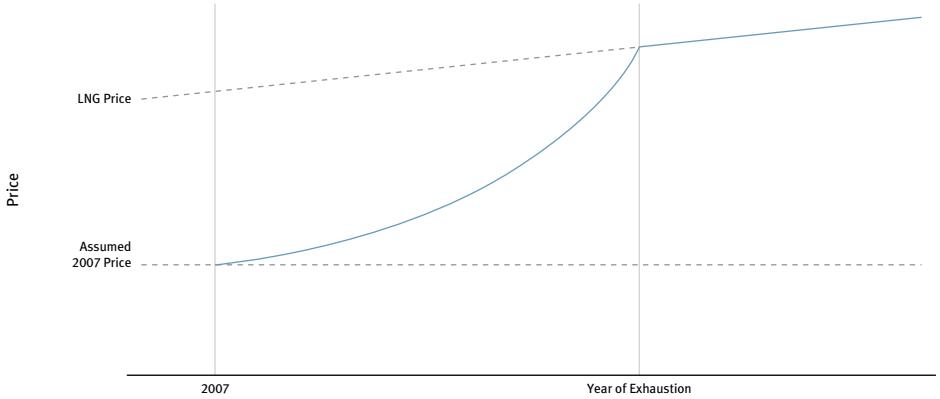
Since demand varies hour by hour, the hours of the season are grouped into six categories, ranging from highest to lowest, to form a "load duration curve". The model seeks to find the lowest cost way to dispatch generation for each of the six load duration curve segments. For each load duration curve segment, generation is dispatched in order of variable costs until the remaining demand can be served with the water available for storable hydro. 4NC Figure B3 illustrates this process. Given the average dispatch pattern over many seasons, it is possible to project marginal generation costs and prices.

Gas price projection

In the gas supply model, gas prices are based on the year domestic supplies are assumed to be exhausted. To determine this year, SADEM sums up the cumulative amount of gas assumed to be available from each major field each year, plus new discoveries. It does the same for gas demand, calculating a total demand each year and a cumulative total demand going forward. The year in which cumulative demand exceeds cumulative supply is the year of exhaustion.

As shown in 4NC Figure B4, the model assumes that after the year of exhaustion, the price of gas is set by the price of imported liquefied natural gas (LNG). The price of LNG is a simple function of the assumed price of oil, since this appears to be how LNG prices are usually set in the real world. Prior to the year of exhaustion the price moves along a smooth curve from whatever price we assume in the year 2007 to the price of LNG in the year of exhaustion.

4NC Figure B4: Gas price calculation



Source: Ministry of Economic Development

Demand

4NC Table B1 summarises the demand models used in SADEM. Three major energy demand sectors are modelled; residential, industrial and commercial, and transport. Each sector includes several sub-sector models. Approximately two-thirds of the total energy demand is modelled using a multi-variate approach that includes price response. About a fifth of the total energy is modelled based on forecasts directly from the industries concerned. The remaining portion is modelled using ordinary least squares (OLS) regressions that effectively produce extrapolations of past trends.

4NC Table B1: Demand sectors and modelling techniques

Major sector	Sub-sector	Model	Net energy (PJ, 2004)	Percentage
Residential	Residential	Multivariate (GDP, Price, HDD, Lagged Demand)	52	10%
Industrial & commercial	Forestry	MAF forecasts	23	4%
	Metals	Company forecasts	40	8%
	Petrochemicals	Company forecasts	52	10%
	Other industrial and commercial	Multivariate (GDP, Price, HDD, Lagged Demand)	105	20%
Transport	Petrol (land)	Multivariate (GDP, Price, Lagged Demand)	104	20%
	Diesel (land)	Multivariate (GDP, Price, Lagged Demand)	80	15%
	Aviation	OLS	48	9%
	Sea	OLS	22	4%
	Other	OLS	9	2%
Total			**533**	**100%**

Greenhouse gas emissions

The one last step after modelling energy supply and demand is to model the emissions of greenhouse gases. Modelling carbon dioxide emissions is fairly simple, since the output of carbon dioxide is a simple function of the amount of each type of fuel burned. Non-carbon dioxide greenhouse gases are more complicated to estimate than carbon dioxide, since the emission factors depend not only on the specific fuel types, but also on the type of use to which the fuel is put.

Annex C

Reporting under Kyoto Protocol Article 7.2

National systems in accordance with Article 5, paragraph 1

New Zealand is developing its national system for its greenhouse gas inventory in accordance with the guidelines for national systems. The development of the national system is well advanced, as demonstrated by New Zealand's National Inventory Report 1990–2003[18] submitted in April 2005. The national system will be fully described in the initial report due to be submitted under Article 7.4 of the Kyoto Protocol. Legislative arrangements for the inventory are described in New Zealand's report on demonstrable progress included with this *Fourth National Communication.*

National registries

New Zealand's national registry is under development in accordance with international standards and guidelines. It will be fully described in the initial report due to be submitted under Article 7.4 of the Kyoto Protocol. Legislative arrangements for the registry are described in New Zealand's report on demonstrable progress included with this *Fourth National Communication.*

Supplementarity relating to the mechanisms pursuant to Article 6, 12 and 17

New Zealand's emission projections relative to its 1990 emission levels are fully described in Chapter 5 of this *Fourth National Communication* as well as in New Zealand's *Report on Demonstrable Progress* annexed to this *Fourth National Communication.*
The exact balance between domestic action and the use of the Kyoto mechanisms is not known at this time.

Policies and measures in accordance with Article 2

New Zealand's polices and measures are fully described in the policies and measures chapter (Chapter 4) of the *Fourth National Communication.*

Regarding emissions from international bunker fuel, the Government is working with the relevant agencies in order to implement recommendations from both the International Civil Aviation Organisation and the International Maritime Organisation.
New Zealand is also represented at meetings of these bodies.

Regarding the minimising of adverse effects of New Zealand's policies on developing countries identified in Article 4, paragraphs 8 and 9 of the Convention, we trust that any emissions reduction in New Zealand is assisting the global effort to minimise the impacts of climate change.

Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures

Legislative arrangements and enforcement and administrative procedures are fully described in New Zealand's *Report on Demonstrable Progress included* with this *Fourth National Communication.* All information on the legislative arrangements is publicly accessible.

Institutional arrangements and decision-making procedures for coordinating activities related to the participation in the mechanisms under Articles 6, 12 and 17, including the participation of legal entities are under development.

[18] *http://www.climatechange.govt.nz/resources/reports/nir-apr05/index.html*

New Zealand has a substantial state of planted forests, created specifically for timber supply purposes. Having a large planted forest resource enables New Zealand to manage its Crown and privately owned natural forest, including for the protection of biodiversity. Less than 0.1 percent of New Zealand's total forest production is now harvested from natural forests.

The New Zealand Carbon Monitoring System (described in New Zealand's National Inventory Report 1990–2003) not only provides data on New Zealand's natural forests for inventory and carbon accounting purposes, but also for other international forestry reporting obligations such as those required under the Montreal Process, the Food and Agriculture *Global Forest Resource Assessment* and the Convention on Biological Diversity.

Information under Article 10 and 11

This information is provided in the *Fourth National Communication* and in the *Report on Demonstrable Progress* included with this *Fourth National Communication*.

Annex D

Summary of policies and measures

4NC Table D1: Summary of policies and measures by sector

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities
Energy					
Sustainable energy work programme/National Energy Strategy	To incorporate sustainable development principles in energy policy decision-making and ensure that New Zealand's energy system can meet present and future challenges, particularly climate change and peak oil.	CO_2	Policy development	Under implementation	Whole of Government
National Energy Efficiency and Conservation Strategy	To encourage, promote, and support energy efficiency, energy conservation, and the use of renewable sources of energy.	CO_2	Policy development	Under implementation	Energy Efficiency and Conservation Authority
Business sector programmes: "Emprove"	To help high-energy-use businesses achieve savings in their energy expenditure.	CO_2	Information/Fiscal	Under implementation	Energy Efficiency and Conservation Authority
Residential sector programmes: Building regulations	To target the building regulatory process to deliver energy-efficient outcomes in New Zealand's building stock.	CO_2	Regulatory	Planned	Department of Building and Housing, with input from the Energy Efficiency and Conservation Authority
Residential sector programmes: EnergyWise home grants	To improve the energy efficiency of pre-1977 homes occupied by low-income families.	CO_2	Fiscal	Under implementation	Energy Efficiency and Conservation Authority
Energy supply and renewables programmes: Renewable energy to the grid	To ensure that more electricity generated for the grid or fed into local distribution networks is sourced from renewable energy.	CO_2	Information	Under implementation	Energy Efficiency and Conservation Authority
Energy supply and renewables programmes: Market development of renewable energy	To increase the sustainability of New Zealand's energy supply by increasing the contribution of renewable energy derived from small-scale energy technologies.	CO_2	Fiscal/Research	Under implementation	Energy Efficiency and Conservation Authority
Energy supply and renewables programmes: Demand response	To significantly improve the responsiveness of medium-sized electricity users to the spot market.	CO_2	Information/ Education	Under implementation	Energy Efficiency and Conservation Authority
Cross-sectoral programmes: Energy efficiency of products	1. To implement minimum energy performance standards and labelling.	CO_2	Regulatory	Under implementation	Energy Efficiency and Conservation Authority
	2. To implement Energy Star, a voluntary endorsement / labelling scheme for home appliances, office products and domestic refrigerators.	CO_2	Voluntary/ Information	Under implementation	Energy Efficiency and Conservation Authority

4NC Table D1: Summary of policies and measures by sector (cont'd)

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities
Transport					
New Zealand Transport Strategy	To recognise all modes and users of transport and to respond directly to the broader social, economic, and environmental needs of the country.	CO_2	Policy development	Under implementation	Ministry of Transport
National Rail Strategy	To achieve an affordable, integrated, safe, responsive and sustainable transport system.	CO_2	Regulatory	Adopted	Ministry of Transport
Air Quality Programme	To improve air quality by introducing mandatory fuel standards and improving the quality of the vehicle fleet.	CO_2	Regulatory	Under implementation	Ministry of Transport and Ministry of Economic Development
Renewable Transport Fuels Programme	To increase production and availability of bio-ethanol/ petrol blends and biodiesel.	CO_2	Regulatory	Considered	Ministry of Transport and Ministry of Economic Development
Information on Vehicle Fuel-Efficiency Programme	To encourage the purchase of fuel-efficient vehicles by providing appropriate consumer purchasing information.	CO_2	Information	Planned	Ministry of Transport
Surface Transport Costs and Charges Programme	To assist the Government to make decisions on the relative competitive position of road and rail for freight transport and of rail, bus and the private car for passenger transport.	CO_2	Information	Completed	Ministry of Transport
Travel Demand Management Programme	To encourage people to use forms of transport involving less energy and reduce their present dependency on the single passenger car.	CO_2	Voluntary	Under implementation	Energy Efficiency and Conservation Authority
Industry					
Sulphur hexafluoride	To improve the management of sulphur hexafluoride emissions.	SF_6	Voluntary/ Negotiated agreements	Under implementation	Minister Responsible for Climate Change Issues on behalf of the Government, and state-owned generators and transmission companies
No-loss campaign	To improve the management of fluorocarbon refrigerants.	HFC PFC	Voluntary/ Educational	Under implementation	Refrigeration industry bodies
Agriculture					
Research into improvement of the agricultural sector national greenhouse gas inventory	To systematically reduce uncertainties and improve the estimates of agricultural methane and nitrous oxide national inventory estimates.	CH_4 N_2O	Research	Completed	Ministry of Agriculture and Forestry
Pastoral Agriculture GHG Mitigation Research Programme	To identify, establish and develop on-farm technologies which lower methane emissions from ruminants and nitrous oxide from grazing animal systems.	CH_4 N_2O	Voluntary/ Research	Under implementation	Pastoral Greenhouse Gas Research Consortium (via the Foundation for Research, Science and Technology)

4NC Table D1: Summary of policies and measures by sector (cont'd)

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities
Waste					
National Waste Minimisation and Management Strategy	To reduce the volume of organic waste being produced through better resource use, and design for re-use.	CH_4	Voluntary	Under implementation	Ministry for the Environment
National environmental standard for landfill methane	To increase the use of methane recovery systems at larger landfills.	CH_4	Regulatory	Under implementation	Regional and local councils, with support from the Ministry for the Environment
Forestry					
Permanent Forest Sinks Initiative	To allow landowners the opportunity to access the value, created under the Kyoto Protocol, of carbon from newly established permanent forest sinks	CO_2	Voluntary/Contractual arrangement between landowners and the Crown.	Being Considered	Ministry of Agriculture and Forestry
East Coast Forestry Project	To facilitate the afforestation of 120,000 of eroding and erodable land in the East Coast region of the North Island over the 28 year period to 2020.	CO_2	Voluntary/Fiscal	Under implementation	Ministry of Agriculture and Forestry
Cross-sectoral					
Energy-intensive businesses	To reduce greenhouse gas emissions resulting from energy use by small and medium enterprises on a cost-effective basis.	CO_2	Information/ Education/Fiscal	Under implementation /Planned	Energy Efficiency and Conservation Authority
Projects to Reduce Emissions	To reduce greenhouse gas emissions by supporting projects that provide emission reductions in the Kyoto Protocol's first commitment period beyond the reductions that would have occurred without the project.	CO_2	Economic	Under implementation	Ministry for the Environment
Local Government					
Partnership with Local Government New Zealand	Establish and maintain regular communication channels between central and local government on climate change matters.	CO_2 CH_4	Information	Under implementation	Ministry for the Environment and Local Government New Zealand
Communities for Climate Protection™ – New Zealand	To reduce greenhouse gas emissions by improving energy efficiency, reducing waste, encouraging sustainable transportation, enhancing urban design, and promoting sustainable farming practices.	CO_2 CH_4	Information	Under implementation	The International Council for Local Environmental Initiatives Australia/ New Zealand
Adaptation	To provide clarification on expected future climate change effects; practical tools to assist councils; and models in the form of case studies.	N/A	Adaptation	Under implementation	Ministry for the Environment
Legislative amendment to the Resource Management Act	To provide for nationally consistent decision-making with respect to managing greenhouse gas emissions.	All GHG	Regulatory	Under implementation	Ministry for the Environment, and the Energy Efficiency and Conservation Authority

4NC Table D1: Summary of policies and measures by sector (cont'd)

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities
Bilateral Partnerships					
United States–New Zealand	To maximise United States–New Zealand business, research, and policy cooperation on climate change.	CO_2 CH_4 N_2O	Information/ Research	Under implementation	Ministry for the Environment/ United States Department of State
Australia–New Zealand	To maximise Australia–New Zealand business, research, and policy cooperation on climate change.	CO_2 CH_4 SF_6	Information/ Research	Under implementation	Ministry for the Environment/ Australian Greenhouse Office

Note: Insufficient information is available to provide a quantitative estimate of the mitigation impact of individual policies and measures.

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Abbreviations and acronyms

APN	Asia-Pacific Network for Global Change Research
ASAP	Automated Shipboard Aerological Programme
BRANZ	Building Research Association of New Zealand
CCP–NZ	Communities for Climate Protection™ – New Zealand
CCRA	The Climate Change Response Act 2002
CDM	clean development mechanism
CH_4	methane
CMS	Carbon Monitoring System
CO	carbon monoxide
CO_2	carbon dioxide
COP1	First Conference of the Parties to the UNFCCC
CP1	Kyoto Protocol's first commitment period 2008–2012
CRF	Common Reporting Format
CSLF	Carbon Sequestration Leadership Forum
EECA	Energy Efficiency and Conservation Authority
FLUXNET	Global Terrestrial Network – Carbon
FRST	Foundation for Research, Science and Technology
GAW	Global Atmosphere Watch of WMO
GCOS	Global Climate Observing System
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEO	Group on Earth Observations
Gg	gigagrams
GIC	Gas Industry Company
GOOS	Global Ocean Observing System
GSN	GCOS Surface Network
GTN-G	Global Terrestrial Network – Glaciers
GTN-P	Global Terrestrial Network – Permafrost
GTOS	Global Terrestrial Observation System
GUAN	GCOS Upper Air Network
GWPs	Global Warming Potentials
HFCs	hydrofluorocarbons
ICLEI-A/NZ	International Council for Local Environmental Initiatives Australia/ New Zealand
ICSU	International Council for Science
IEA	International Energy Agency
IGBP	International Geosphere-Biosphere Programme
IGOS	Integrated Global Observing Strategy
IOC	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
IPHE	International Partnership for the Hydrogen Economy
JI	Joint Implementation projects
LTCCP	Long Term Council Community Plans
LULUCF	land use, land-use change and forestry sector
MAF	Ministry for Agriculture and Forestry
MED	Ministry of Economic Development
MfE	Ministry for the Environment
Mt	Megatonne (one million tonnes)
N_2O	nitrous oxide
NEECS	National Energy Efficiency and Conservation Strategy
NIR	National Inventory Report
NMVOC	non-methane volatile organic compounds
NO_x	oxides of nitrogen
NSSCCC	National Science Strategy Committee for Climate Change
NZAID	New Zealand Agency for International Development
NZCAS	New Zealand Carbon Accounting System
OECD	Organisation for Economic Co-operation and Development

OI&C	"other industrial and commercial"
PFCs	perfluorocarbons
PGGRC	Pastoral Greenhouse Gas Research Consortium
PI-GCOS	Pacific Islands Global Climate Observing System
ppm	parts per million
PRE	Projects to Reduce Emissions
RMA	Resource Management Act 1991
SADEM	Ministry of Economic Development's Supply and Demand Equilibrium Model
SF_6	sulphur hexafluoride
SFC	surface
SO_2	sulphur dioxide
SOLAS	Surface Ocean Lower Atmosphere Study
SOOP	Ship of Opportunity Programme
SOPAC	South Pacific Applied Geoscience Commission
SPREP	Secretariat of the Pacific Environment Programme
Sub-SFC	sub-surface
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VOS	Volunteer Observing Ship
WCRP	World Climate Research Programme
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organization
WWW	World Weather Watch of WMO
XBT	expendable bathythermograph

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New Zealand's Report on the Global Climate Observing System (GCOS)

Introduction

New Zealand has built up an archive of systematic atmospheric, oceanic and terrestrial observations of climate related parameters. Details of these observations are tabulated in this report made in accordance with the United Nations Framework Convention on Climate Change Reporting Guidelines on Global Climate Change Observing Systems.

Observing, data and monitoring system support for developing countries

The New Zealand Meteorological Service, under a New Zealand Government contract, provides general assistance to Kiribati, Tuvalu, Samoa, Tokelau, Tonga, Niue and the Cook Islands in ensuring that weather and climate observing systems run smoothly and the quality of the observations is maintained. Targeted New Zealand overseas development aid programmes have covered training in technical maintenance and observing practices in the Cook Islands, Tuvalu and the Tokelaus.

The Meteorological Service also administers the World Meteorological Organization (WMO) trust fund which supports upper air observations at Tuvalu, Kiribati and Penrhyn, and provides technical support regarding the operation of these stations. This support has now been extended under Global Climate Observing System (GCOS) funding and the Meteorological Service has been contracted to supply additional support to the south-west Pacific under the PI-GCOS Technical Support Project.

Progress since New Zealand's *Third National Communication*

The National Institute of Water and Atmospheric Research (NIWA) also assists meteorological services undertaking climate observations in the south-west Pacific, through informal advice when requested, by backing up climate records from many of the islands in the New Zealand climate database, and by providing data from this database to them when requested. NIWA has run and partnered several training programmes supported by the Asia-Pacific Network for Global Change Research. These have included training staff from Pacific Island developing states with recovering historical data records and defining and coding meta-data.

In 2004, the Asia-Pacific Network for Global Change Research supported a "training institute" at the University of the South Pacific in Fiji on "Extreme Weather Events". The training staff were drawn from NIWA, the East–West Centre in Hawaii, the United States and from the University of the South Pacific in Suva, Fiji. The training modules developed for the training institute will be taken to individual communities in Samoa and to Kiribati in 2005. With the support of the New Zealand Agency for International Development, NIWA scientists have worked with staff from various organisations in the Pacific Islands, Australia, United States, and France, to produce the monthly *Island Climate Update*, which summarises recent climatic conditions and provides climate outlooks for the next three months. The New Zealand Agency for International Development also supported in early 2005, the training of two staff from the Fijian Meteorological Service at NIWA's National Climate Centre on climate database management and quality control.

New Zealand has been very active in supporting GCOS initiatives in the Pacific region. A Pacific Island GCOS committee was formed in 2000 with Pacific Island and regional representatives and New Zealand has been an active participant since its inception. This committee developed a regional implementation plan with 36 discrete projects that will help the Pacific region contribute to the GCOS objectives. The development has involved a high degree of collaboration between the Pacific Island countries and donors and in particular New Zealand has supported initiatives to:

- restore and upgrade the regional upper-air networks
- produce a Pacific regional climate bulletin
- recover historical climate data
- assist with capacity building of Pacific Island hydrological and meteorological services.

Key New Zealand agencies involved in climate observing

The National Institute of Water and Atmospheric Research makes dedicated atmospheric and hydrological climate observations as well as atmospheric constituent measurements with climate relevance. These data are archived in the National Climate Database and the National Water Resources Archive. NIWA also makes routine oceanic observations as well as maintaining a sea-level recording network around the coast of New Zealand.

The Meteorological Service of New Zealand undertakes routine surface and upper air weather observations and these are also archived in the National Climate Database.

The New Zealand Ministry of Fisheries contracts out regular surveys of various fish species, in order to set maximum allowable catch limits and quotas. The resulting data sets are relevant for assessing climate change impacts on fisheries.

Landcare Research maintains the National Vegetation Survey Databank (NVS) and also maintains five New Zealand long-term ecological research and monitoring sites.

The Ministry of Agriculture and Forestry maintains a planted forest cover database for New Zealand and keeps records of carbon absorbed in new planting and lost through logging, fires and vegetation clearance.

Atmospheric observing systems

Programmes

There are two prime sources of New Zealand atmospheric observations relevant to climate change: the routine surface and upper air weather observations undertaken by the Meteorological Service of New Zealand, and dedicated climate observations and atmospheric constituent measurements undertaken by NIWA. NIWA is assisted by many voluntary observers, especially for rainfall monitoring. The Meteorological Service forwards its weather observations to NIWA, where they are archived in the National Climate Database along with NIWA's own measurements. The Meteorological Service and NIWA both play particular attention to quality control. NIWA's climate monitoring and archiving programme carries ISO9002 certification, and the Meteorological Service has ISO9001 certification.

Support

Funding for the core weather observations is from a Ministry of Transport contract to the Meteorological Service, with some extra observations funded out of commercial revenue. Dedicated climate observations are funded by a contract to NIWA from the Foundation for Research, Science and Technology, which recognises the climate database as a database of national importance. Recent revision of the funding levels allocated by the foundation, combined with revenue from commercial applications of the data, provides for the database and recording network to be maintained at their current levels for another decade. Atmospheric constituent measurements are also funded by the foundation, as part of specific research programmes.

National plans

NIWA's plans for the national climate network include continuing with gradual automation as finances permit, and NIWA staff regularly review the network in the light of user requirements. Planning for climate and atmospheric constituent measurements takes place as part of the Foundation for Research, Science and Technology proposal and contracting process. Particular attention is paid to continuity of the 25-station reference climate network.

Availability and exchange

NIWA has developed user-friendly web access to the National Climate Database, which is available on request. The address is *http://cliflo.niwa.co.nz/*. Appropriate weather observations are forwarded to other countries by the Meteorological Service in real time, through World Meteorological Organization (WMO) networks. New Zealand provides climate and greenhouse gas monitoring data to international data centres under the WMO/ICSU (International Council of Scientific Unions) programmes which comprise the Global Climate Observing System.

Weather and climate observations

New Zealand has nine stations providing data to international data centres as part of the Global Surface Network (GSN) of the Global Climate Observing System (GCOS), and four stations which report as part of the Global Upper Air Network (GUAN). A total of 208 stations[19] provide climate observations at 9 a.m. to the National Climate Database, and 118 of these are automatic stations which also provide information at other times of day. There are currently 654 stations providing daily rainfall data into the database. In addition, NIWA maintains satellite data archives for the New Zealand region of NOAA HRPT data (1992–present), Global Geostationary Meteorological Satellite data products (August 1998–present) and SeaStar SeaWiFS HRPT data (May 2000– present).

Atmospheric constituents

New Zealand has three stations providing atmospheric constituent data to international data centres as part of the Global Atmospheric Watch (GAW). Concentrations and isotope ratios of carbon dioxide, methane and nitrous oxide, as well as aerosol properties and non-methane hydrocarbons, are monitored at the Baring Head clean air monitoring station (41°S). Some of these gases are also monitored at two other sites, including one at Scott Base (78°S) in the Antarctic. Surface ozone is monitored at seven stations (including one in Antarctica), column-integrated ozone concentrations are measured at two stations (including one in Antarctica), and a regular balloon-borne sampling programme for vertical profiles of ozone and water vapour concentrations is operated at one station. New Zealand also uses ships of opportunity to collect air samples for the analysis of the principal greenhouse gases between Nelson, New Zealand and Osaka, Japan.

Recently, a new suite of in-situ trace gas measurements has been initiated at Lauder (45°S). These complement the measurements of a wide range of trace gases that has been undertaken there since the 1990s. The purpose of these measurements is to better understand New Zealand's contribution to global warming, and to contribute to global efforts to understand the distribution and variability of key greenhouse gases.

GCOS Figure 1: Key atmospheric constituent climate sites

GCOS Table 1: Participation in the global atmospheric observing systems

	GSN (1)	GUAN (2)	GAW (3)
How many stations are the responsibility of the Party?	10	4	2
How many of those are operating now?	10	4	2
How many of those are operating to GCOS standards now?	9	4	2
How many are expected to be operating in 2009?	10	4	2
How many are providing data to international data centres now?	9	4	2

Notes:

(1) GSN Global Surface Network

(2) Global Upper Air Network

(3) Global Atmosphere Watch of the World Meteorological Organization

[19] Of these 208 stations, 165 provide a sufficiently broad suite of climate measurements to be useful for national climate monitoring.

Ocean observing systems

There are 11 open-coast sea level monitoring gauges operating around the New Zealand coast (as part of a network of 22 gauges, including the Chatham Islands and Scott Base in Antarctica). Sea surface temperature is measured at 13 coastal stations. In addition, 90-year tide gauge records are held for the ports of Auckland, Wellington, Lyttelton and Dunedin, and short records from several other ports.

Since the 1980s, New Zealand has maintained a network of around seven drifting buoys in the Tasman Sea, and has yearly contributed and deployed two sub-surface floats under the Argo programme. Additionally New Zealand deployed 146 floats for other nations in 2004 and will deploy a further 179 in 2005. In collaboration with Australian and United States research institutions, NIWA maintains three high resolution XBT (Expendable Bathythermograph) sections in the Tasman/Coral Sea area to monitor ocean temperature changes in the upper 800 metres.

New Zealand, through the Government-sponsored NIWA-led research programmes maintains three long-term moorings in deep waters to the east and north-east of the country. One supports the acquisition of current temperature data in the subtropical inflow region of the East Auckland Current to the northeast of New Zealand and has been in place for six years. The second and third support the acquisition of long-term, time-series biophysical data – either side of the subtropical front along the Chatham Rise. Measurements have now been in progress for five years. In addition, time series are being collected in the Hauraki Gulf.

Ocean waves are routinely monitored at five sites around the New Zealand coast. Remote coastal video cameras have been installed for long-term monitoring of beach conditions and erosion at seven sites.

The Ministry of Fisheries contracts out regular surveys of various fish species, in order to set maximum allowable catch limits and quotas. The resulting data sets may also be relevant for assessing climate change impacts on fisheries.

GCOS Table 2: Participation in the global oceanographic observing systems [1]

	VOS	SOOP	Tide gauges	SFC drifters	SUB-SFC floats	Moored buoys	ASAP
For how many platforms is the Party responsible?	36 [2]		15	7	6		
How many are providing data to international data centres?	36			7	6		
How many are expected to be operating in 2009?	36		16	7	12		

Notes:

(1) See list of abbreviations and acronyms for explanation of acronyms.

(2) In addition to the VOS fleet, NIWA (New Zealand) in collaboration with CSIRO (Australia) and Scripps Institution of Oceanography (USA) maintain 3 high resolution XBT sections in the Tasman/Coral Sea area.

Terrestrial observing systems

There are approximately 500 stream-flow gauges in operation around New Zealand, and around 300 groundwater monitoring sites. More than half of the stations are operated by NIWA, and the remainder are operated by regional and district councils. More than half of the NIWA stations are funded by the Foundation for Research, Science and Technology, in conjunction with the Climate Network above. The NIWA stream-flow monitoring stations and a river water quality network of over 70 river locations, and their databases, are known as the Water Resources Archive. As with the Climate Network and Climate Database, the Water Resources Archive received its first dollar increase from the foundation since 1994, when funding increased by 30 percent in 2005.This augurs well for the long-term commitment by New Zealand to climate and water resources monitoring at the same spatial levels as in the 1990s. Furthermore, a soil moisture monitoring network has been established (see GCOS Table 12, Note 6).

End-of-summer snowline elevations and photographic images of 50 glaciers from special aircraft flights are available annually since 1979, and the terminus positions of key glaciers in the Southern Alps are available from 1800 to the present.

To meet its Kyoto Protocol commitments, New Zealand is developing a carbon accounting system. This comprises a soil carbon monitoring system and the collection of natural forest, shrubland, and planted forest measurements from permanent plots. Carbon stock changes will be made from these time sequential measurements. The national Land Cover Database developed using SPOT satellite imagery in 1995/1996 was remapped in 2001/2002.

The National Vegetation Survey Databank (NVS) maintained by Landcare Research holds records from approximately 45,000 vegetation survey plots around New Zealand, including 12,000 permanent plots.Landcare Research also maintains five New Zealand long-term ecological research and monitoring sites, and also monitors the presence or range of self-advective fungal and insect species.

The Ministry of Agriculture and Forestry maintains a planted forest cover database, and keeps records of carbon absorbed in new planting and lost through logging, fires and vegetation clearance.

GCOS Table 3: Participation in the global terrestrial observing systems

	Global Terrestrial Network – Permafrost	Global Terrestrial Network – Glaciers	Global Terrestrial Network - Carbon
How many sites are the responsibility of the Party?	Nil	48+ 7	Nil
How many of those are operating now?		48+ 7	
How many are providing data to international data centres now?		48+ 7	
How many are expected to be operating in 2005?		48+ 7	

Supplementary guidance to assist in preparation of detailed national reports on systematic observations

Meteorological and atmospheric composition observations

GCOS Table 4: National climate monitoring systems for land surface (meteorological) observations

Systems [1]	Climate parameters	Total # stations	Appropriate for characterising national climate?			Time series [2] # stations/platforms (#data digitised)			Are QC procedures adequate?			Metadata available? [3] Total # stations (% digitised)	Continuity? [4] # expected operational in 2009
			Fully	Partly	No	> 30y	> 50y	> 100y	Fully	Partly	No		
Stations useful for national climate monitoring purposes (specify parameters observed*)	Air press	4			X	1 (1)	1 (1)			X		4 (100)	4
	Cld layer	2			X	2 (2)				X		2(100)	2
	Desc wx	0											
	Humidity	42		X		11 (11)	11 (11)			X		42 (100)	42
	Prec liq	46		X		10 (10)	11 (11)	4 (4)		X		46 (100)	46
	Radiation	19			X	2 (2)				X		19 (100)	19
	Sunshine	14		X		3 (3)				X		14 (100)	14
	Sfc air TT	48		X		9 (9)	11 (11)	2 (2)		X		48 (100)	48
	Visib	5			X	4 (4)				X		5 (100)	5
	Wind-run	25			X	3 (3)	3 (3)			X		25 (100)	25
	Wind	20			X	2 (2)				X		20 (100)	20
Stations reporting internationally	Air press	30								X			31
	Cld layer	8								X			8
	Desc wx	0											
	Humidity	30								X			30
	Prec liq	30								X			30
	Sfc air TT	30								X			30
	Visib	8								X			8
	Wind	30								X			30
CLIMAT reporting stations	Air press	12				4 (4)	6 (6)	1 (1)		X			12
	Cld layer	5				4 (4)				X			5
	Desc wx	0											
	Humidity	14				4 (4)	9 (9)			X			14
	Prec liq	14				1 (1)	10 (10)	2 (2)		X			14
	Radiation	11				6 (6)				X			11
	Sunshine	4				4 (4)				X			4
	Sfc air TT	14				3 (3)	8 (8)	2 (2)		X			14
	Visib	7				5 (5)	1 (1)			X			7
	Wind-run	11						1 (1)		X			11
	Wind	11				4 (4)	2 (2)			X			11

GCOS Table 4: National climate monitoring systems for land surface (meteorological) observations (cont'd)

Systems [1]	Climate parameters	Total # stations	Appropriate for characterising national climate?			Time series [2] # stations/platforms (#data digitised)			Are QC procedures adequate?			Metadata available? [3] Total # stations (% digitised)	Continuity? [4] # expected operational in 2009
			Fully	Partly	No	> 30y	> 50y	> 100y	Fully	Partly	No		
Reference climate stations	Air press	26		X		9 (9)	7 (7)	3 (3)		X		26 (100)	26
	Cld layer	8			X	7 (7)				X		8 (100)	8
	Desc wx	0											
	Humidity	41		X		12 (12)	18 (18)	1 (1)		X		41(100)	41
	Prec liq	44		X		5 (5)	18 (18)	8 (8)		X		44(100)	44
	Radiation	30			X	9 (9)				X		30 (100)	30
	Sunshine	12			X	1 (1)	7 (7)			X		12 (100)	12
	Sfc air TT	45		X		9 (9)	16 (16)	5 (5)		X		45 (100)	45
	Visib	13			X	11 (11)	1 (1)			X		13 (100)	13
	Wind-run	32			X		7 (7)	1 (1)		X		32 (100)	32
	Wind	30			X	5 (5)	1 (1)			X		31 (100)	31

Notes:

(1) For "Systems", "Stations useful for climate monitoring" are additional stations to those listed in the other three categories. "Stations reporting internationally", "CLIMAT" and "Reference" climate stations may have stations included in more that one category. For "CLIMAT" and "Reference", earlier stations have been checked and periods include early data.

(2) For "Time series (data digitised)", all monthly data done, much daily data still on forms.

(3) For "Metadata available", only basic metadata digitised; some information about instrumentation digitised.

(4) For "Continuity", we do not anticipate changes in instrumentation. We do not anticipate a change in the number of stations.

Source: Data is held in the National Climate Database, National Institute for Water and Atmospheric Research (NIWA), Wellington.

GCOS Table 5: Available homogeneous data sets for land surface (meteorological) observations.

Data set name	Variable	# Stations or grid resolution	Describe period	References
Individual station files	Monthly rainfall	25	Site dependant	NIWA Climate Database, NIWA-Wellington
Individual station files	Monthly mean temperatures	25	Site dependant	NIWA Climate Database, NIWA-Wellington

GCOS Table 6: National climate monitoring systems for upper air observations (meteorological).

Systems useful for national climate monitoring purposes	Total # stations or platforms	Appropriate for characterising national climate?			Time series # stations/platforms (#data digitised)				Are QC procedures adequate?			Metadata available? Total # stations (% digitised)	Continuity? # expected operational in 2009
		Fully	Partly	No	> 5y	> 10y	> 30y	> 50y	Fully	Partly	No		
Radiosonde stations	5		X			2 (2)	3 (3)			X		5 (100)	5
Wind-only stations	6		X		4 (4)	2 (2)				X		6 (100)	6
Stations reporting internationally [1]	8				1 (1)	4 (4)	3 (3)			X			8
CLIMAT TEMP [2] reporting stations	4					1 (1)	3 (3)			X			4
ASAP stations													
Profilers													
Aircraft (land locations) [3]	6				3 (3)								3
GPS													
Others (eg satellite-based)													
Total upper air network			**X**										

Notes:

(1) Stations reporting internationally are a subset of the "Radiosonde stations" plus the "Wind-only" stations.

(2) Climate temperature stations are also recorded in "Radiosonde stations".

(3) Aircraft (land locations) are Aircraft Meteorological Data Relay (AMDR) stations.

GCOS Table 7: Available homogeneous data sets for upper air observations (meteorological)

Data set name	Variable	# Stations or grid resolution	Describe period	References
None				
None				
None				

GCOS Table 8: National climate monitoring systems for atmospheric constituents

Components	Total # stations or platforms	Appropriate for characterising national climate?			Time series # stations/platforms (#data digitised)				Are QC procedures adequate?			Metadata available? Total # stations (% digitised)	Continuity? # expected operational in 2009
		Fully	Partly	No	> 10y	> 20y	> 30y	> 50y	Fully	Partly	No		
CO_2 stations	1	X					1 (1)		X			x	1
Ozone (surface)	7 (1)		X		-				6	1		6 (86)	6
Ozone (column)	2 (1)	X			1 (1)	1 (1)			X			2 (100)	2
Ozone (profile)	1	X				1 (1)			X			1 (100)	1
Atmospheric water vapor	6		X		-				X			6 (100)	6
Other greenhouse gases	3 (1), (2)	X			3 (3)				X			2 (66)	3
Aerosol measurements	2		X		1 (1)				1	1		1 (50)	21
UV radiation	7 (3)		X		3 (3)		1 (1)		X			7 (100)	7

Notes:

(1) One station at Scott Base, Antarctica.

(2) At Bearing Head (42°S): N_2O and CH_4 mixing ratios and stable isotopes. At Lauder (45°S): a wide range of trace gases have been measured by absorption spectroscopy since 1990 – in-situ measurements of O_3, CO, CO_2, CH_4 began in 2004.

(3) Including one station in the Cook Islands and 1 in Fiji.

GCOS Table 9: Available homogeneous data sets for atmospheric constituents

Data set name	Variable	# Stations or grid resolution	Describe period	References
NIWA assimilated data set	Total column ozone	Global daily maps at 1.25° longitude 1° latitude resolution	Nov. 1978 –Dec. 2004	Version 1: Bodeker et al. 2001 Version 2: Bodeker et al. 2005

References:

Bodeker, G.E., J.C. Scott, K. Kreher, and R.L. McKenzie, "Global ozone trends in potential vorticity coordinates using TOMS and GOME intercompared against the Dobson network: 1978-1998", Journal of Geophysical Research, 106 (D19), 23029-23042, 2001.

Bodeker, G.E., H. Shiona, and H. Eskes, "Indicators of Antarctic ozone depletion", Atmospheric Chemistry and Physics, submitted 2005.

Oceanographic observations

GCOS Table 10: National climate monitoring systems for oceanographic observations

Network component	Total # stations	Appropriate for characterising national climate?			Time series # stations/platforms (#data digitised)			Are QC procedures adequate?			Metadata available? Total # stations (% digitised)	Continuity? # expected operational in 2009
		Fully	Partly	No	> 30y	> 50y	> 100y	Fully	Partly	No		
Sea level e.g., tide gauges	15	X			11 (11) (13 years to date)	4		X			11 (100)	12
SST (coastal stations)	13		X		13 (13)			X			13 (100)	13
Meteorological obs from drifting buoys (e.g., temp, precip, pressure)	7			X	7 (7) (20 years to date)			X			7 (1)	7
Sub-surface profiles	3			X								
Ocean circulation	Research mode											
Carbon fluxes	Research mode											
Energy fluxes	Research mode											

Note:

(1) Data from drifting buoys not held in National Climate Database

GCOS Table 11: Available homogeneous data sets for oceanographic observations

Integrated data sets name and brief description	Variable	Platforms and/or grid resolution	Describe period	References
NIWA SST Archive (NSA)	SST (validated)	Retrieved from NOAAs 11, 12, 14, 15, 16. at 1.1 km resolution over a 3504 (3504 grid	1992 to present	Uddstrom, M.J. and Oien, N.O. 1999: "On the use of high resolution satellite data to describe the spatial and temporal variability of sea surface temperatures in the New Zealand Region". Journal of Geophysical Research (Oceans) 104, C9, 20729 – 20751.
NSA Climatology	SST monthly means and anomalies	3504 (3504 by 1.1 km resolution)	January 1992 to present	As above
Drifting Buoy Archive	MSLP, SST, air temp (some u, v)	Meteorological drifters within 4000 km of Wellington	January 1992 to present	As above

Terrestrial observations

GCOS Table 12: National climate monitoring systems for terrestrial observations

Systems useful for national climate monitoring	Total # stations	Appropriate for characterising national climate?			Time series # stations/platforms (#data digitised)			Are QC procedures adequate?			Metadata available? Total # stations (% digitised)	Continuity? # expected operational in 2009
		Fully	Partly	No	> 30y	> 50y	> 100y	Fully	Partly	No		
River discharge (streamflow gauges)	500+ [1]	40	200+		80 (80)	50 (50)		X [2]			X	X (100%)
Ground water storage (e.g. boreholes)	300+	50+	200+		50 (50)	30 (30)			X		50%	90%
Snow	7 [3]		X		7 (7)				X			7
	46 indicator glaciers	X			Since 1979	3 (3)		X			Photographic images	46 indicator glaciers
Glaciers	48 [4]		X		Since 1979			X	X		48 (48)	48
	46 indicator glaciers	X									Photographic images	46 indicator glaciers
Permafrost												
Ice	See glaciers above											
FluxNet												
Radiation	Research mode											
Soil	[5], [6]											

Notes

(1) Reference Pearson, C.P., 'Changes to New Zealand's National Hydrometric Network in the 1990s', Journal of Hydrology (NZ), 37(1): 1-17, 1998.

(2) Reference: Hudson, H.R., MacMillan, D.A., Peason, C.P., 'Quality assurance in hydrological measurement', Hydrological Sciences – Journal – des Sciences Hydrologiques, 44(5), 1999.

(3) Snow observations of snow depth, water equivalent and density are available from selected glaciers and some skifields. Not included are snow estimates made from modelling and satellite analysis. Modelling data of snow covered area and total water stored as snow is available for 1930 to 1998. Satellite observations of snow covered area are available for 1985 to 2004.

(4) Data for New Zealand glaciers is available from 3 sources: end of summer snowline elevations (a surrogate for mass balance) for the period 1978–2001; terminus position of key glaciers in the Southern Alps available from 1800–2001; and photographic images of 46 glaciers made each year from special aircraft flights from 1979 to the present.

(5) A soil carbon monitoring system for New Zealand using country-specific land use and soil carbon information has been developed. The system pre-stratifies the country by soil type, climate, and land-use. Soils were placed in six IPCC soil categories; Podzols were added as they are widespread throughout New Zealand. Temperature was stratified into two categories, each spanning 7°C. Moisture categories were based on water balance, and included five categories. Temperature and moisture stratification was based on the USDA Soil Classification system. Land-use (ten categories) was based on 1980s survey data initially, but we now use the national Land Cover Database (LCDB) developed using SPOT satellite imagery for New Zealand in 1995/1996. Overall, 39 combinations of these three factors (cells) described 93% of the New Zealand landscape. Geo-referenced soil carbon data (carbon concentration and bulk density) was used to quantify average soil carbon for each of the 39 cells. Aggregating the polygons gave an estimated 1990 soil carbon baseline of 1152 ± 44, 1439 ± 73, and 1602 ± 167 Mt C (mean ±SD) for the 0–0.1, 0.1–0.3, and 0.3–1.0m depth increments. The system is designed to quantify equilibrium changes in soil C associated with land-use change. Land use is planned to be updated from new LCDB's produced every five years.

(6) A soil moisture monitoring network exists for New Zealand. NIWA implemented the network over the last four years, and to date the network has over 30 sampling locations spread throughout the country. More than half of the soil moisture probes are located at NIWA climate stations. Soil moisture percentages are recorded as time series at 15-minute intervals.

GCOS Table 13: National climate monitoring systems for ecological observations

Systems useful for national climate monitoring	Total # stations	Appropriate for characterising national climate?			Time series # stations/platforms (#data digitised)				Are QC procedures adequate?			Metadata available? Total # stations (% digitised)	Continuity? # expected operational in 2009
		Fully	Partly	No	> 30y	> 50y	> 100y	> 300y	Fully	Partly	No		
Phenological	see note "Phenological"												
Biomass change	see note "Vegetation"												
Vegetation type	1200 see note "Vegetation"		X			1200 (1200)				X		1200 (100)	1200
Land cover	1200 see note "Vegetation"		X			1200 (1200)				X		1200 (100)	1200
Fire distribution													
Land-use change	see note "Forest"												
PaleoClimate	60		X					60	X			60 (50)	60 records
Forest catchment	see note "Forest"		X		1 (1)				X			1 (100)	1

Phenological: Range of phenological series: native plant flowerings; shellfish numbers and depths; penguin numbers. Not yet in systematic data base.

Forest: Purukohukohu Catchment experiment in Puruki catchment from 1968 with soil type and chemistry, biomass productivity, hydrology and rainfall for 3 land use types: (1) native forest, (2) managed pasture, (3) managed pine forest. Measurements through full forest rotation and now in second cycle. Reference: Beets, P.N. and Brownlie, R.K., "Puruki experimental catchment; site, climate, forest management and research", NZ Journal of Forest Science, 17, 137–160, 1987.

Vegetation: The National Vegetation Survey Databank (NVS - 'Nivs') is a physical archive and computer databank containing records from approximately 45,000 vegetation survey plots – including data from over 12,000 permanent plots. NVS provides a unique record, spanning more than 50 years, of indigenous and exotic plants in New Zealand's terrestrial ecosystems, from Northland to Stewart Island and the Kermadec and Chatham islands. A broad range of habitats are covered, with special emphasis on indigenous forests and grasslands The Permanent Plot Data in the archive are from where fixed area plots or transects have been established, and the vegetation has been measured precisely (e.g. tagged trees, sapling and seedling counts, species lists). Assessments of these 12,000 permanent plots in NVS provide the ideal base for monitoring vegetation changes as well as the effects of management. Nearly all follow standard methods, e.g. in forests all trees within a fixed area (usually 400 m^2) are permanently tagged to allow repeat measurements.

Most forest plots contain permanently marked seedling subplots to determine changes in seedling and herbaceous composition with time.

Most are along objectively located transects.

More than 80% have NZMS grid references (for forest plots, >95%).

Reference: *www.landcare.cri.nz/science/nvs/*

GCOS Table 14: Available homogeneous data sets for sustained terrestrial and ecological observations

Data set name	Variable	# Stations or grid resolution	Describe period	References
The National Vegetation Survey Databank	tree diameters	1200	Regular measurement	http://www.landcare.cri.nz/science/nvs/
The National Vegetation Survey Databank	seedling density	1200	Regular measurement	http://www.landcare.cri.nz/science/nvs/
The National Vegetation Survey Databank	plant species composition	1200	Regular measurement	http://www.landcare.cri.nz/science/nvs/

Space-based observing programmes

New Zealand researchers are actively involved with a range of climate change satellite projects with collaborators in the USA, Europe and Japan. Of particular importance is the role New Zealand plays in the validation, and on going calibration, of these satellite experiments through co-relative measurements made in New Zealand and Antarctica. Understanding the internal drift in satellite instrumentation is vital if satellite data are to be used for credible trend analysis.

In addition, the National Institute of Water and Atmospheric Research (NIWA) holds three satellite data archives:

- NOAA HRPT data (in satellite data stream format) 1992–present, for NOAAs 10, 11, 12, 14, 15, 16.
- Geostationary Meteorological Satellite (GMS) data products (imagery), August 1998 to present (including those from the backup of GMS-5 by GEOS-9).
- SeaStar SeaWiFS HRPT data (in satellite data stream format) May 2000 to present[20].

NIWA has developed a one kilometre resolution collocation archive of meteorological radar (three radars), Advanced Microwave Sounder Unit (AMSU) (20 spectral intervals), High Resolution InfraRed Sounder (HIRS) (20 spectral channels), Advanced Very High Resolution Radiometer (AVHRR) (5/6 channels), SST, cloud mask and cloud-type, for all data derived from NOAA15 (from August 1998) NOAA16 (from April 2001 and NOAA17 (from November 2002). This is called the NIWA ATOVS Collocation Archive (NACA) and is being used to develop algorithms that may be used to monitor the hydrological cycle over area of radius 2000 km from Wellington (see Korpela, A.V., and Uddstrom, M.J., 2001: The use of ATOVS, AVHRR and radar data in the development and validation of rain-rate algorithms. In the Technical Proceedings of the Eleventh International ATOVS Study Conference, Budapest, Hungary, 20–26 September, 2000. 12 pp).

Further, NIWA has developed a cloud-type and amount algorithm that will be used during 2001/02 to derive a cloud climatology (at 1 km resolution) over a region of 4672 x 4976 km (centred on New Zealand) and for the period 1992 to the present (Uddstrom, M.J., J.A. McGregor, W.R. Gray and J.W. Kidson: 2001: A high resolution analysis of cloud amount and type over complex topography. Journal of Applied Meteorology 40, 16-33).

NOAA16 AVHRR data will be used to derive high resolution (1 km) daily and weekly snow-cover analyses for the New Zealand region (beginning from April 2001), using a Bayesian method based on the work of M. J. Uddstrom and W. R. Gray (Udstrom and Gray, 1996, "Satellite cloud classification and rain rate estimation using multi-spectral radiances and measures of spatial texture", *Journal of Applied Meteorology,* 35, 839–858).

Glaciers in the Southern Alps are also monitored as part of the international satellite project GLIMS (Global Land Ice Mapping from Space).

[20] SeaStar SeaWiFS HRPT data decrypted until December 2004.

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New Zealand's Report on Demonstrable Progress under the Kyoto Protocol

Introduction

This report on demonstrable progress under Article 3, paragraph 2 of the Kyoto Protocol is being prepared as agreed in Decision 22/CP.7. As further agreed in Decision 25/CP.8 this report contains four chapters:

- Chapter 1. A description of domestic measures, including any legal and institutional steps to prepare to implement New Zealand's commitments under the Kyoto Protocol to mitigate greenhouse gas emissions, and any of its programmes for domestic compliance and enforcement
- Chapter 2. Trends in, and projections of, New Zealand's greenhouse gas emissions
- Chapter 3. An evaluation of how such domestic measures, in light of these trends and projections, will contribute to New Zealand meeting its commitments under Article 3
- Chapter 4. A description of the activities, actions and programmes undertaken by New Zealand in fulfilment of its commitments under Articles 10 and 11.

1. Domestic measures

This chapter presents an overview of New Zealand's domestic climate change policy in place at the end of December 2005. **Reflecting the transitional phase of the Government's climate change policy package at the time of publication, this report does not include further domestic policies and measures that currently are under development.** For more information on the policies themselves, refer to Chapter 4, "Policies and measures" in the *Fourth National Communication.*

Climate change policy package

The Government's climate change policy package was developed during 2001 and 2002, and was announced at the time when New Zealand ratified the Kyoto Protocol. The 2002 climate change policy package involved policies and measures focused on the energy, transport, industry, agriculture, waste and forestry sectors. The 2002 climate change policy package included the introduction of a carbon tax from 2007. Associated Negotiated Greenhouse Agreements were available for firms that met a competitiveness-at-risk test whereby, in exchange for relief from the proposed carbon tax, firms would agree to move towards world's best practice in emissions intensity.

Development of the 2002 climate change policy package involved several rounds of public consultation before final decisions were taken by Government.

As well as outlining New Zealand's climate change policies, the 2002 climate change policy package also noted that it would be important to review the progress of the policy package at regular intervals to monitor progress with emissions reductions, assess the effectiveness of policies, and confirm that New Zealand was positioned to meet its commitments.[21] A full policy review was commissioned by Cabinet in mid-2005 and completed in November 2005.

The policy review concluded that some elements of the 2002 climate change policy package should be modified to better position New Zealand to respond to the longer-term challenges of climate change. A key outcome of the policy review was the announcement by the newly elected Government in December 2005 that the previously announced carbon tax would not proceed. In addition, a suite of future work programmes would be required to inform Government decisions in light of the review and contribute to further development of policies and measures. In that announcement, the Government reaffirmed its commitment to the Kyoto Protocol.

As a result of the policy review, Government officials are undertaking further policy work, in consultation with stakeholders, and will report back to Ministers on a range of work programme areas. At the time of publication of this *Report on Demonstrable Progress,* Ministers had not yet taken decisions on the work programmes. Therefore, this chapter reflects the Government's decision not to proceed with the announced carbon tax, but does not reflect any impact from the new work programmes being considered by the Government at the time of publication.

Energy

The **Sustainable Energy** work programme, within the Sustainable Development Programme of Action, sets the context for the future development of energy policy. At the end of 2005, the Government announced it would develop a National Energy Strategy to provide long-term direction and leadership to put New Zealand firmly on the path to an energy system that supports economic development while being environmentally responsible. It aims to incorporate sustainable development principles in energy policy decision-making and to ensure that New Zealand's energy system is well-positioned to meet present and future challenges, particularly climate change and peak oil.

[21] The Kyoto Protocol commits New Zealand to reducing its greenhouse gas emissions to 1990 levels, on average, over the period from 2008 to 2012, or to take responsibility for any emissions above this level.

The **National Energy Efficiency and Conservation Strategy** promotes energy efficiency, energy conservation and renewable energy. The strategy targets a 20 percent improvement in energy efficiency and a 30 petajoule per year increase in renewable energy by 2012. The Government agreed, in March 2006, to replace the strategy within the next 12 to 18 months. Ongoing programmes related to the National Energy Efficiency and Conservation Strategy include the following:

- **Emprove,** which includes the provision of grants for energy audits, loans to implement energy savings and activities to raise awareness of the opportunities to improve profitability through good energy management
- **Building regulations,** which seeks to make ongoing changes to the Building Code to improve the energy efficiency of residential and commercial dwellings
- **EnergyWise home grants,** which focuses on fitting insulation – as well as other energy efficiency measures – for existing homes
- **Renewable energy to the grid,** which ensures that more electricity generated for the grid or fed into local distribution networks is sourced from renewable energy
- **Market development of renewable energy,** which encourages the uptake of small-scale renewable energy technology through interest-free loans, information provision and education, and supporting market research
- **Demand response,** which identifies and instigates practical measures to facilitate greater demand response within the electricity industry
- **Energy efficiency of products,** which includes minimum energy performance standards and labelling (a regulatory approach); and "Energy Star" voluntary labelling.

Transportation

The **New Zealand Transport Strategy** defines the Government's vision of an affordable, integrated, safe, responsive and sustainable transport system by 2010. One of its five objectives is to ensure environmental sustainability. This includes encouraging more energy-efficient modes of transport.

The **National Rail Strategy** was released in May 2005 and will be implemented by the Ministry of Transport. It sets out the Government's rail policy objectives and priorities for action over the next 10 years and outlines key initiatives that are intended to achieve the outcomes sought. The strategy focuses on growth in two key areas: freight, both bulk and containerised; and urban passenger transport.

Specific programmes in the transport sector include:

- **Air quality,** which aims to improve air quality by introducing mandatory fuel standards and improving the quality of the vehicle fleet
- **Renewable transport fuels,** which aims to increase production and availability of bio-ethanol/petrol blends and biodiesel
- **Information on vehicle fuel efficiency,** which encourages the purchase of fuel-efficient vehicles by providing appropriate consumer purchasing information, covering both new and second hand vehicles
- **Surface transport costs and charges,** which assists the Government to make decisions on the relative competitive position of road and rail for freight transport and of rail, bus and the private car for passenger transport
- **Travel demand management,** which encourages people to use forms of transport that use less energy and reduce their present dependency on the single passenger car
- **Aviation and maritime transport,** which involves periodic communication with the International Maritime Organisation and International Civil Aviation Organisation.

Industry

When the Government completed the review of the climate change policy package in November 2005, it subsequently decided that a new focus will be required to address industry issues more effectively. As a result, the previously announced carbon tax and associated Negotiated Greenhouse Agreements for eligible industrial emitters will not now be introduced. A work programme will examine alternative measures to the announced carbon tax, including consideration of emissions trading and new, possibly voluntary, arrangements to replace Negotiated Greenhouse Agreements.

New Zealand's current climate change policies for industry are focused on the Projects to Reduce Emissions programme, measures to assist energy-intensive businesses, and the National Energy Efficiency and Conservation Strategy (all described elsewhere). In addition, New Zealand has two programmes addressing emissions of fluorinated gases. Under the **sulphur hexafluoride programme,** the Government has exempted users of sulphur hexafluoride from any application of its climate change policies in return for their signature of a Memorandum of Understanding supporting movement towards best practice in managing sulphur hexafluoride emissions.

The **No-loss campaign** programme is aimed at improving the awareness of refrigeration and air conditioning engineers about the greenhouse gas risks associated with fluorocarbon refrigerants.

Agriculture

Until at least 2012, the agricultural sector will be exempt from any charge on the methane and nitrous oxide emissions it produces. There are currently no practicable options for reducing these emissions without reducing output and the industry's international competitiveness. Instead, the Government will cover the full cost of these emissions. The **Pastoral Greenhouse Gas Research Consortium** has been formed with funding from both the Government and the agricultural sector to develop safe, cost-effective greenhouse gas reduction technologies that improve productivity and reduce methane and nitrous oxide emissions from livestock. The Consortium aims to achieve a 20 percent or greater reduction in these emissions below business as usual by 2012.

A programme was undertaken from 2001 to 2005 to provide **support for improvement of the agricultural sector national greenhouse gas inventory.** The objective of this programme was to systematically reduce uncertainties and improve the estimates of agricultural methane and nitrous oxide national inventory estimates, for the purpose of reporting to the United Nations Framework Convention on Climate Change and fulfilling other reporting requirements.

Waste

The **New Zealand Waste Strategy** aims to minimise New Zealand's waste and improve recovery and management, including encouraging the use of landfill gas for electricity generation.

A **national environmental standard** requires landfills with a lifetime design capacity exceeding one million tonnes and a current stock capacity of 200,000 tonnes to collect and destroy landfill gas. The standard is expected to prevent around 40,000 tonnes of methane being emitted over the first commitment period.

Methane emissions from wastewater are addressed by local authorities, some of whom extract methane from wastewater treatment plants and use it for generating electricity, heating boilers and heating digesters.

Land use, land-use change and forestry

Between 1990 and 2003, it is estimated that 660,000 hectares of new forest was established as a result of afforestation and reforestation activities. Chapter 3 "Greenhouse gas inventory" and Chapter 4 "Policies and measures" of the *Fourth National Communication* provide further detail. In the Government's 2002 climate change policy package, the Government announced that it would retain all sink credits and their associated liabilities in respect of Kyoto production forests (i.e., forest plantings post-1990) for at least the first commitment period of the Kyoto Protocol. The Government would also retain the liability for deforestation of pre-1990 forests up to a cap of 21 Mt CO_2 during the first commitment period. The Government is currently considering a work programme on forestry policy options for managing deforestation and encouraging afforestation and reforestation.

The **Permanent Forest Sinks Initiative** proposed by the Government would allow landowners the opportunity to access the value, created under the Kyoto Protocol, of carbon from newly established permanent forest sinks. The Crown would agree to devolve an amount of tradable carbon emission units equal to the amount of carbon sequestered in new permanent forest sinks over the Kyoto Protocol's first commitment period. Obligations under the contract would be registered against land titles and would run with and bind the land. These forests must maintain a continuous canopy cover, although limited timber harvesting is allowed.

Under the **East Coast Forestry Project,** landholders in the specified area are encouraged to tender for Government grants which help fund the cost of establishing and managing forest on severely erosion-prone land. This financial assistance offsets the additional costs and risks associated with afforestation on this land. The project allows a range of treatments to be applied to erosion-prone land including commercial forestry, poplar and willow planting, and the setting aside of areas for regeneration of native forests.

Cross-sectoral policies and measures

Under the policy for **energy intensive businesses,** assistance in the form of energy audits, financial grants, demonstration projects, education and training is available for energy-intensive small and medium enterprises.

The **Projects to Reduce Emissions** programme supports projects that will reduce New Zealand's emissions during the first commitment period. The programme uses a competitive tender to allocate tradable entitlements to Kyoto emission units to successful projects following an additionality and eligibility assessment. The project portfolio comprises 41 projects selected through two tender rounds and an early projects process, and nearly 11 million emission units[22] have been allocated. Following the review of climate change policies in November 2005, the Government has sought confirmation that there is a need for further cross-sector incentives, and if so what type of intervention is appropriate. A work programme will address this issue. The Government's consideration of future policy in this area will not affect the implementation of projects already undertaken to date under the Projects to Reduce Emissions programme.

[22] An emission unit is equivalent to one tonne of carbon dioxide equivalent.

Local government

A **partnership programme between the Government and Local Government New Zealand** coordinates the two-way flow of information and dialogue on climate change policy and programmes between central and local government. The partnership also assists in alerting the local government sector to wider funding opportunities.

The Government has introduced a **Communities for Climate Protection™ – New Zealand programme.** Based on a model that has proven successful in other countries, this programme helps local councils develop greenhouse gas emission inventories, set targets for emission reductions, and devise action plans for achieving them. The programme monitors the reductions achieved.

The **Resource Management Act** has been amended to reflect the focus on nationally based policies to manage greenhouse gas emissions, rather than reliance on regional controls. The Act also now requires special consideration to be given to renewable energy and the efficiency of the end use of energy. It is important to note that the Government's decision not to proceed with the announced carbon tax in December 2005 could affect the operation of the amended Resource Management Act. This issue will be addressed by Government officials in the new work programmes currently under development.

Bilateral climate change partnerships

New Zealand has established **bilateral climate change partnerships** with the United States of America and Australia. The partnerships enhance and accelerate collaboration and practical cooperation on climate change issues.

Public awareness and education

A public awareness and education programme entitled **"4 Million Careful Owners"** aims to raise public awareness about climate change and the actions New Zealanders can take to reduce greenhouse gas emissions (see *http://www.4million.org.nz*).

Response to the climate change policy review

As noted above, a full policy review was commissioned by Cabinet in mid-2005 and completed in November 2005. Updated commitment period projections completed in May 2005 indicated that under current policy settings, New Zealand would not meet its emissions reduction target for the first commitment period (2008-2012) of the Kyoto Protocol unless further action was taken.

The climate change policy review investigated how New Zealand should respond to the projected deficit against the Kyoto target and gave consideration to New Zealand's high-level climate change goal: "to be set towards a permanent downward path for total gross emissions by 2012." The review was designed to identify (at a high level) an appropriate mix of policies for New Zealand up to 2012 and beyond. The review addressed the following types of questions:

- What is the best balance between further mitigation policies and Kyoto flexible mechanisms?
- Who is best placed to undertake decisions about this balance?
- How would any devolution of New Zealand's emission reduction obligations be achieved?
- What should the broad direction of any further, or alternative, policies to mitigate New Zealand's emissions be?
- What are the implications of these policies for New Zealand's strategic climate change goal and does this need to be updated?

The review report has been publicly released and can be found at *http://www.climatechange.govt.nz/resources/reports/policy-review-05/index.html.*

As noted above, as an outcome of the review the Government announced in December 2005 that it would not proceed with the previously announced carbon tax. The Government is currently considering other ways to ensure that New Zealand will meet its commitments to reduce greenhouse gas emissions. Officials are undertaking further policy work, in consultation with stakeholders, and will be reporting back to Ministers on a range of areas including:

- providing incentives for investment in renewable energy
- encouraging new tree planting and reducing deforestation
- improving fuel efficiency of the transport fleet
- assessing alternative measures to the announced carbon tax, including consideration of emissions trading and new, possibly voluntary, arrangements to replace Negotiated Greenhouse Agreements
- improving energy efficiency and conservation.

Compliance provisions relating to the climate change policy package

Projects to Reduce Emissions

Once a project has been approved for the Projects to Reduce Emissions programme, the Crown enters into a Project Agreement (contract) with the Participant. The Project Agreement provides that the Participant must demonstrate compliance with their obligations under the agreement by delivering:

- a milestone report within 20 business days of completion of a milestone. The milestone report must provide confirmation of the completion of a milestone
- an interim milestone report, if a milestone has not been completed by the due date, within 20 business days. The interim milestone report must provide progress towards the completion of the milestone, reasons for the delay in completion and the date by which the Participant expects to complete the milestone
- an annual report for each year, beginning in the year that emissions abatement commences through to 2012, to be delivered by 31 January the following year.

The Annual Report must include:

- tonnes of carbon dioxide equivalent emissions reductions resulting from the Project during the year, determined in accordance with a specified methodology for determining the emissions reductions, which is a schedule to the Project Agreement
- where another measure is used as a proxy measure to determine the emissions reductions, then the quantum of that measure is also reported, along with information to support this
- details of anything which the Participant is aware of that is, or has the potential to be a material impediment to achieving emissions reductions during the commitment period.

In relation to any report (including milestone reports, interim milestone reports and annual reports), the Crown has the right to request further information, or an audit by an independent person appointed by the Participant and approved by the Crown to verify any information contained in any report.

The Crown also has the right to initiate the verification process to verify whether the participant has complied with the agreement. This includes the right to:

- inspect the Project and interview the Participants personnel
- make copies of any documents, records or data
- appoint a delegate to undertake the verification of each report.

In addition to the above reporting requirements, Participants are to provide advice to the Crown, within 10 business days, on any material impediments to the implementation or operation of the Project.

Legal and institutional steps

It is well-established constitutional practice that New Zealand only ratifies an international treaty after it has in place the legislative and other measures necessary to enable full compliance with the treaty once it is in force for New Zealand. The Climate Change Response Act 2002, which passed into law in November 2002, provides for all the measures required to implement the legal obligations of the Kyoto Protocol that were not provided for in existing New Zealand law.

The Climate Change Response Act establishes the institutional arrangements needed under the Kyoto Protocol as well as containing compliance provisions. Its purpose is to enable New Zealand to meet its international obligations under the UNFCCC and the Kyoto Protocol, including the obligation to retire units equal to emissions in the commitment period, and the obligation to report to the Conference of the Parties and the Conference of the Parties/Meeting of the Parties under Article 12 of the UNFCCC and Article 7 of the Kyoto Protocol respectively.

Role of the Minister of Finance

The Climate Change Response Act gives powers to the Minister of Finance to carry out trading activities with respect to units, and to give direction to the Registrar regarding the establishment of accounts and the recording, issuance, and transfer of units.

The Registry

The Climate Change Response Act describes the purpose of the Registry which is to ensure the accurate accounting of units and to ensure accurate, transparent and efficient exchange of information between New Zealand's registry and those of other countries, and with the independent transaction log. The Climate Change Response Act also provides for the appointment of a Registrar and describes the Registrar's responsibilities, including maintaining the commitment period reserve.

The form and operation of the unit register is specified in some detail in the Climate Change Response Act, including the accessibility of account information via the Registry's internet site.

The Climate Change Response Act is currently in the process of being amended (Climate Change Response Act Amendment Bill) to allow the Crown to transfer emission units to businesses and individuals and to allow those businesses and individuals to hold accounts in the Registry and to trade in emission units.

Inventory agency

The Climate Change Response Act establishes the Ministry for the Environment as the inventory agency. The primary functions of the inventory agency are specified to include the estimation of emissions and removals of greenhouse gases in New Zealand and preparation of New Zealand's annual inventory report, national communication and the report for calculation of assigned amount under Article 7.4 of the Kyoto Protocol. Under the Climate Change Response Act, the inventory agency must identify source categories, collect data, estimate emissions and removals, undertake uncertainty assessments, undertake procedures to verify the data, and archive information and documents that show how the estimates were determined. These functions closely align with the national system requirements under Article 5.1 of the Kyoto Protocol.

Compliance

The compliance provisions of the Climate Change Response Act are there to ensure that New Zealand can still report a complete greenhouse gas inventory even if current voluntary and cooperative systems for the collection of information were to break down. These provisions cover the power to enter land or premises to collect information on which the estimates of emissions and removals are based, as well as provisions for the way in which this power may be exercised. The Climate Change Response Act also covers offences and penalties including for the failure to provide information to the inventory agency, and for wilful interference with any survey, investigation or test carried out under the Act.

Regulations can be made under the Climate Change Response Act for a range of purposes including in relation to the powers of the Minister of Finance, the operation of the registry, and to require persons to provide information to the inventory agency for the purpose of estimating emissions and removals of greenhouse gases.

2. Trends in, and projections of, greenhouse gas emissions

The trends and projections described in this chapter are based on the information in Chapter 5, "Projections and the total effect of policies and measures," of the *Fourth National Communication,* and in part on the report *Projected Balance of Units During the First Commitment Period of the Kyoto Protocol* published by the Ministry for the Environment in May 2005. Emissions and removals are projected for the energy, transport, industrial processes, agriculture, waste, and forestry (i.e., land use, land-use change and forestry, or LULUCF) sectors.

The projections of greenhouse emissions sources and removals included in this report as well as the *Fourth National Communication* conform to the definition of the "with measures" projection. **It is important to note that the projections reported in this document reflect the Government's decision not to proceed with the previously announced carbon tax in December 2005, but do not reflect any impact from the new work programmes being considered by the Government at the time of publication. The projections therefore reflect the climate change policy settings in place at the end of 2005.** The projected balance of units report will be officially updated in mid-2006 and will take into account the effect of policy developments following the 2005 climate change policy review.

National trends in New Zealand's emissions and removals

The summary by gas and trend tables from the 2003 Common Reporting Format are provided in Annex 1 of the *Fourth National Communication.* More detailed information on national trends in emissions and removals can be found in Chapter 3 "Greenhouse gas inventory" of the *Fourth National Communication.*

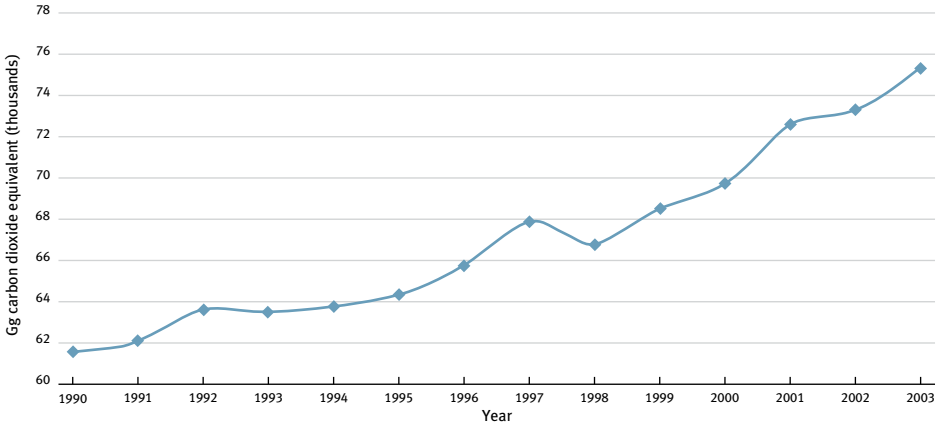
In 1990, New Zealand's total greenhouse gas emissions (excluding net removals from the LULUCF sector) were equivalent to 61,525 gigagrams of carbon dioxide (Gg CO_2). In 2003, total greenhouse gas emissions (excluding net removals from the LULUCF sector) were 75,345 Gg CO_2 equivalent, equating to a 22.5 percent rise since 1990 (RDP Figure 1). Net removals from the LULUCF sector (including emissions of methane and nitrous oxide) increased from 21,366 Gg CO_2 in 1990 to 22,862 Gg CO_2 in 2003. The LULUCF figures include both pre- and post-1990 forests.

Fluctuations in the trend are largely driven by emissions from electricity generation. This category can show large year-to-year fluctuations because of the use of thermal stations to supplement the hydroelectric generation, which cannot meet the demand for electricity during dry years.

Hydroelectricity generation in New Zealand is predominately flow of river with limited hydro storage. Generation in a year with normal rainfall requires lower gas and coal use and a year with less rainfall requires higher gas and coal use. This is a different trend from the steady increase in emissions from coal and gas used in electricity generation found in many other countries.

There have also been changes in the relative amounts of the different greenhouse gases emitted. Whereas methane (CH_4) and carbon dioxide (CO_2) contributed equally to New Zealand's emissions in 1990, carbon dioxide is now the major greenhouse gas in New Zealand's emissions profile (RDP Table 1). This is attributed to increased growth in the energy sector compared to the agriculture sector. However, the agriculture sector continues to dominate New Zealand's emissions profile in that 49.4 percent of total emissions in 2003 were produced by the agriculture sector (RDP Figure 2).

RDP Figure 1: New Zealand's total greenhouse gas emissions 1990 – 2003



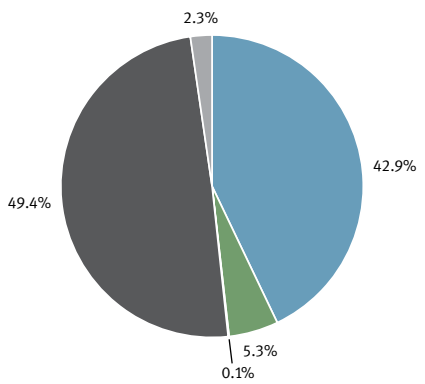
Source: Ministry for the Environment (2005b)

RDP Table 1: Emissions of greenhouse gases in 1990 and 2003

Greenhouse Gas Emissions	Gg CO_2 equivalent		Change from 1990 (percent)
	1990	2003	
Net CO_2 emissions / removals	3,944.36	11,833.84	200.02
CO_2 emissions (without LULUCF)	25,314.81	34,699.55	37.07
CH_4	25,283.98	26,644.97	5.38
N_2O	10,398.71	13,499.53	29.82
HFCs	0.00	403.96	NA
PFCs	515.60	84.90	-83.53
SF_6	12.33	12.38	0.39
Total emissions without CO_2 from LULUCF	**61,525.43**	**75,345.29**	**22.5**

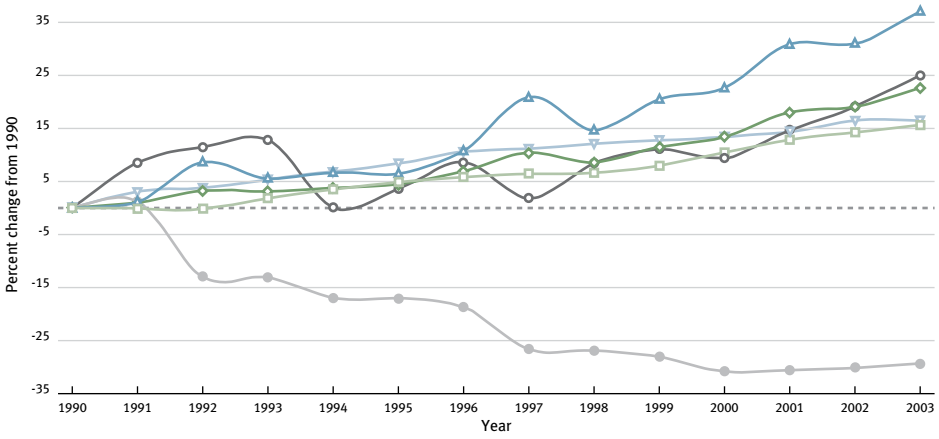
Source: Ministry for the Environment, 2005b

RDP Figure 2: New Zealand's sectoral emissions in 2003 (all figures Gg CO_2 equivalent)



Source: Ministry for the Environment (2005b)

RDP Figure 3: Percentage change in greenhouse gas emissions by sector 1990 – 2003



Source: Ministry for the Environment (2005b)

Percentage changes in greenhouse gas emissions by sector are illustrated in RDP Figure 3 relative to the 1990 baseline.

Projected emissions and removals in the period 2008 to 2012

Projected total emissions over the first commitment period of the Kyoto Protocol are a combination of emissions from the energy, industrial processes, agriculture and waste sectors. Emissions are projected for the mid-point of the first commitment period (2010). This value is multiplied by five to obtain total emissions over the first commitment period. Three scenarios – a pessimistic, most-likely, and an optimistic scenario – are used to assess uncertainty in the projection.

For domestic purposes, New Zealand updated its projected emissions and removals of greenhouse gases for the first commitment period (2008–2012) of the Kyoto Protocol in May 2005 *(Projected Balance of Units During the First Commitment Period of the Kyoto Protocol)*. The emissions calculation was consistent with the methodology used for the national inventory of greenhouse gas emissions and removals submitted to the United Nations Framework Convention on Climate Change Secretariat in April 2005.

The update also contained a report of projected removal units from Article 3.3 forests. The May 2005 projected balance of units report remains the official reference for projections until updated in mid-2006.

However, for the purpose of submitting the best available information for the *Fourth National Communication* and the *Report on Demonstrable Progress under the Kyoto Protocol* as of December 2005, officials prepared a **provisional** update of the May 2005 projections to reflect the policy status following the 2005 review, namely the removal of the carbon tax and associated Negotiated Greenhouse Agreements. The projections do not reflect any new policies under consideration by the Government following the 2005 policy review. The provisional projections reported in this document will be updated in mid-2006.

Under the policy settings in effect as of the end of December 2005, New Zealand's total emissions of greenhouse gases (excluding net removals from the LULUCF sector) were projected to increase to 82,431 Gg CO_2 equivalent in 2010, compared to the 1990 level of 61,521 Gg CO_2 equivalent and the 2003 level of 75,341 Gg CO_2 equivalent.

Over the five years of the first commitment period, total emissions were therefore projected to be 412,156 Gg CO_2 equivalent (412.2 Mt CO_2 equivalent).[23] Based on the provisional update, net removals from the LULUCF sector were projected to be 9,597 Gg CO_2 equivalent in 2010, compared to the 1990 level of 21,366 Gg CO_2 equivalent and the 2003 level of 22,861 Gg CO_2 equivalent. These net removals were calculated using the prescribed IPCC national inventory methodologies, and do not conform with the LULUCF eligibility criteria for the crediting of removals under Article 3.3 of the Kyoto Protocol.

RDP Table 2 presents provisional projections for emissions and removals in 2010 by sector. Historical data for 1990-2003 are provided for reference.

RDP Table 2: Projected emissions of gases and sources listed in Annex A of the Kyoto Protocol in 2010 (Gg CO_2 equivalent)

	1990	1995	2000	2003	2010
Energy	23,594.1	25,072.5	28,905.8	32,320.9	36,230.2
Industrial processes	3,211.7	3,325.2	3,511.7	4,014.2	4,325.7
Solvent and other product use	41.5	45.0	47.1	48.4	52.3
Agriculture	32,193.8	33,770.3	35,509.2	37,203.2	40,476.0
Forestry (LULUCF)	-21,366.2	-14,645.9	-22,818.9	-22,861.6	-9,596.9
Waste	2,480.1	2,058.7	1,717.4	1,754.5	1,347.1
Total emissions (excluding net emissions from forestry)	**61,521.2**	**64,271.7**	**69,691.2**	**75,341.2**	**82,431.3**
Total emissions (including net emissions from forestry)	**40,155.0**	**49,625.8**	**46,872.3**	**52,479.6**	**72,834.4**

Sources: Ministry of Economic Development, Ministry of Agriculture and Forestry, and Ministry for the Environment

[23] Note that 1,000 gigagrams (Gg) equals 1 megatonne (Mt).

RDP Table 3: Calculation of projected removal units (Mt CO_2 equivalent)[24] in CP1 (figures have been rounded)

Projected removal units in CP1	Mt CO_2 equivalent		
	Pessimistic	Most likely	Optimistic
Total sequestration combined with new planting rates (0, 10k and 30k ha/yr)	91.9	95.3	102.0
Loss of soil carbon with afforestation	-8.6	-2.2	0
Natural scrub meeting Kyoto Forest definition	0	0	3.75
Planted forest not meeting the Kyoto Forest definition	-19.3	-14.7	-7.4
Burning of scrub for forest planting	-1.25	-1.25	-1.25
Deforestation emissions	-21.0	-6.3	-6.3
Total removal units	41.8	70.9	90.8
Likely total removals from simulations (95% CI around mean)	**48.1**	**67.8**	**85.6**

Source: Ministry for the Environment, 2005c

As noted above, New Zealand's May 2005 report on the *Projected Balance of Units During the First Commitment Period of the Kyoto Protocol* included an accounting of projected removals from Kyoto forests under Article 3.3 of the Kyoto Protocol during the first commitment period (2008-2012). This projection is reported in RDP Table 3.

New Zealand's assigned amount for the first commitment period is five times the 1990 emissions level, or 307.6 Mt CO_2 equivalent. Additional detail on New Zealand's balance of units under the policy settings prior to the 2005 review is provided in the May 2005 report.

Uncertainty in the projections reflects the difficulty in modelling the complex interactions of the New Zealand energy sector, projecting agricultural markets and animal productivity, estimating the reductions from the climate change policy package and predicting removals from forest sinks prior to the New Zealand Carbon Accounting System being fully operational. In addition, a review has highlighted that a number of improvements are required in the model used for carbon dioxide emissions from the energy and industrial processes sector.

The updated projections show a substantial decrease from the 32.6 Mt CO_2 equivalent surplus during the first commitment period that was reported in the previous projection (May 2004) and the 55 Mt CO_2 equivalent surplus projected prior to ratification of the Kyoto Protocol. The decrease from the 2004 projection is due primarily to an increase in projected energy and industrial processes emissions and a decrease in the removals via forest sinks. The decrease in removals is due to the quantification of previously unknown risks and updating of previous estimates with improved scientific information.

3. How measures contribute to meeting commitments

The projections described above include the estimated impacts of the climate change policy settings as of the end of December 2005. These settings do not include new policies and measures under consideration.

Energy sector

The projected emissions from the energy and industrial processes sectors are a product of modelling the complex interactions of the New Zealand energy sector. The scenarios evaluated are not an attempt to project what will actually happen in the energy sector; rather they attempt to provide a range of possible outcomes under a number of different assumptions.

[24] Note that 1,000 gigagrams (Gg) equals 1 megatonne (Mt).

The abatement from some policies in the climate change policy package that impact mainly on the energy sector but that are not easily included in the energy sector modelling are deducted from model runs separately. The energy sector projections reflect the combined effect of the Projects to Reduce Emissions programme, the National Energy Efficiency and Conservation Strategy, local government initiatives, and the energy-intensive small and medium enterprises and business opportunities programme.

Agriculture sector

The projections of emissions from the agriculture sector in the period 2008 to 2012 do not include any potential impacts of the work undertaken by the research consortium. The potential of technologies to reduce emissions in this sector is more likely to be in the longer term, rather than in the next five years. New products currenty entering the market will lower the emissions intensity of agriculture, but as yet the impacts have not been quantified.

Waste sector

The projections for emissions from the waste sector reflect the effects of the New Zealand Waste Strategy and the national environmental standard for landfill gas collection. Since 1990 there has been a large decrease in emissions due to decreased waste volumes and less organic matter entering landfills. The New Zealand Waste Strategy and the national environmental standard for landfill gas collection are projected to further decrease emissions from waste.

Land use, land-use change and forestry sector

The projections of removals of carbon dioxide via forest sinks reflect consideration of three scenarios of new forest planting (zero, 10,000 and 30,000 hectares per year). Current planting rates are around 10,000 to 15,000 hectares per year. The historical average planting rate is around 40,000 hectares per year meaning that the estimate of 10,000 hectares per year is low in the historical context. The projections include emissions from deforestation and from the burning of scrub prior to forest planting. At this stage no estimate has been included in the projections for the Permanent Forest Sinks Initiative.

4. Actions and programmes under Articles 10 and 11 (technology and other cooperation; financial resources)

These actions and programmes are described in full in Chapter 7, "Financial resources and transfer of technology", of the *Fourth National Communication*.

In summary, New Zealand is particularly focused on helping to meet the concerns and needs of Pacific Island countries – these countries are on the front line of climate change impacts. New Zealand contributes to the Global Environment Facility and makes financial contributions to a number of other multilateral funds and programmes.

In 2001, New Zealand joined with several other countries in a Political Declaration on Financial Support for Developing Countries. New Zealand's share of this voluntary commitment is NZ$5 million per year from 2005. The voluntary commitment comprises the proportion of funds from New Zealand's total Global Environment Facility contribution that is likely to be spent on climate change projects; the New Zealand Agency for International Development's (NZAID) climate change-related support in the Pacific;

funding for lump sum contributions to one or more of the UNFCCC funds; and funding for ad hoc contributions towards projects which advance international action to address climate change.

New Zealand recognises its commitments under Article 10 to take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. New Zealand does this primarily through the work of NZAID.

New Zealand also contributes through various Global Climate Observing System-related initiatives in the Pacific region; for example, supporting initiatives to restore and upgrade the regional upper-air networks, produce a Pacific regional climate bulletin, recover historical climate data, and assist with capacity building in Pacific Island hydrological and meteorological services.

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